

**MOBILE EDUTAINMENT AR TREASURE HUNT APPLICATION**

**BY**

**CHONG JIA NI**

**A REPORT**

**SUBMITTED TO**

**Universiti Tunku Abdul Rahman**

**in partial fulfillment of the requirements**

**for the degree of**

**BACHELOR OF COMPUTER SCIENCE (HONOURS)**

**Faculty of Information and Communication Technology**

**(Kampar Campus)**

**JANUARY 2021**

## REPORT STATUS DECLARATION FORM

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\_\_\_\_\_  
(Supervisor's signature)

Address:

H2, Taman Bukit Bidor  
35500 Bidor,  
Perak

Tan Joi San  
\_\_\_\_\_  
Supervisor's name

Date: 16/4/2021

Date: 16th April 2021

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Signature :  \_\_\_\_\_  
Name : Chong Jia Ni  
Date : 16/4/2021

## **ACKNOWLEDGEMENTS**

First and foremost, I would like to express my sincere gratitude to my FYP supervisor, Dr. Tan Joi San for her advisory and guidance throughout the project development. Without her assistance and support, this project would not have been accomplished as expected. Her willingness to guide and keep reminding me as well as the constructive suggestions given to me, I do really appreciate from the bottom of my heart. I would also like to thank my friends for giving me useful suggestions so that I can further enhance and optimize my project. Lastly, I would also like to express my appreciation to my parents for keep supporting me in completing this project whenever I encounter any issues.

## ABSTRACT

Mobile Edutainment AR Treasure Hunt is a virtual treasure hunt simulation game by implementing Augmented Reality (AR) feature into the application. Treasure hunt is being known by the public since long time ago. In western country, this game is being adopted widely in education field particularly in pre-school due to their education nature that promoting creative learning process compared to eastern country that mostly implementing practical-based learning method. Due to different education systems, the learning process in eastern country tend to be rigid and lack of interactivity causing most of the children lost their motivation to learn. Henceforth, this treasure hunt application is developed to improve the interactivity of learning through gaming in order to boost children motivation to learn as well as to conduct a favourable and interesting learning process for children. With the transformation of digital technology, treasure hunt now can be implemented virtually through mobile application platform. In this application, both “Creator” (the one creates treasure hunt) and “Player” roles can be performed in one mobile platform. The “Creator” can hide the treasures through phone camera and set clues and questions. After done with the setting, the “Creator” then can pass to the “Player” to play. Hence, through this application, user can play treasure hunt effortlessly without having to prepare clue cards and treasures then find a place to hide it which requires lots of effort. To achieve the hiding of virtual treasure into the real world through camera, AR technique is used. The AR feature in this application is implemented through Vuforia which is an AR SDK for user to bring the virtual object into a real world. Last but not least, in order to integrate 3D model, animation and audio effects for a game, Unity game engine is used with the Vuforia SDK to develop this treasure hunt application.

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## LIST OF ABBREVIATIONS

<i>AR</i>	Augmented Reality
<i>VR</i>	Virtual Reality
<i>2D</i>	Two Dimensional
<i>3D</i>	Three Dimensional
<i>SDK</i>	Software Development Kit
<i>JDK</i>	Java Development Kit
<i>SDLC</i>	Software Development Life Cycle
<i>IOS</i>	iPhone Operating System
<i>UWP</i>	Universal Windows Platform
<i>APK</i>	Android Application Package
<i>Q&amp;A</i>	Question and Answer

## CHAPTER 1 INTRODUCTION

### 1.1 Problem Statement

Nowadays, as technology evolved, many countries have reformed their education system, shifting from traditional education towards modern and smart education system. However, some countries still adopting the traditional education system. For instance, education system in Malaysia. Although education system in Malaysia has continue to evolve, more and more digital elements are being introduced and used to bring a new learning experience. However, Malaysia still has not improve much. This is because Malaysia still adopting a traditional and standard teaching method which instead of emphasizing on creativity and cultivating love in learning, the current system tends to spoon feeding the students and follow strictly on the syllabus in order to fulfil the industrials' expectation (School Advisor, 2020). The most concern priority in current education system is the academic achievement. Because of these, students started to lose interest in learning because learning for them is to hit a good result in exams and getting a well-looked certificate. They can't find joy but instead stress in learning (Rafidi, 2020).

#### **1. Lack of interactivity in traditional teaching and learning process.**

As mentioned above, spoon-feeding has become the common teaching method in Malaysia education system. This passive learning method has greatly reduced the interaction and engagement of students in the class as most of the teachers just merely teach according to the syllabus and provides any solution with explanation. While the students behind just busy to take note of it. Not only that, the conventional teaching method using textbooks is lack of interactive and interesting contents. It cannot be denied that textbook is important in teaching as a supplement of knowledge. However, the overload information and lack of interactive contents which mainly are text-based in a textbook cause student find it difficult to understand and concentrate. Worse still, with the spoon-feeding teaching method, students tend to memorise the textbook instead of understanding it (Inspiration Education, 2018). Hence, it promotes a thinking laziness behaviour among the student. Instead of thinking creatively and critically, students just merely accept it as everything has just provided to them.

## **2. Loss of motivation due to boring and overloading teaching method.**

Current education in Malaysia has caused students losing motivation to keep learning. The passive learning environment where teachers teach and students listen in the classroom and strictly following the syllabus has caused the learning process become tedious and less interesting. Not only that, education system in Malaysia as mentioned above is focused on academic performance, hence students always have to do many exercise and face lots of tests and exams. This has given lots of pressure to a student and even plant a seed of phobia within them (Rafidi, 2020). According to Ann (2019), she stated that even in majority preschool teachers, they only prioritise on completing workbooks and activity exercise and they fail to implement “play” in teaching process which “play” is important to raise a kid’s passion to learn starting from young. Therefore, students gradually loss their motivation to learn as they cannot find joy in learning process. Learning for them is just a must to get good grade. They are not enjoying it.

### **1.2 Background and Motivation**

Growing up with modern technology era, education is transformed. The purpose of education is not just only to impose a set of theory, knowledge and skills on children but it is to inspire the children to learn and think while discovering their great talents. And here comes the edutainment arise in teaching and learning process. Edutainment is simply the combination of education and entertainment. It is a platform to play and learn at the same time. It has becoming a trend because of the breakthroughs in fusion of digital technology, animations and multimedia that provide a platform in making the learning process even more interesting and interactively to motivate the children to learn (Delhi, 2019).

Comparing to traditional education that emphasize on compliance and achievement especially in result, it has caused the students to struggle in learning due to loss of motivation and interest as well as it has driven a fear of learning due to intense tests and exams (Soulunii, 2019). Therefore, entertainment feature is started to involve and one of the features is by adopting games in learning.



Game-based learning has been introduced and studied for past decades. The only difference comparing to current method is the use of technology to promote a new version of game-based learning method. In the past, traditional games like chess, cards and board games were included in teaching process to teach students to think strategically. Nowadays, instead of traditional game, digital games are involved. A research had been done and it found that by adopting digital games such as educational video game in learning process is able to engage students in critical thinking about what they have studied, improve learning motivation, enhance collaboration with peers as they might need to work as a team to score the game and improve their learning achievement (Sung & Hwang, 2012). For instance, the prominent video game “Minecraft”. Many may argue that Minecraft is actually wasting a child time and cause a child addict on it. However, if looking at it in another perspective, Minecraft is actually a good learning tool as it helps to brainstorm and discover a child unlimited creativity and thinking skill. It helps a child to think out of the box on creating a new thing and discover its own solution to create whatever he/she can imagine (Cabral, 2014).

In this project, an edutainment game-based learning application is developed and the game feature selected is the adoption of treasure hunt. This learning application is to provide a playable learning platform to motivate children to learn as well as provide an interactive teaching method for both parents and teachers.

Treasure hunt is a well-known game that can be played in anywhere where the participants have to solve the clues provided to look for the objects. Adoption of treasure hunt game in education especially for preschool has becoming a basic for the children. During preschool, children started to learn and discover new things. If we keep adopting the traditional teaching method which to keep spoon-feeding a kid, it will cause the kid to relay on whatever provided to them and refuse to think on his/her way. By implementing treasure hunt game, it provides the children an opportunity to truly discover and explore on their own, think to solve the problem as well as learn to work as a team. All these skills are important to a child as it will be carried up a long way to help them as they grew up. Not only that, it also ignites a child’s passion to learn because the learning process becomes attractive and interesting. Hence, it motivates a child to keep learning (Scavenger Hunt Ideas, 2018).

With the rapid advancement in technology, treasure hunt can be enhanced to bring up a whole new learning experience via the adoption of augmented reality (AR). AR is a technology that allows us, the real-world environment to interact with the digital elements. With the rise of mobile, implementation of mobile AR has becoming even bigger and easier as mobile will soon become the mainstream platform in the community (Merel, 2017). One of the incredibly famous implementations of AR is Pokemon Go. Because of this application, it had brought the mass awareness of AR into the society and worldwide. People around the world started to realize AR and how futuristic is it to apply in different area. Pokemon Go has become a precedence for adopting AR in gaming sector and creating a whole new experience. Just imagine how success Pokemon Go making people goes crazy on it. Therefore, by incorporating treasure hunt with AR feature for education purpose will surely make the learning process more interesting and interactive.

### **1.3 Project Objective**

In this project, objectives are discussed as follows. The main objective for this project is to develop a treasure hunt learning game with augmented reality to motive children in learning and make the learning process more interactive and fun.

#### **1. To develop a virtual treasure hunt learning game to improve interactivity and engagement in learning.**

This project is aimed to develop a game-based learning tool to promote interactivity and make children engage more in learning. To promote interactivity, question setting feature is provided in the treasure hunt which allows the creator to set any question for children to answer. This is to bring the paper-based exercise or activity question into a game so that children are more enjoyable in exploring and answering the question. For example, parents can set some vocabulary questions for children to answer via play. This can help the children to improve their understanding and memorizing the vocabularies instead of rote learning via everyday dictation.

**2. To improve teaching method by adopting augmented reality technique to increase children motivation in learning.**

Augmented reality is adopted in this project to enhance the boring traditional learning method by including some technology features into it. Therefore, by implementing augmented reality into treasure hunt game, it can bring a whole new playing and learning experience to children. The attractive and interactive animated treasure and graphic shown in the real world are also able to make the mobile treasure hunt more realistic and interesting. Therefore, it can increase the children interest and boost their motivation in learning.

### **1.4 Project Scope**

The scope for this project is to develop a mobile treasure hunt application with augmented reality on android platform for education purpose. This game-based learning platform is aimed to bring excitement and enjoyment for children to learn while playing. Since AR technique has being wisely used in many areas nowadays, AR feature is designed and implemented in this project to connect the visual treasure hunt to the real world in order to bring a whole new experience of treasure hunt to the children. This project is mainly developed using Unity platform with the integration of Vuforia engine. The language used mainly is C# language.

In this virtual treasure hunt application, 2 roles are provided - Creator and Player. The Creator can create and design the treasure hunt while the Player will play the treasure hunt created by the Creator. Creator is provided functions to create treasure hunt, hide treasure using camera, set the clues, provide question and option for Player to play as well as edit and delete the created treasure. Before the Creator creates the treasure hunt, the application will let the creator to name and give introduction about the treasure hunt. After that, it will proceed to the treasure item creation page for Creator to create treasure items for the treasure hunt game. This treasure item is the treasure that the Player has to look for while playing the game. Within the treasure item, there are three components which are “Hide”, “Clue” and “Question”. To hide the treasure, the Creator chooses the “Hide” component and the camera of the phone or device will turn on and allow Creator to choose a location or object to hide the treasure via camera.

For better playing experience, it is advisable that to choose a surface that is immobile, stable and unique with good illumination so that it is easier to recognize. Object such as plain wall is not suitable to be captured and hide as treasure. It will be difficult for the Player to find the treasure as plain wall is anywhere. After that, the Creator is asked to set the clue of the treasure and question for Player to answer. Once all the treasures are done with the setting, Creator can save the lists of treasure items for that particular treasure hunt game. Before saving, validation function is implemented to check whether the treasure has been hidden properly or the clue has been set by checking the check image for each component. This is to ensure all the treasures are prepared properly without missing any clue setting or hidden place setting before saving into the database. After done creating the treasure hunt game, a random unique game PIN code is generated for the treasure hunt game where Creator can give it game code to the Player to enter the treasure hunt game.

For Player, before Player enters the treasure hunt, an introduction of treasure hunt is displayed to show Player the general overview of the treasure hunt. Once treasure hunt starts, the first clue will show up and the camera of the phone will open to let Player to find and capture the hidden treasure. Once the camera of the phone locates the hidden surface, the treasure will appear on the screen and the Player just has to capture it by touching the screen. Once the treasure is captured, a question will pop up to let the Player to answer it. If correct answer chosen, a reward will be given. The next clues will then continue until the end depends on the number of treasures created by the Creator. There is a collection module provided to the Player where the Player can view the collection and also use the obtained score in the treasure hunt game to unlock the collection item.

### 1.5 Proposed Approach/ Study

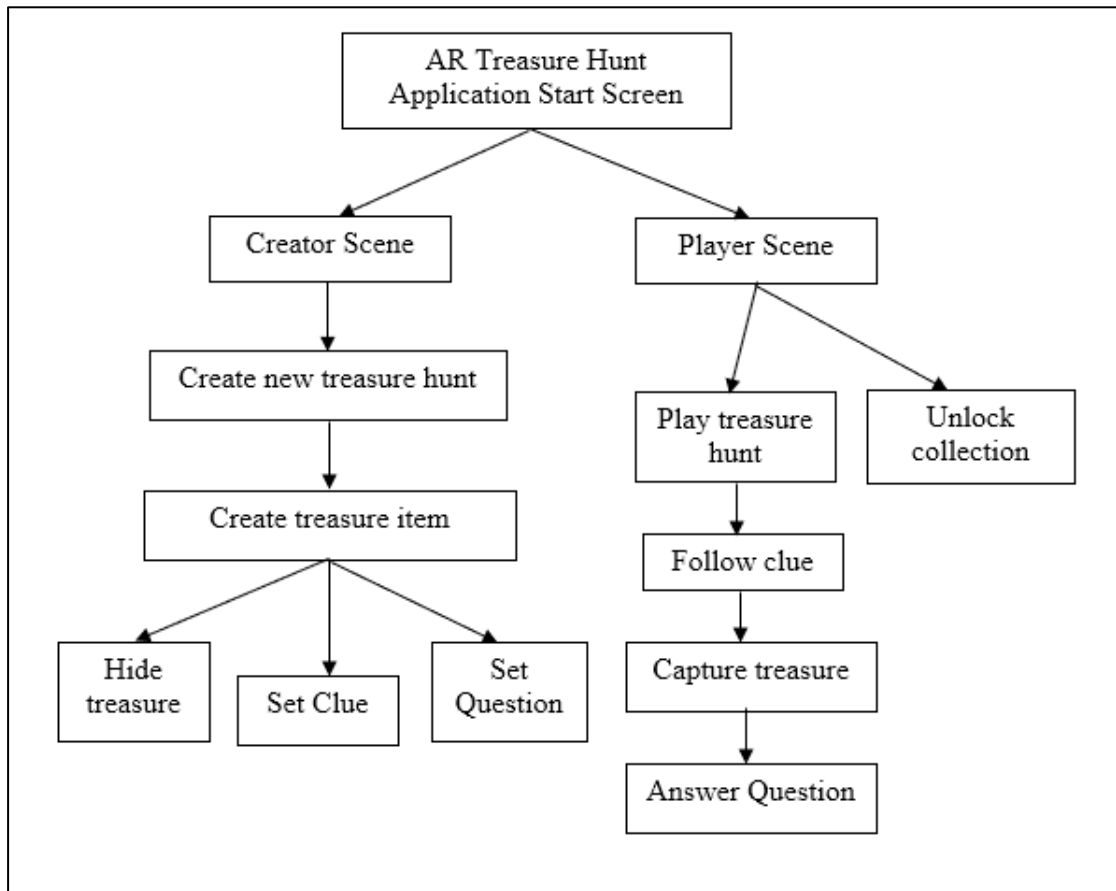


Figure 1.5.1 General Flow of the Application

Figure 1.5.1 above shows the general flow of the treasure hunt application. Generally, this application has 2 roles that can be assigned which are creator and player. Both roles will be implemented under different scenario. Creator is given the functionalities to create new treasure hunt, create list of treasure item, hide the treasure item, set the clue for the treasure item as well as set the question and answer. On the other hand, player is provided with the functionalities to play the treasure hunt and unlock the collections. While playing the game, the player has to follow the provided clues provided to find the treasure by using the phone's camera, then capture it by touching the screen and lastly answer the corresponding question. This section is just a general briefing on the how the application works as well as the responsibility for each role. More detailed explanation will be discussed in Chapter 3 system design.

## **1.6 Highlight of What Have Been Achieved**

In this application, a virtual treasure hunt application with augmented reality feature has been developed. 2 roles are created which are creator and player. A user can register an account which is meant for both roles and login freely as the creator (set the game) or the player (play the game).

While setting the treasure, the creator can hide the treasures using the phone's camera at anywhere as long as the pictures taken are clear (illumination of the place must be acceptable). After creator done with the setting creating of the game, a game PIN code will be automatically generated and a record will be created at the game record list so that everytime the creator login to the application, the creator is able to see a list of created game history on the screen. After that, the creator can pass or tell the generated PIN code to the players so that the players can play the created treasure hunt.

For player role, functionalities such as play the game, follow the clues, capture the treasure, answer question as well as rewarding system have been implemented. When player enters the game PIN code, the player is able to enter the particular treasure hunt. The player is able to see the clue provided and by following the clue, the player is able to capture the pop-up 3D treasure model and answer the correspondent question in order to gain the score. Once finish the treasure game, the player is able to use the gained score to purchase and unlock the item or collection.

Therefore, based on the features and functionalities mentioned above, it can be said that those requirements have been achieved in this application.

## **1.7 Report Organization**

This report is divided into 6 chapters. Chapter 1 is discussed about the introduction of the project including the background and motivation, problem statement, project objective, project scope and proposed approach.

Chapter 2 is the literature review which this reviewed on several similar existing application in the market and make comparison between those application.

Chapter 3 describes the design of the application include its functionalities and architecture using flowchart, use case diagram and activity diagram.

Chapter 4 is the further detailed explanation of chapter 3 which include the explanation on the methodology and tools used to implement the application design. The requirement in term of user and system, verification plan as well as the project timeline will also include in this chapter.

Chapter 5 is the implementation part of the system which this chapter will show the implementation of each module and functionalities of the application. Some code snippets will also include to further explain the implementation of the application part by part.

Chapter 6 is the conclusion which this chapter will conclude up all the parts in term of project review, novelties and contributions as well as future works.

## CHAPTER 2 LITERATURE REVIEW

### 2.1 Overview

In this literature review, similar existing applications are being reviewed and compared based on their strengths and weaknesses. The review existing applications include “Gamar”, “Quiver” and “Catchy Words AR”.

### 2.2. Gamar



Figure 2.2.1 Gamar Logo

Gamar is an interactive learning and gaming application with intense augmented reality features which allows anyone to play and create their AR games or tours easily. Gamar is adopting treasure hunt and scavenger hunt concept as gaming feature and implementing location-based augmented reality methods to provide a learnable gaming platform to discovery a place or location. It aims to make tours intuitive, self-guided to let guests to explore themselves, maximize guest’s enjoyment in visiting public attractions as well as provide an interactive activity to keep kids engaged together with family.

Gamar has provided 2 different platforms - webpage and mobile application. Since it supports play and create functions, it allows users to create and manage their games or tours on webpage and play it on mobile application. At first, Gamar was first developed for museums and art galleries to provide an innovative way for guests to have fun in engaging with the content. As time passed, Gamar platform had opened to more and more areas including homes, cities, historical buildings, schools and universities and whatever places that would like to provide a creative self-guided tour for visitors.



To create own tour or game, users just have to use Gamar mobile apps to scan anything including objects, sculptures, buildings or photos to create tour stops. After that, log in to the Gamar webpage to link the scanned stops and create a tour. Users can arrange the scanned stops and then add clues, stories, fun activities, music or pictures by using the online Gamar tour builder as shown in Figure 2.2.2. Once all the scanned stops are linked in a trail, users can test it and publish it on the Gamar platform so that other Gamar’s users can play it once they visit that place. It also allows the tour’s creator to check the guests’ reviews on the created tours whether there is room for improvement (Gamar, 2020).

The tours creation above is mainly for commercial use and organisation plan as outdoor activities that will publish to the public. Considering to indoor and simple implementation, Gamar has released a quick and easy treasure hunts that allows anyone especially family to have a play in anywhere without publish to the Gamar platform. It allows parents to create a quick treasure hunt game for their kids around their home or garden especially during this pandemic when everyone needed to be stay home. All they need to do is use Gamar mobile app to hide the treasure anywhere in the house as shown in Figure 2.2.5 and provide clues for children to find (Gamar, 2019).

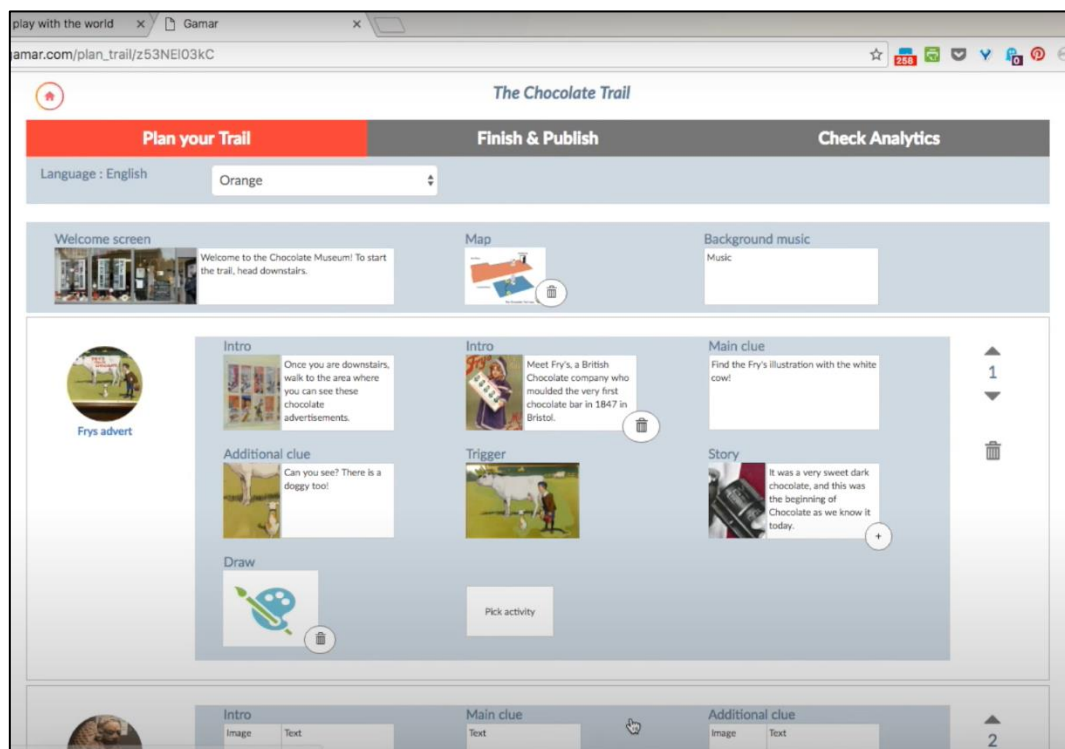


Figure 2.2.2 Gamar Tour Builder Webpage (Gamar, 2019)

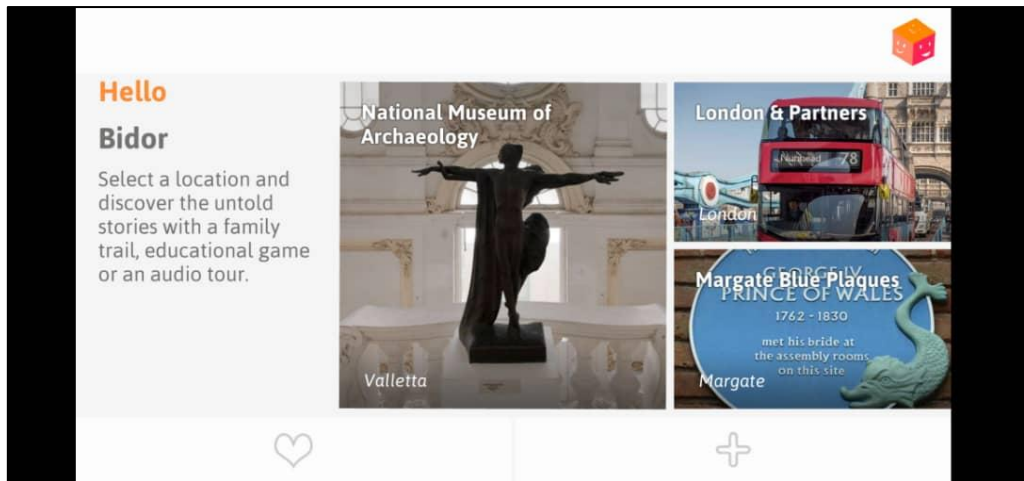


Figure 2.2.3 User Interface of Gamar App (Gamar, 2019)



Figure 2.2.4 Surface Scanning Before Treasure Hiding (Gamar, 2019)

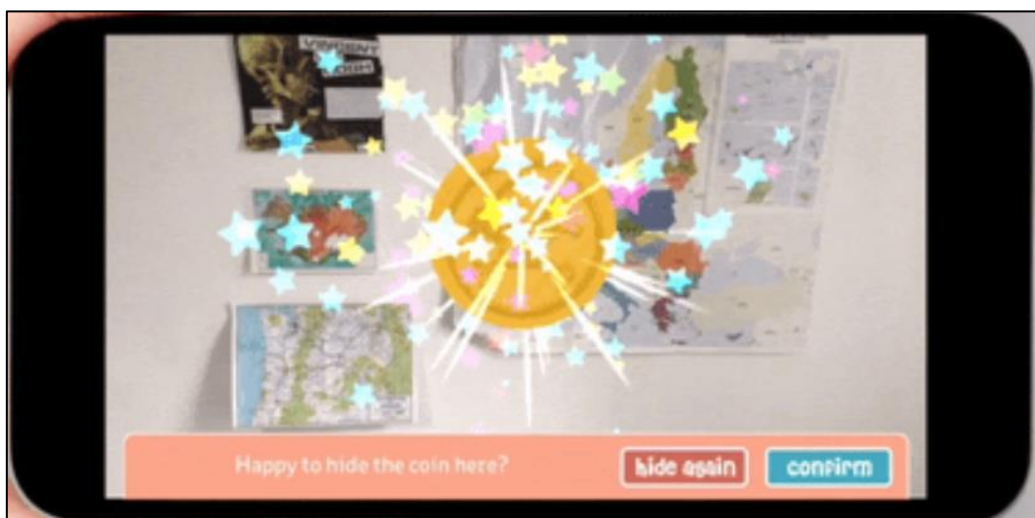


Figure 2.2.5 Hiding Treasure Using Gamar App (Gamar, 2019)

### **Strength**

- Gamar has provided their own platform for user to save and publish the created tour for other users in the Gamar platform to play.
- It has provided many interactive activities such as quiz, animation, audio player, image guessing and drawing board to be added in each stop to make the trail more interesting.
- The multi-angle scanning method in Gamar let the guests to easily scan the object from different angle especially for 3D object.
- During scanning, the application will examine the surface first then only the hide button can be clicked by the user to hide the treasure if the surface is clean and can be recognized by the system in the application.
- It allows the guests to provide feedback and review after they complete the tour so that the creator can improve the tour based on the feedback.
- The free treasure hunt creator within the app is very simple, fast and easy to implement as well as very convenient especially when parents wonder to give mini game to their children.
- It provides additional clue as well which the application will show a small region of the hiding surface to help player in case the player is not able to find the hidden treasure.

### **Weakness**

- It does not provide rewarding system to user after completing the tour or trail.
- It does not provide save function for the free treasure hunt creator within the application.
- The augmented reality in the apps is not able to recognise plants or any moving scene yet.
- It is not fully free for user. User has to pay in order to create and publish the tour although the mobile application is free to download and play the published tour.

### 2.3 Quiver



Figure 2.3.1 Quiver Logo

Quiver is an interactive 3D augmented reality application that visualizes a 2D image into a 3D object in AR world. The augmented reality features in Quiver are adopted on colouring. Through colouring, Quiver will animate the object coloured by student from a colouring page and make it alive in the real world via augmented reality. Therefore, Quiver has provided a more engaging way for students or children to go beyond the pictures in the textbooks to interact with the 3D figures.

In this application, Quiver has separated the colouring into 4 categories which are Quiver, Quiver Education, Quiver Fashion and Quiver Mask. Quiver is the overall that visualizes the colouring pages and bring it to life in AR with interactive animation. For Quiver Education, it is more than just visualizing the colouring, it focuses more on educational content. The colouring sheet designed is around the areas including biology, geometry and solar system. When visualizing those colouring pages, it has included interactive activity as well such as question and animation to making the learning process more interesting as shown in Figure 2.3.2.

For Quiver Fashion, it is similar as Quiver Education but the colouring sheets designed is more on fashion. It allows the students to colour the outfit of a model and bring it to life in the apps as shown in Figure 2.3.3. Not only that, in the application, it has also provided a stimulation of fashion show which user can choose to let the model to walk the runway. For Quiver Masks, it is the combination of augmented reality with face-tracking system which allows student to design and decorate their own masks and visualize it via AR. It also allows students to wear the mask via AR in the application as shown in Figure 2.3.4.

In order to use Quiver, Quiver colouring sheet is required to be downloaded first from the colouring packs. After that, print it to the students or children to colour it. Once done colouring, Quiver app is used to scan and visualize the colouring sheet. Before it comes to life, a blue coloured square will appear across the colouring sheet to show that the sheet is successfully recognized. Then, the 3D content is shown in real life where students can interact with it using the UI buttons provided on the screen (QuiverVision, 2020).

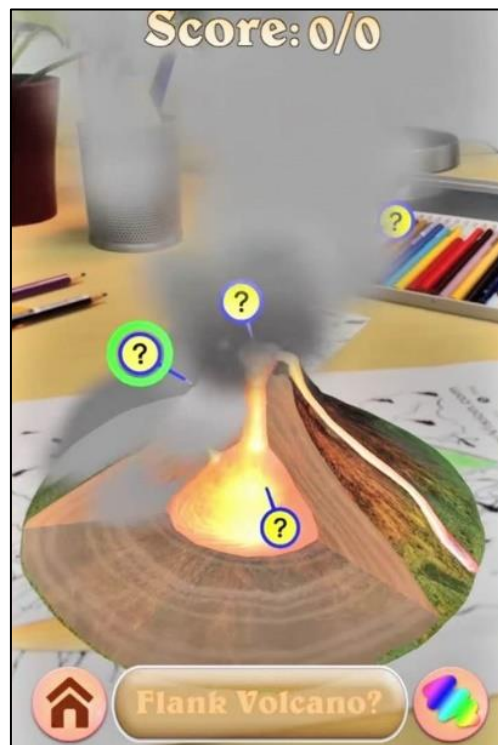


Figure 2.3.2 Quiver Education (QuiverVision, 2020)

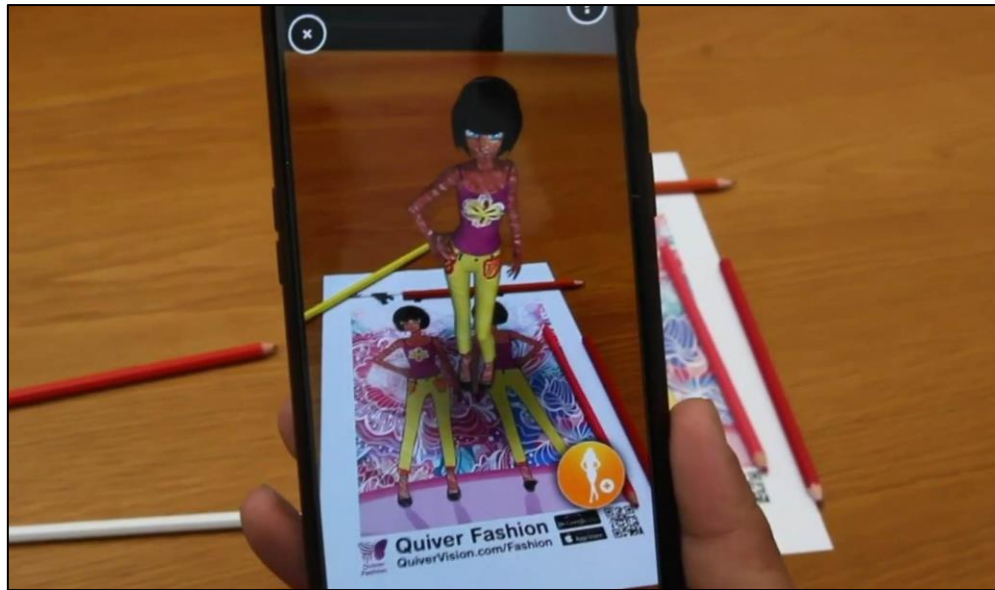


Figure 2.3.3 Quiver Fashion (QuiverVision, 2020)



Figure 2.3.4 Quiver Mask (QuiverVision, 2020)

### **Strength**

- The conversion of 2D image to 3D object with the children's colouring is impressive and attractive which is able to build up children's confidence.
- It has provided interactive activities which allows the user to interact and play game with the 3D character by touching the screen
- It also provides educational pages that including quiz to test the user's knowledge as well as some interactive features to show the experimental result.
- It has provided many amazing and attractive graphic contents as well as different sound effects for each colouring pages that further make it more fun and interesting.
- User can easily know whether they have successfully scanned the pages as the application will show a blue colour square if successfully matches and recognizes the pages.

### **Weakness**

- The colouring packs are not free. Users have to purchase it in order to print it out for children but the application is free to download.
- Some interactive features needed to be downloaded prior to interact directly to the 3D character. Some may even need to download one by one within a page which is time and battery-consuming.

## 2.4 Catchy Words AR



Figure 2.4.1 Catchy Words AR Logo

Catchy Words AR is an incredibly simple and easy word-solving game mobile application with augmented reality in mind. It focuses on providing a unique and impressive learning way for kids and children to learn words and spelling instead of just hard memorizing the words. This application has been used mainly in kindergartens and elementary school.

Catchy Words AR is very easy to use for everyone. Once enter the application, the kids can start play the game. On the screen, there will be a large bubble shown in the AR world. What the kids need to do is they just have to approach the bubble and pop the bubble without touching the screen which means they just have pop bubble using the device (mobile phone). Once the bubble pop, all the letters will spread around and float in the real world. Then, the kids need to catch the float letters using their device and solve the word by putting it into the frame.

Not only that, Catchy also considers letting the whole family or school teacher to involve in this game regardless of age. Therefore, Catchy has provided a feature that allows parents or teacher to set a list of words with maximum 12 letters long for the kids to play. Parents or teachers can either read the word for kids to spell or just let the kids to explore themselves. For example, teacher can use this method to give spelling to students instead of just writing it on a book and let teacher to mark.

Hence, what make this AR app different and unique from others common AR apps is that Catchy Words AR does not need to touch the screen to interact with the elements inside the AR world. The player just needs to walk around, approach the virtual element and touch it using the device itself. Therefore, it is a totally new experience to interact with AR world compared to other common AR apps that touch



the screen in order to interact with the digital elements inside the AR world (Revkov, 2018).

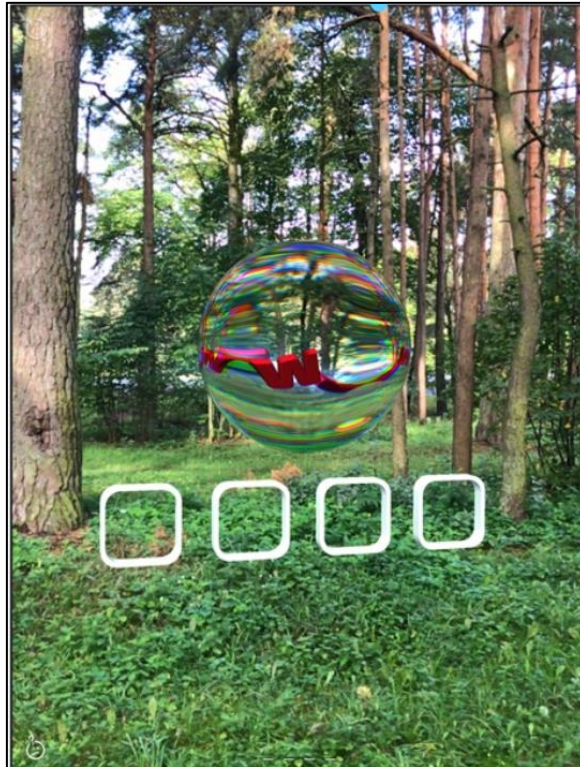


Figure 2.4.2 Large Bubble Containing Letters (Simanovics, n.d.)

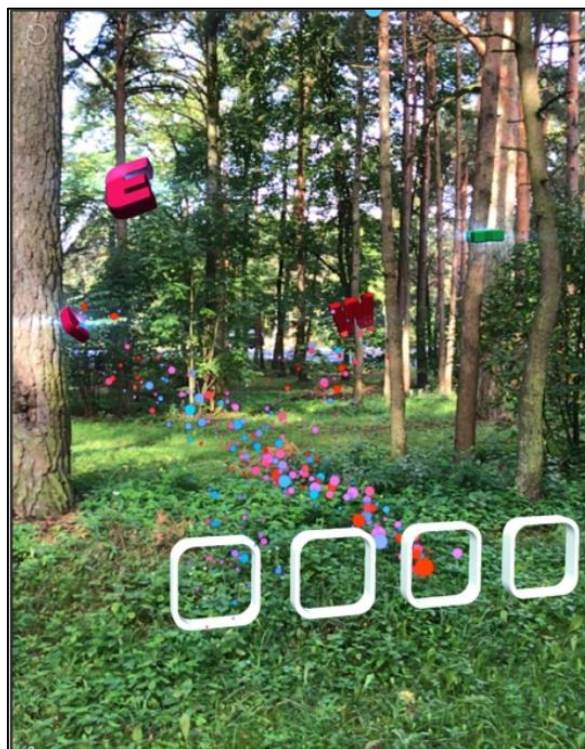


Figure 2.4.3 Floating Letters After Bubble Pop (Simanovics, n.d.)



Figure 2.4.4 Animation After Solving Word (Simanovics, n.d.)

### Strength

- It provides a touchscreen-free method for user to interact with the digital elements which user just needs to approach the elements and interact with it by using device itself. This new and fun augmented reality experience are awesome and impressive.
- The animation effect is incredible and impressive especially when the words fly out from the bubble and spread around.
- If user is not able to find the letter, there is a hint button which it will show and guide user to capture the letter. The guiding animation effect is attractive as well.
- Catchy words AR is very simple to use and to create vocabulary.

### Weakness

- It is only support English letter but not other languages.
- There is no rewarding system to encourage children. It is just simply finding and solving the word and then proceed to next word.
- The augmented reality content can easily become unstable and need to replace the content frequently.
- There is no user interface which the phone's camera will straight open up and let user to play once the user enters the application.

## 2.5 Chapter Summary

In this chapter, three similar existing applications including “Gamar”, “Quiver” and “Catchy Words AR” are reviewed based on their features, strength and weakness. The summarization of strengths and weakness of these application is as shown in table below.

Table 2.5.1 Comparison of Features Between Existing Applications

	<b>Gamar</b>	<b>Quiver</b>	<b>Catchy Words AR</b>
In-app purchase	Yes. Users have to purchase the subscription plan in order to create and publish the trail.	Yes. Users have to purchase the colouring packs in order to download the colouring pages.	No.
AR interaction method	Touch the phone screen.	Touch the phone screen.	Without touching phone screen. Approach the AR object and capture it using device itself.
Social platform	Gamar has its own social platform that allowing users to publish the created trails on to it and let other users to play.	No.	No.
Educational content	Gamar mainly used in public attraction such as historical place. It allows creators to set historical background, Q&A,	Quiver provides interactive Q&A, education facts and experimental result trigger shown on the AR objects.	Catchy Words AR provides educational content focus on vocabulary solving and learning.

## CHAPTER 2 LITERATURE REVIEW

	survey and quiz for each stop.		
Graphic design and content	Nothing much on animation and design. Images are all uploaded from the device directory.	Contains interesting and attractive 3D objects with animation and music.	Letters and AR objects design are attractive and impressive especially when providing hint to the player.
Rewarding system	No.	No.	No.

## CHAPTER 3 SYSTEM DESIGN

### 3.1 Overview

In this chapter, it shows the design diagram of the project such as the flow chart, use case diagram and activity diagram to explain the overall flow of the application, how the application works, the functionalities in the application as well as the responsibilities for each module in this application. The features in the project will also briefly described and explained.

### 3.2 System Flow Chart

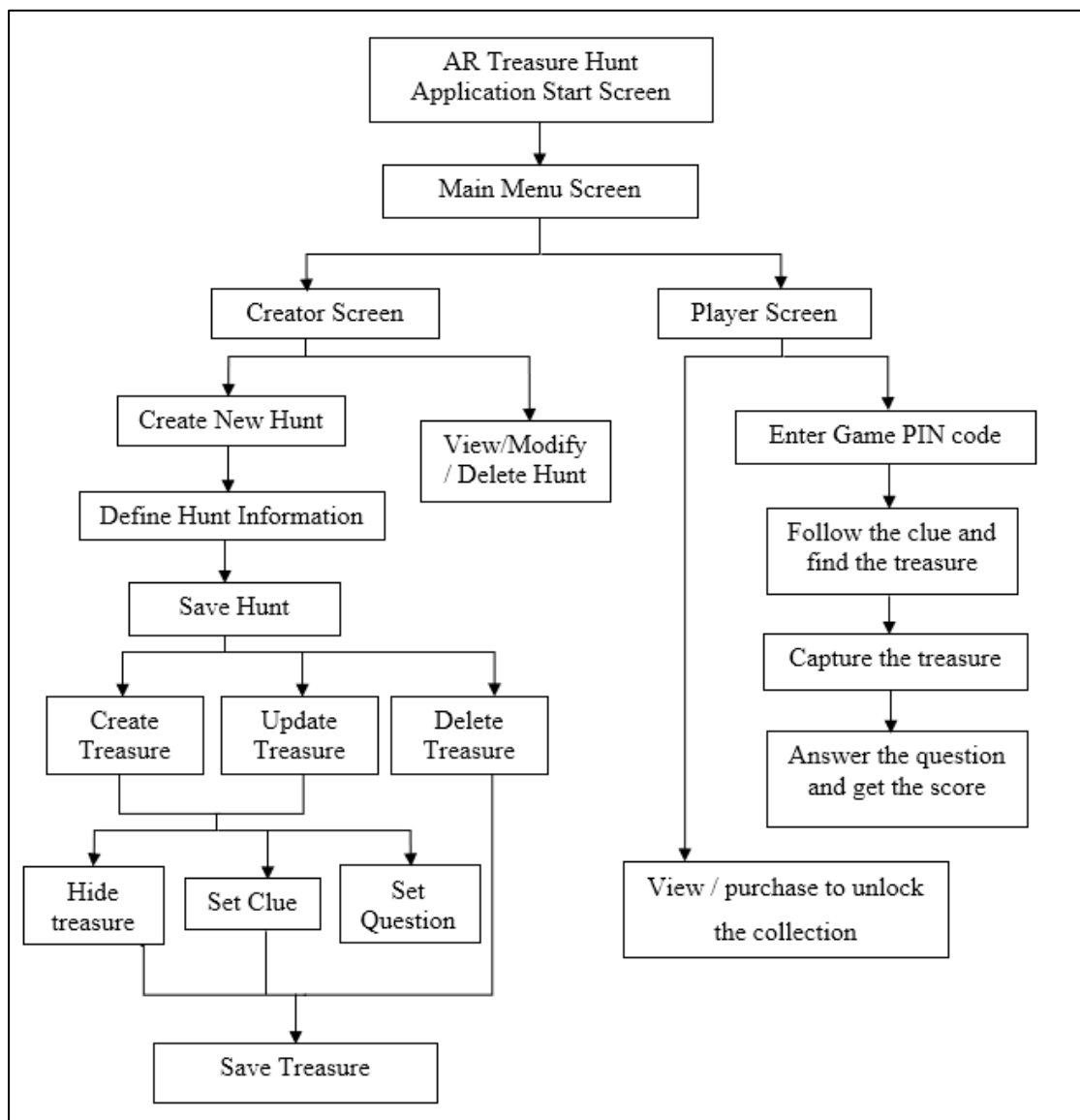


Figure 3.2.1 Flow Chart Diagram for AR Treasure Hunt Application

Figure above is the general flow on how the application works. Basically, there are three scenes in this application. The first scene is the main menu screen, then is the creator scene and player scene. When the application starts, the screen first shows the start game screen then it proceeds to main menu screen which let the user to choose whether to become a player or creator. After that, it asks the user to sign up or login as the character he/she chosen previously.

In the creator screen, the screen first shows a list of created treasure hunt game created by the specific creator. The creator can then view, modify or delete the created treasure hunt. Besides that, creator can also create another new treasure hunt game. When creator chooses to create new treasure hunt, treasure hunt information is asked to fill up by the creator. After that, it proceeds to the create treasure screen which allows the creator to hide the treasure by using the phone camera, then set up the clue as well as the question and answer. Besides creating new treasure, the creator can also modify the created treasure as well as delete. After the treasures done created, the creator can then save the treasures and a new treasure hunt game will be created with a Game PIN code provided.

In the player screen, the screen first shows the Game PIN code entry that let the player to enter the PIN code provided by the creator to play the treasure hunt game. Once the player enters the game, it first shows the introduction of the treasure hunt game then the instruction on how to play. After that, the player has to follow the clue shown on the screen then start the find the treasure using the phone camera based on the clue. Once the player found it, the treasure model displays on the screen and player has to capture it by touching it. After that, player has to answer the question in order to get the score. If player really cannot find the treasure, the player can choose to skip to the next round but of course the player will lose the score. Hence, this is how the player plays the game. For the collected score, the player can use to purchase and unlock the collection.

In short, the mentioned above shows how the AR treasure hunt application works in term of creator role as well as the player role.

### 3.3 Use Case Diagram

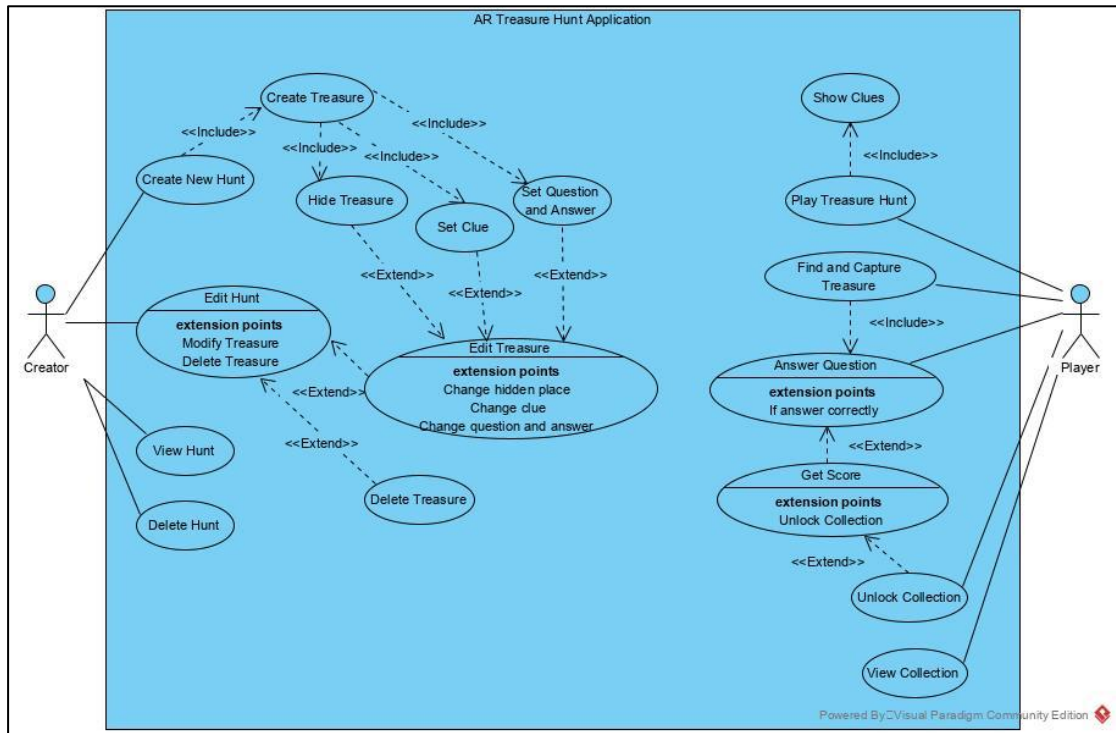


Figure 3.3.1 Use Case Diagram

### 3.4 Use Case Description

Table 3.4.1 Use Case Description for “Create New Hunt” Use Case

Use Case ID	1	Use Case Name	Create New Hunt
Primary Actor	Creator		
Brief Description	Creator can create a new treasure hunt game with hiding treasure, set clue as well as set question and answer functionalities.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Creator clicks the add button to create new treasure hunt game.</li> <li>2. Creator fills in the new hunt game name and introduction.</li> <li>3. Creator clicks the next button to save the hunt information and proceed to create treasure screen.</li> <li>4. Creator clicks the add button to create treasure item.</li> <li>5. Creator can choose to hide the treasure first, set the clue of the treasure or set the question and answer. <ul style="list-style-type: none"> <li>- If creator choose to hide treasure <ul style="list-style-type: none"> <li>• S-1: Hide treasure subflow is performed.</li> </ul> </li> <li>- If creator choose to set clue <ul style="list-style-type: none"> <li>• S-2: Set clue subflow is performed.</li> </ul> </li> <li>- If creator choose to set question and answer. <ul style="list-style-type: none"> <li>• S-3: Set question and answer subflow is performed</li> </ul> </li> </ul> </li> <li>6. The system activates the check image of the treasure.</li> <li>7. Creator clicks the save button to save the created treasure items together with the created treasure hunt game.</li> </ol>		
Sub Flows	S-1: Hide Treasure		



	<ol style="list-style-type: none"> <li>1. Creator finds a place to hide the treasure by using the phone camera.</li> <li>2. Creator clicks the button the capture the image of the place.</li> <li>3. Creator clicks the continue button to confirm the captured image.</li> <li>4. The system saves the captured image into the phone storage.</li> </ol> <p>S-2: Set Clue</p> <ol style="list-style-type: none"> <li>1. Creator set the clue for the treasure.</li> <li>2. Creator clicks the save button to save the clue.</li> <li>3. The system updates the clue list.</li> </ol> <p>S-3: Set Question and Answer</p> <ol style="list-style-type: none"> <li>1. Creator set the question for the treasure.</li> <li>2. Creator set the options and the answer for the question.</li> <li>3. Creator clicks the save button to save the setting.</li> <li>4. The system updates the question object list.</li> </ol>
Alternative Flows	<p>S-1, 3a: If creator clicks the recapture button, the system will reopen the camera and let creator to recapture the image.</p> <p>S-2, 2a: If creator keys in empty clue, the system will display alert message to the creator.</p> <p>S-3, 3a: If creator keys in empty question, options and answer, the system will display alert message.</p>

Table 3.4.2 Use Case Description for “Edit Hunt” Use Case

Use Case ID	2	Use Case Name	Edit Hunt
Primary Actor	Creator		
Brief Description	Creator can edit the treasure hunt game by changing the hunt description or modify the treasure item such as		

	change the hidden place of the treasure, modify the clue as well as the set question and answer.
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Creator clicks the created treasure hunt game to open the setting panel.</li> <li>2. Creator can modify the hunt introduction and save it.</li> <li>3. Creator chooses the next button to proceed to the treasure item menu page.</li> <li>4. Creator can choose to edit the hidden place first, change the clue or change the question and answer for the particular treasure item or even delete the whole treasure item. <ul style="list-style-type: none"> <li>- If creator choose to edit the hidden place <ul style="list-style-type: none"> <li>• S-1: Hide treasure subflow is performed.</li> </ul> </li> <li>- If creator choose to change the clue <ul style="list-style-type: none"> <li>• S-2: Set clue subflow is performed.</li> </ul> </li> <li>- If creator choose to change the question and answer. <ul style="list-style-type: none"> <li>• S-3: Set question and answer subflow is performed</li> </ul> </li> <li>- If creator choose to delete the treasure item. <ul style="list-style-type: none"> <li>• S-4: Delete treasure item subflow is performed.</li> </ul> </li> </ul> </li> <li>5. Creator clicks the save button to save and update the changes made.</li> </ol>
Sub Flows	<p>S-1: Hide Treasure</p> <ol style="list-style-type: none"> <li>1. Creator finds a new place to hide the treasure by using the phone camera.</li> <li>2. Creator clicks the button the recapture the image of the new place.</li> </ol>

	<ol style="list-style-type: none"> <li>3. Creator clicks the continue button to confirm the captured image.</li> <li>4. The system updates the new captured image in the phone storage.</li> </ol> <p>S-2: Set Clue</p> <ol style="list-style-type: none"> <li>1. Creator edits the clue for the treasure.</li> <li>2. Creator clicks the save button to save the clue.</li> <li>3. The system updates the clue list.</li> </ol> <p>S-3: Set Question and Answer</p> <ol style="list-style-type: none"> <li>1. Creator edit the question for the treasure.</li> <li>2. Creator edit the options and the answer for the question.</li> <li>3. Creator clicks the save button to save the setting.</li> <li>4. The system updates the question object list.</li> </ol> <p>S-4: Delete Treasure Item</p> <ol style="list-style-type: none"> <li>1. A confirmation panel shown up to double confirm with the creator whether to delete the treasure item.</li> <li>2. Creator clicks delete button to delete the treasure item.</li> <li>3. The system updates the treasure item list.</li> </ol>
Alternative Flows	<p>S-1, 3a: If creator clicks the recapture button, the system will reopen the camera and let creator to recapture the image again.</p> <p>S-2, 2a: If creator keys in empty clue, the system will display alert message to the creator.</p> <p>S-3, 3a: If creator keys in empty question, options and answer, the system will display alert message.</p> <p>S-4, 2a: If creator chooses not to delete the treasure item, the confirmation panel will close and no delete action will be performed.</p>

Table 3.4.3 Use Case Description for “View Hunt” Use Case

Use Case ID	3	Use Case Name	View Hunt
Primary Actor	Creator		
Brief Description	Creator can view the information and treasure item list for a particular treasure hunt game.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Creator clicks the existing treasure hunt game to open the information panel.</li> <li>2. The system shows the hunt information including game PIN code, hunt name and description.</li> <li>3. Creator clicks next button to proceed to the treasure item menu page.</li> <li>4. Creator clicks the hide button to see the hidden place.</li> <li>5. Creator clicks the set clue button to see the set clue.</li> <li>6. Creator clicks the set question button to see the set question and answers.</li> </ol>		
Sub Flows	Not applicable		
Alternative Flows	3a: If creator clicks the close button, the system returns to the main page.		

Table 3.4.4 Use Case Description for “Delete Hunt” Use Case

Use Case ID	4	Use Case Name	Delete Hunt
Primary Actor	Creator		
Brief Description	Creator can delete the existing treasure hunt game.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Creator clicks the delete button on the treasure hunt game item.</li> <li>2. The system displays the confirmation message.</li> <li>3. Creator clicks the delete button to confirm delete the treasure.</li> </ol>		

	4. The system updates the treasure hunt game item list.
Sub Flows	Not applicable
Alternative Flows	3a: If creator clicks the cancel button, the system returns to the previous UI without deleting the treasure.

Table 3.4.5 Use Case Description for “Play Treasure Hunt” Use Case

Use Case ID	5	Use Case Name	Play Treasure Hunt
Primary Actor	Player		
Brief Description	Player can start to play the treasure hunt		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. The system displays the playing rule.</li> <li>2. The system displays the clue of the treasure.</li> <li>3. Player follows the clue to find treasure.</li> <li>4. Player captures the found treasure by clicking it.</li> <li>5. Player answers the popup question.</li> <li>6. Player collects the score.</li> <li>7. Player completes the treasure hunt game.</li> </ol>		
Sub Flows	Not applicable.		
Alternative Flows	<p>6a: If player answers wrongly, player will not get the score.</p> <p>7a: If it is not the last treasure, player continues to look for other treasures by following the clues.</p>		

Table 3.4.6 Use Case Description for “Find and Capture Treasure” Use Case

Use Case ID	6	Use Case Name	Find and Capture Treasure
Primary Actor	Player		
Brief Description	Player finds the treasure following the clue and capture the treasure.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Player finds the treasure by pointing the phone camera to the place following the clue.</li> <li>2. Player captures the found treasure by clicking the treasure.</li> </ol>		

Sub Flows	Not applicable.
Alternative Flows	Not applicable.

Table 3.4.7 Use Case Description for “Answer Question” Use Case

Use Case ID	7	Use Case Name	Answer Question
Primary Actor	Player		
Brief Description	Player answer the question to get the score and continue the game.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Player clicks the found treasure.</li> <li>2. The system popup the question with options.</li> <li>3. Player answers the question.</li> <li>4. The system displays the correct message and player gets the score.</li> <li>5. The system displays the clue for the next treasure.</li> </ol>		
Sub Flows	Not applicable.		
Alternative Flows	<p>4a: If player answers wrongly, the system displays the incorrect message and player will not get the score.</p> <p>5a: If it is the last treasure, the system will not show the clue for next treasure but instead showing the completion message.</p>		

Table 3.4.8 Use Case Description for “View Collection” Use Case

Use Case ID	8	Use Case Name	View Collection
Primary Actor	Player		
Brief Description	Player can view the his/her unlocked collection		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Player clicks the profile button</li> <li>2. The system opens the profile panel.</li> <li>3. Player clicks the collection button.</li> <li>4. The system opens the collection panel.</li> <li>5. Player clicks the unlock item.</li> </ol>		

	6. The system shows the description of the unlock item.
Sub Flows	Not applicable.
Alternative Flows	Not applicable

Table 3.4.9 Use Case Description for “Unlock Collection” Use Case

Use Case ID	9	Use Case Name	Unlock Collection
Primary Actor	Player		
Brief Description	Player can use his/her score to unlock item in the collection.		
Normal Flow of Events	<ol style="list-style-type: none"> <li>1. Player clicks the profile button</li> <li>2. The system opens the profile panel.</li> <li>3. Player clicks the collection button.</li> <li>4. The system opens the collection panel.</li> <li>5. Player clicks the item to purchase and unlock.</li> <li>6. The system pops up the confirmation panel.</li> <li>7. Player clicks the unlock button to unlock the chosen item.</li> <li>8. The system displays the unlock item description.</li> <li>9. The system updates the unlock item list in the collection.</li> </ol>		
Sub Flows	Not applicable.		
Alternative Flows	7a: If player clicks cancel to deny the purchase, the purchase confirmation panel close.		

### 3.5 Activity Diagram

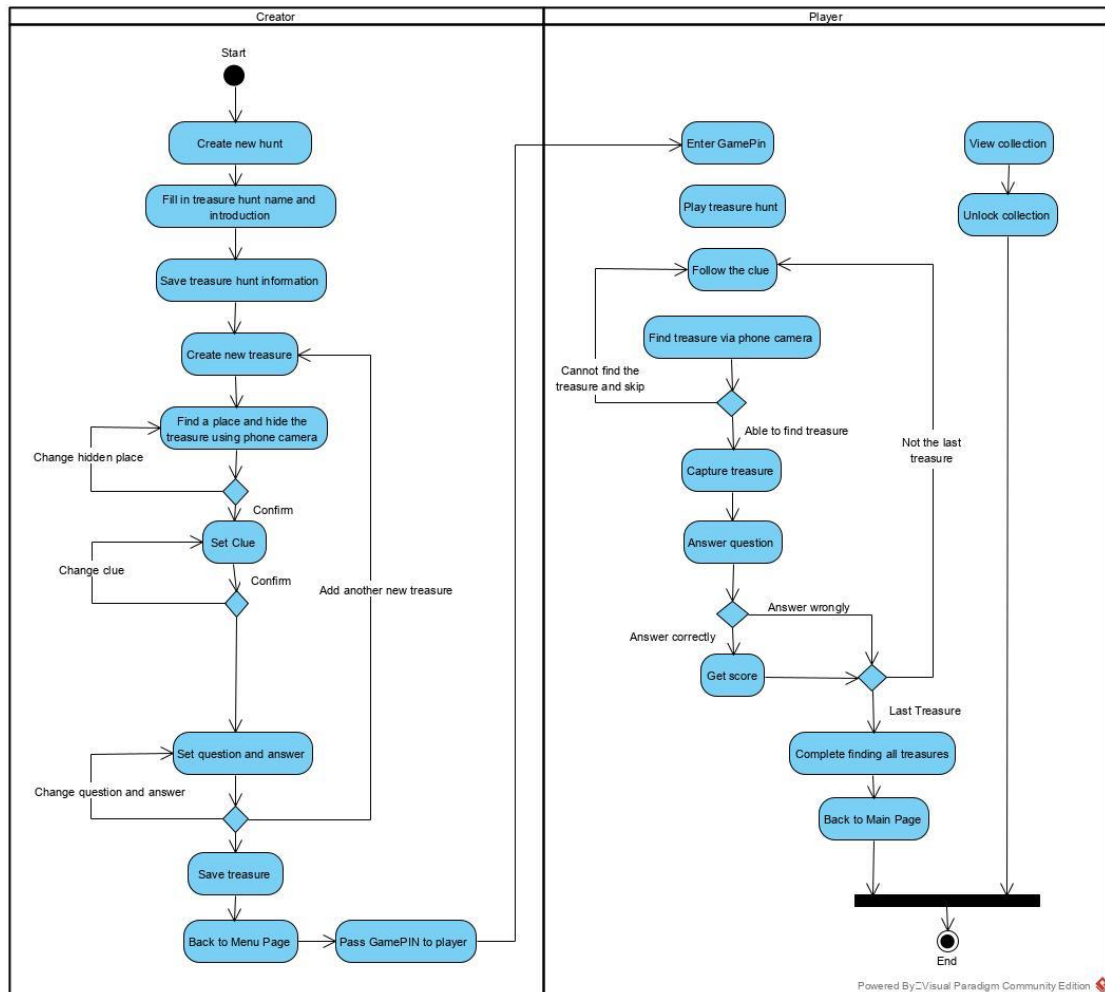


Figure 3.5.1 Activity Diagram

### 3.6 Chapter Summary

In this chapter, it consists of flow chart diagram for the whole application, use case diagram for both creator and player role, use case description for each use case as well as activity diagram to show how the application flows for both creator and player. This design diagram is aimed to provide a clearer description on the flow and process of the application as well as the functionalities of the application.



## CHAPTER 4 METHODOLOGY AND TOOLS

### 4.1 Overview

In this chapter, it shows the preliminary work and progress have been done in the current project. The functions and features of the project as well as the outcome of the project are showed and discussed as well in this chapter.

### 4.2 Methodology

Prototyping-based methodology is being chosen as the software development life cycle in this project. In this methodology, a prototype is built, examined, test and re-enhanced until the prototype is satisfied enough to be deployed. As shown in the figure below, the design and implementation phases are repeated to build and enhance the prototype until it is able to be implemented into the final project.

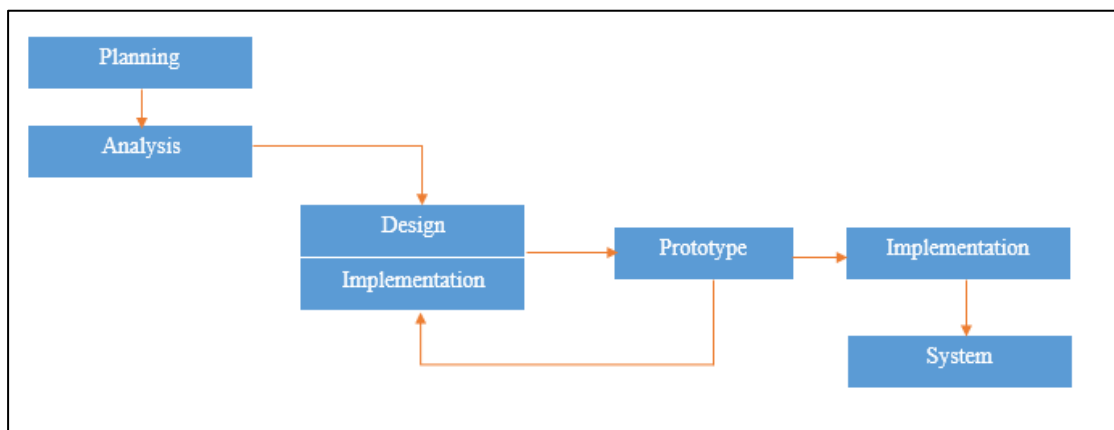


Figure 4.2.1 Prototyping Model

#### 4.2.1 Planning and Analysis Phases

The project starts with planning phase. Study and research on the background of the project is performed such as the history and story behind the treasure hunt, the information about augmented reality and so on. It is important to know about the background of the project before start building it. After that, the next phase is analysis phase. After completing the research, analyse the user requirement and expectation are

done in order to understand more about the current market needs. Hence, similar existing systems in the market are being reviewed and compared to learn about the strengths and weaknesses as well as the user feedback from those systems. After done reviewing, the requirements of the project is identified in term of project objectives and project scopes

### **4.2.2 Design and Implementation Phase**

Design phase is the next phase to design the application based on the defined requirements in the previous phase. In this phase, the requirement specifications are turned into design specifications. The functionalities and features of the application are also designed in the form of use case diagram and activity diagram. Once completing design phase, the next phase is starting to build up the application via coding. In this phase, the first prototype is built. The coding part is done on Unity platform with the integration of Vuforia engine. C# language is the main language used to develop the module of the application. The first prototype is then being tested and modified to become the second prototype until the prototype is good enough to be deployed. Hence, the process is iterated and the prototype is reworked until the final satisfying prototype is built and ready to be implemented as the final application.

### **4.2.3 Implementation and Documentation**

The finalized prototype is implemented with all the functionalities that are workable without any errors and the performance is satisfying. Then, the outcome and the deliverable from all the phases are documented including all the research outcomes, related information and data, modules and functionalities of the application as well as the results and reviews from the application testing.

### 4.3 Tools to Use

In this project, several hardware and software are required in order to develop the application. For hardware specifications, it requires laptop and mobile phone. While for software specifications, development environment includes game engine, software development kit (SDK), Java Development Kit (JDK), 3D Model Design, programming language, coding IDE and back-end environment.

#### 4.3.1 Hardware Specifications

The following table shows the hardware tools used to develop the proposed application.

- Laptop Model: ROG Strix G513G

Table 4.3.1.1 Laptop Specification

Components	Requirements
Operating System	Window 10
Processor	Intel® Core™ i7-9750H CPU @ 2.60GHz 2.59GHz
RAM	8GB
Graphic Card	NVIDIA GeForce GT520M
System type	64-bit operating system, x64-based processor

- Mobile Phone Model: Huawei Nova 4 VCE-L22

Table 4.3.1.2 Mobile Phone Specification

Components	Requirements
Operating System	Android
Android Version	10
Processor	HiSilicon Kirin 970
RAM	8GB
Resolution	2310 x 1080
Phone Storage	128GB

### 4.3.2 Software Specifications

The following shows the software tools used to develop the proposed application.

Table 4.3.2.1 Software Specification

Component	Software Tools
Game Engine	Unity
Software Development Kit (SDK)	Vuforia SDK, Android SDK
Java Development Kit (JDK)	Java JDK
3D Model Design	Blender 3D
Programming Language	C#, PHP
Coding IDE	Microsoft Visual Studio, Visual Studio Code
Back-end	phpMyAdmin, MySQL, AWS EC2

## 4.4 Requirements

### 4.4.1 User Requirement

#### User

- User should be able to register as creator or player.
- User should be able to login as creator or player.

#### Creator

- Creator should be able to create, modify and delete a treasure hunt game.
- Creator should be able to create, modify and delete the treasure item inside a treasure hunt.
- Creator should be able to hide a treasure by using the phone camera.
- Creator should be able to set and modify the treasure clue.
- Creator should be able to set and modify the treasure question and answers.
- Creator should be able to save the treasure items as well as the whole treasure hunt game.
- Creator should be able to obtain the generated game PIN code.

Player

- Player should be able to play the treasure hunt game by entering the game PIN code.
- Player should be able to view the treasure clues.
- Player should be able to find the treasure by using the phone camera.
- Player should be able to see the treasure model on the screen.
- Player should be able to capture the treasure by touching the screen.
- Player should be able to answer the question after the treasure found.
- Player should be able to skip a round if cannot find the treasure.
- Player should be able to check the score obtained.
- Player should be able to purchase and unlock an item using the score obtained.
- Player should be able to click and view the unlocked item description.

**4.4.2 System Requirement**

- System should be able to provide user the function to login or register as a creator or player.
- System should be able to let creator to creator a new treasure hunt game.
- System should be able to let creator to open the phone camera to capture the treasure hidden place.
- System should be able to let creator to save the treasure hunt game.
- System should be able to generate a game PIN code for each newly created treasure hunt game.
- System should be able to let player enter a treasure hunt game by a Game PIN code.
- System should be able to let player to open the phone camera to find and capture the treasure item.
- System should be able to display and update the player's total score for each round of game.
- System should be able to show player the updated unlock collection.

#### 4.5 Verification Plan

AR Treasure Hunt is an application that providing both creator and player functions at the same platform which creator is to create the treasure hunt game while player is to play the game. Hence, it is important that both roles are able to perform well without any error especially dealing with the AR feature which phone camera is needed. Hence, few verification steps (only few important features) are explained as follow.

- Create new treasure hunt game by Creator

Table 4.5.1 Verification P1

Procedure Number	P1
Method	Testing
Applicable Requirements	Create and save newly created treasure hunt game as well as generate game PIN code.
Purpose/Scope	To create and save newly created treasure hunt with generated game PIN code.
Items Under Test	Create and save functions
Precautions	Creator should sign up an account in advance.
Special Conditions/Limitations	-
Equipment/Facilities	Android phone.
Data Recording	The created treasure hunt game details will save into the database.
Acceptance Criteria	The system should allow the creator to create a new treasure hunt game and save all the details into database.
Procedures	<ol style="list-style-type: none"> <li>1. System shows the treasure hunt information that is needed to be filled up by the creator.</li> <li>2. Creator fills up the information and clicks the save button.</li> <li>3. System saves the treasure hunt information and generates a game PIN code for the particular treasure hunt game.</li> </ol>

	4. System proceeds creator to a treasure item creation screen. 5. Creator performs treasure item creation process.
Troubleshooting	Repeat the procedure
Post-Test Activities	None

- Hide treasure function by Creator

Table 4.5.2 Verification P2

Procedure Number	P2
Method	Testing
Applicable Requirements	Capture and save the hidden place.
Purpose/Scope	To capture and save the hidden place for a particular treasure item.
Items Under Test	Phone camera.
Precautions	The hidden place should have good illumination and object in the hidden place should be static
Special Conditions/Limitations	If the illumination is low, it may cause inaccurate AR detection.
Equipment/Facilities	Phone camera.
Data Recording	The capture image will store in the phone storage as well as database.
Acceptance Criteria	The system should able to capture the hidden place and save the hidden place image.
Procedures	1. System opens the phone camera. 2. Creator clicks camera button to capture the hidden place. 3. Creator clicks save button to save the hidden place image. 4. System save the image into the phone storage as well as database.
Troubleshooting	Repeat the procedure

Post-Test Activities	None
----------------------	------

- Play treasure hunt game with provided game PIN code

Table 4.5.3 Verification P3

Procedure Number	P3
Method	Testing
Applicable Requirements	Play treasure hunt game with entry of game PIN code
Purpose/Scope	To play the treasure hunt game using the provided game PIN code as entry.
Items Under Test	Play and verify game PIN code functions
Precautions	Creator should sign up an account in advance.
Special Conditions/Limitations	-
Equipment/Facilities	Android phone.
Data Recording	The obtained score in the treasure hunt game will be saved and updated into the database.
Acceptance Criteria	The system verifies the game PIN code and let player to enter the treasure hunt game and play.
Procedures	<ol style="list-style-type: none"> <li>1. Player enters the game PIN code provided by the creator.</li> <li>2. System validates the game PIN code.</li> <li>3. If the game PIN code is correct, system will direct the player to the treasure hunt game screen to start play the game.</li> </ol>
Troubleshooting	Repeat the procedure
Post-Test Activities	None

- Display 3D treasure model when AR engine recognizes the hidden place.

Table 4.5.4 Verification P4

Procedure Number	P4
Method	Testing



Applicable Requirements	Display the 3D treasure model when phone camera locates the hidden place and the AR engine recognizes the hidden place.
Purpose/Scope	To pop up the 3D treasure model when AR camera recognizes the hidden place.
Items Under Test	3D treasure model
Precautions	Player has entered play mode.
Special Conditions/Limitations	The surrounding environment should have good illumination.
Equipment/Facilities	Phone camera.
Data Recording	The hidden place images will be retrieved from database and store it into the phone storage for AR recognition purpose.
Acceptance Criteria	The AR engine in the application recognizes the hidden place and display the 3D treasure model on the phone screen.
Procedures	<ol style="list-style-type: none"> <li>1. System opens the phone camera for player to find the hidden treasure.</li> <li>2. Player locates the hidden place by pointing the camera at the place.</li> <li>3. AR engine recognizes the hidden place and display the 3D treasure model on the screen.</li> <li>4. Player captures the treasure model by clicking it and proceed to QnA section.</li> </ol>
Troubleshooting	Repeat the procedure
Post-Test Activities	None

- Score collection in player module

Table 4.5.5 Verification P5

Procedure Number	P5
Method	Testing

Applicable Requirements	System records and updates the player total score obtained in the database.
Purpose/Scope	To save and update the player's total score in the database.
Items Under Test	Score
Precautions	Player has registered an account in advance.
Special Conditions/Limitations	-
Equipment/Facilities	Android phone.
Data Recording	The total score gained by the player in the treasure hunt game will be saved and updated to the database.
Acceptance Criteria	The system will save and update the player's total score in the database whenever the player logout the application.
Procedures	<ol style="list-style-type: none"> <li>1. System records the total score gained by the player in every treasure hunt game.</li> <li>2. Player sign out the application.</li> <li>3. System saves and updates the total score gained by the player in the database.</li> </ol>
Troubleshooting	Repeat the procedure
Post-Test Activities	None

- Unlock collection

Table 4.5.6 Verification P6

Procedure Number	P6
Method	Testing
Applicable Requirements	Purchase and unlock the collection using the score obtained.
Purpose/Scope	To purchase and unlock the collection using the score.
Items Under Test	Unlocked collection

Precautions	Player has enough score.
Special Conditions/Limitations	-
Equipment/Facilities	Android phone.
Data Recording	The unlock item index number will be saved into a text file that stored in the phone storage.
Acceptance Criteria	The system updates the unlock item list and player's score as well as saves the unlock item index into a text file.
Procedures	<ol style="list-style-type: none"> <li>1. Player purchases and unlocks the item using the score.</li> <li>2. System updates the unlock item list.</li> <li>3. System saves the unlock item index into a text file in the phone storage.</li> <li>4. System updates the player's score in the database.</li> </ol>
Troubleshooting	Repeat the procedure
Post-Test Activities	None

### 4.6 Gantt Chart

Task	Duration (week)	January				February				March				April			
		Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Research and Literature Review	1	█															
System Design	2		█	█													
System Development	10				█	█	█	█	█	█	█	█	█	█			
Scene Construction	$\frac{1}{2}$				█												
Menu Scene Development	$1\frac{1}{2}$				█	█											
Creator Scene Development	4					█	█	█	█								
Player Scene Development	3									█	█	█					
UI Construction and Enhancement	3											█	█	█			
FYP 2 Documentation	1															█	

Figure 4.6.1 Gantt Chart

### 4.7 Chapter Summary

In chapter 4, it has described the methodology used in this project including explaining each phase in the software development life cycle. The tools used includes the hardware and software specifications have also mentioned in this chapter. It has also briefly described what is the user as well as system requirements for this application. Lastly, verification plan which to verify the important features in this application as well as the timeline used for this application have also explained and included in this chapter.

## CHAPTER 5 SYSTEM IMPLEMENTATION

In this project, the whole game application is implemented in the Unity environment as shown in Figure 5.1. The functionalities, user interface design, AR feature as well as Blender model are being developed and integrated into the Unity environment as well.

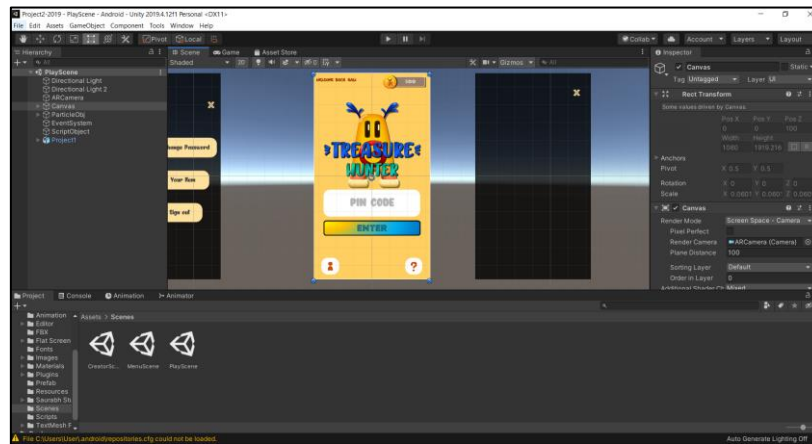


Figure 5.1 Unity Environment

### 5.1 Setup of Unity Environment

#### 5.1.1 Setup of Android SDK and JDK

By default, the Android SDK has been installed together with the Unity engine as shown in Figure 5.1.1.1. It means the installation of Android Studio is also included in the package of Unity installation so that it allows the Unity to support Android platform development.

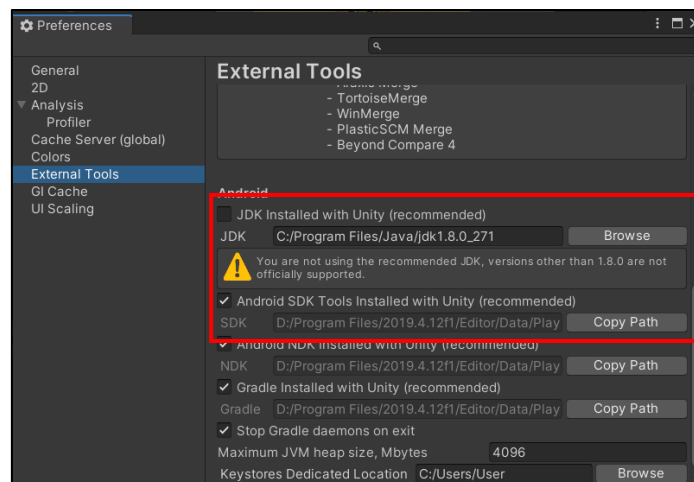


Figure 5.1.1.1 Android SDK and JDK Setup in Unity Preferences

### 5.1.2 Setup Vuforia SDK

In order to use Vuforia engine in Unity, a Vuforia engine has to be downloaded and imported into the Unity platform. After that, an app license key has to be registered in the Vuforia portal. Once registered, a license key is generated and it is required to copy and paste the key into the Unity Vuforia Configuration panel as shown in Figure 5.1.2.1, then only the Vuforia engine can be used in the Unity environment.

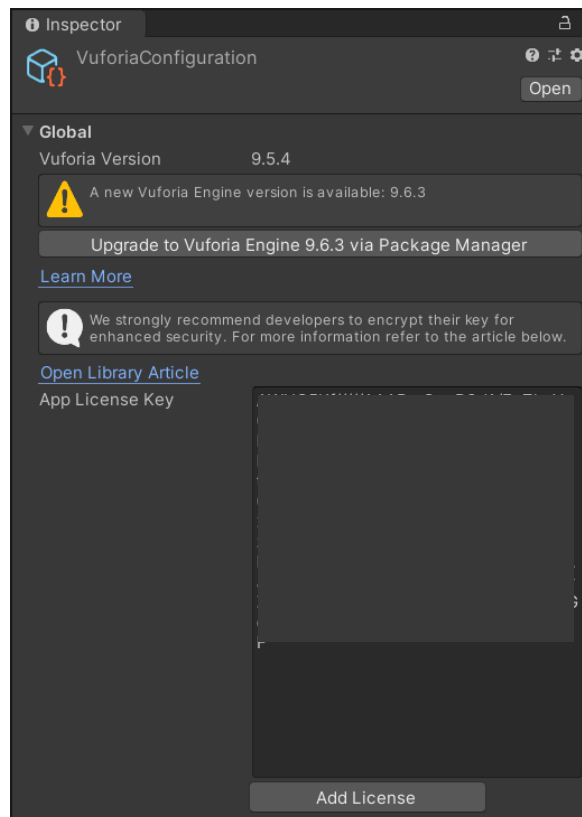


Figure 5.1.2.1 Setup Vuforia SDK in Unity

## 5.2 Development of Menu Scene (Scene 1)

When user enters the application, the very first interface is as shown in Figure 5.2.1 which it allows user to enter the game or quit the game. The cartoon character shown in the background image is named as “Gali”. Gali is the designed logo as well as the representation for this application. The design idea for this logo is actually came from the word “Gali” itself and “Gali” is actually a person’s nickname.



Figure 5.2.1 Homepage of AR Treasure Hunt Application

Once user clicks the start button, it proceeds to the roles menu interface as shown in Figure 5.2.2 to let the user to choose either become a creator (blue background) or a player (yellow background). In the middle, there is Gali floating and moving around. This is an animation effect. Whenever the user clicks the Gali, Gali will do the greeting.



Figure 5.2.2 Role Menu Interface

After user choose the role, it proceeds to the login page as shown in Figure 5.2.3. If user choose to become a creator, the login interface is having the blue colour background as shown in Figure 5.2.3. Else if user choose to become a player, the login interface is having a yellow colour background as shown in Figure 5.2.4. After that, user has to sign up an account in order to login to the game as a creator or a player. Creator and player both will have different interfaces and scenes as well as the functionalities.

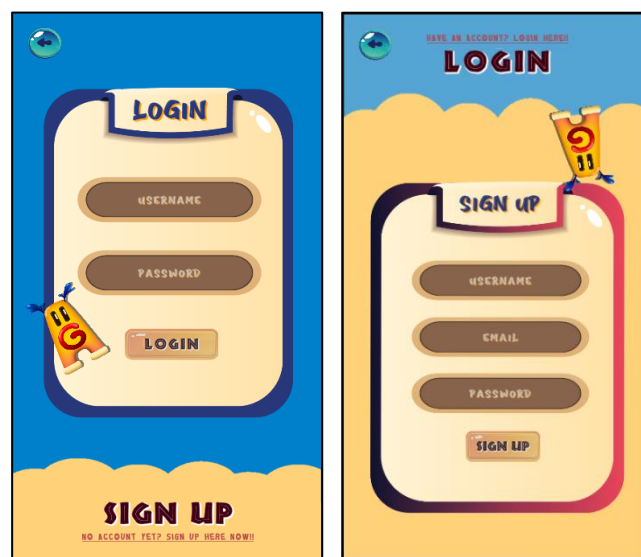


Figure 5.2.3 Login and Sign Up Interface for Creator



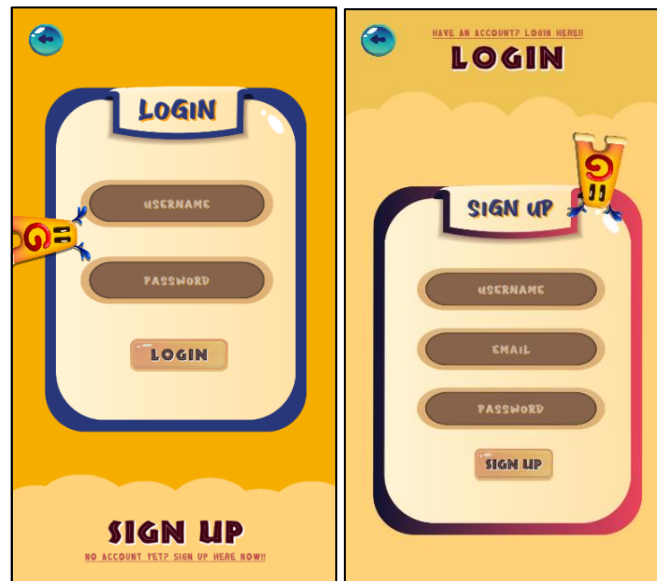


Figure 5.2.4. Login and Sign Up Interface for Player

### 5.3 Development of Creator Scene (Scene 2)

Once creator login to the game, it proceeds to the creator home game page which is the treasure hunt game menu interface. In this interface, all the treasure hunt game records that have been created by the creator is listed out. However, if the user is a new creator who just sign up to the application without creating any treasure hunt before, the screen shows the notification to guide the creator on how to create the treasure hunt as shown in Figure 5.3.1.



Figure 5.3.1 Hunt Game Menu Interface

### 5.3.1 Create New Treasure Hunt Game

When creator clicks the “Create New Game” button, the system opens the new treasure hunt information fill in page to let creator to fill in the details. After that, the creator can click the next button to save the treasure hunt information. The next button will only available when the fill in fields are not empty.

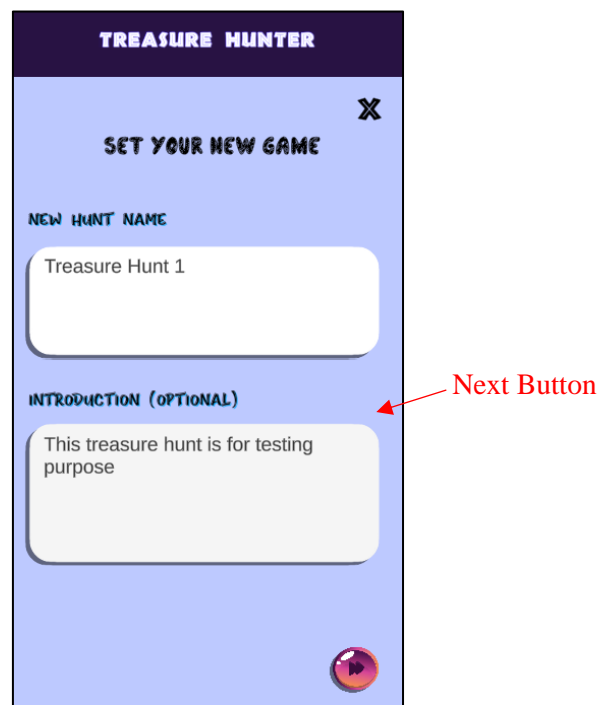


Figure 5.3.1.1 Setup Treasure Hunt Information

After the system saves the treasure hunt information, a random game PIN code is generated automatically as shown in Figure 5.3.1.2. In this example, a random PIN code “CMUTUE” has been generated for this particular treasure hunt application. Every treasure hunt game is having an unique Game PIN code. After that, the creator can click the create button to proceed to the next interface which to create a list of treasure item. The overall coding is as shown in figure below which after the creator clicks the save button, the system passes the parameters as a form to the URL in order to store into the database. The URL is the link of the php file stored in the server. (the link shown in the code is the temporary local machine, it will change to the host server later.)

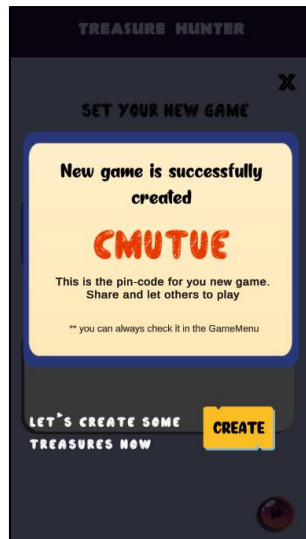


Figure 5.3.1.2 Generated Game PIN Code

```

0 references
public void saveHuntInfoClicked()
{
    string curObjName = EventSystem.current.currentSelectedGameObject.name;
    string action = "";
    string pinCode = "";
    string desc = "";
    string name = "";

    if (curObjName.Equals("saveBtn")) //DisplayGameInfoPanel
    {
        action = "UPDATE";
        pinCode = displayGameInfoPanel.transform.Find("pincodeText").GetComponentInChildren<TextMeshProUGUI>().text;
        name = displayGameInfoPanel.transform.Find("huntNameText").GetComponentInChildren<TextMeshProUGUI>().text;
        desc = intro2.text;
    }
    else if (curObjName.Equals("NxtBtn"))
    {
        action = "INSERT";
        pinCode = RandomPIN(6);
        name = huntName.text; Pin code generation
        desc = intro.text;
    }
    gamePanel.transform.Find("Addbtn").GetComponent<Animator>().enabled = true;
    StartCoroutine(saveHuntInfo(curObjName, action, pinCode, name, desc));
}
1 reference
IEnumerator saveHuntInfo(string curObjName, string action, string pinCode, string huntname, string desc)
{
    string userID = auth.getUserID();
    DateTime today = DateTime.Today;
    string date = today.ToString("dd/MM/yyyy");

    // check whether there is same hunt name in the database
    WWWForm form = new WWWForm();
    form.AddField("action", action);
    form.AddField("userID", userID);
    form.AddField("huntName", huntname); //huntName cannot update
    form.AddField("intro", desc);
    form.AddField("date", date);
    form.AddField("pincode", pinCode);

    Debug.Log(userID + " " + huntname + " " + intro.text + " " + date + " " + pincode);

    //http://localhost/treasurehuntbackend/saveHuntInfo.php
    using (UnityWebRequest www = UnityWebRequest.Post("http://localhost/treasurehuntbackend/saveHuntInfo.php", form))
    {
        yield return www.SendWebRequest();

        if (www.isNetworkError || www.isHttpError)
        {
            Debug.Log("1" + www.error);
            errorMsg.text = "404 not found";
        }
    }
}

```

Figure 5.3.1.3 Save Treasure Hunt Information Coding

### 5.3.2 Create Treasure Item

After the random game PIN code is successfully created, the creator can proceed to this treasure item menu interface as shown in Figure 5.3.2.1. In this interface, creator can create a list of treasure items. This treasure item is the item that allows the player to find when they play the game. Creator can click the add button to add a new treasure item. Within a treasure item, there are three main components which are “Hide”, “Clue” and “Question”.

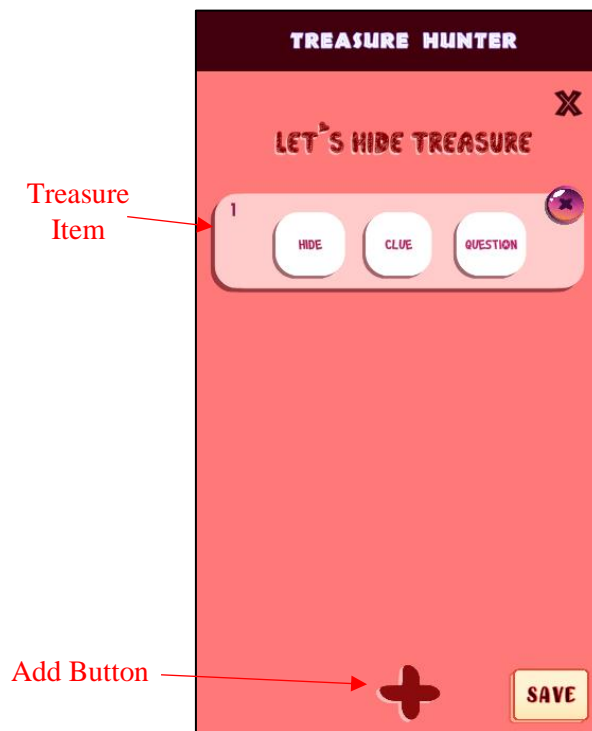


Figure 5.3.2.1 Treasure Item Menu Interface

#### Hide Treasure

When creator clicks the “Hide” component to hide the treasure, the creator’s phone camera is opened up and let the creator to look for a place to hide the treasure using the camera. For example, Figure 5.3.2.2 shows that the creator chooses to hide the treasure on a “Iron Man”. Then, the creator can click the camera button to capture the hidden place. A confirmation panel is then showed up and asked for confirmation whether to hide the treasure at that place. If creator confirms to hide the treasure, the hidden place image is stored in the phone storage as well as the database.



Figure 5.3.2.2 Capture Screen

To implement this hiding feature, the Unity engine does provide the camera library as shown in Figure 5.3.2.3 which it will capture the screen rendering from the camera object and save it as PNG file into the phone storage for later AR usage.

```

public void Snapshot()
{
    StartCoroutine(CaptureScreen());
}

1 reference
public IEnumerator CaptureScreen()
{
    yield return null; // Wait till the last possible moment before screen rendering to hide the UI
    GameObject.Find("Canvas").GetComponent<Canvas>().enabled = false;
    yield return new WaitForEndOfFrame(); // Wait for screen rendering to complete

    if (Screen.orientation == ScreenOrientation.LandscapeLeft || Screen.orientation == ScreenOrientation.LandscapeRight)
    {
        mainCamera = Camera.main.GetComponent<Camera>(); // for Taking Picture
        renderTex = new RenderTexture(height, width, 24);
        mainCamera.targetTexture = renderTex;
        RenderTexture.active = renderTex;
        mainCamera.Render();
        screenshot = new Texture2D(height, width, TextureFormat.RGB24, false);
        screenshot.ReadPixels(new Rect(0, 0, height, width), 0, 0);
        screenshot.Apply(); //false
        RenderTexture.active = null;
        mainCamera.targetTexture = null;
    }

    screenshotName = treasuremenu.getTreasureIndex() + ".png";
    File.WriteAllBytes(Application.persistentDataPath + "/" + screenshotName, screenshot.EncodeToPNG());

    count += 1;

    GameObject.Find("Canvas").GetComponent<Canvas>().enabled = true; // Show UI after we're done
    confirmation();
}

```

Figure 5.3.2.3 Code Snippet for Taking Picture

### Set Clue

After that, the creator can set the clue for the particular treasure. When the creator clicks the “Clue” component, the clue interface is opened up and let the creator to key in the clue for the particular treasure as shown in Figure 5.3.2.4. This clue is helped to guide the player to locate the hidden treasure. Then, the creator can click the save button to save it.

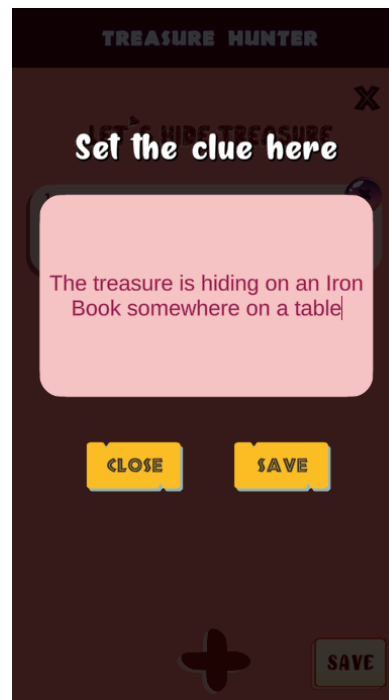


Figure 5.3.2.4 Clue Interface

### Set Question and Answers

After done setup the clue, creator can then set up the question and the following answers for the particular treasure as shown in Figure 5.3.2.5. This allows the player to answer it once they find the treasure and capture it. Creator can fill in the question field as well as the answer field. However, it is not mandatory for creator to fill up “Answer3” and “Answer4” fields. In other words, it means that “Answer3” and “Answer4” are optional. Then, creator has to choose the correct answer for this question before saving this section (Q&A).

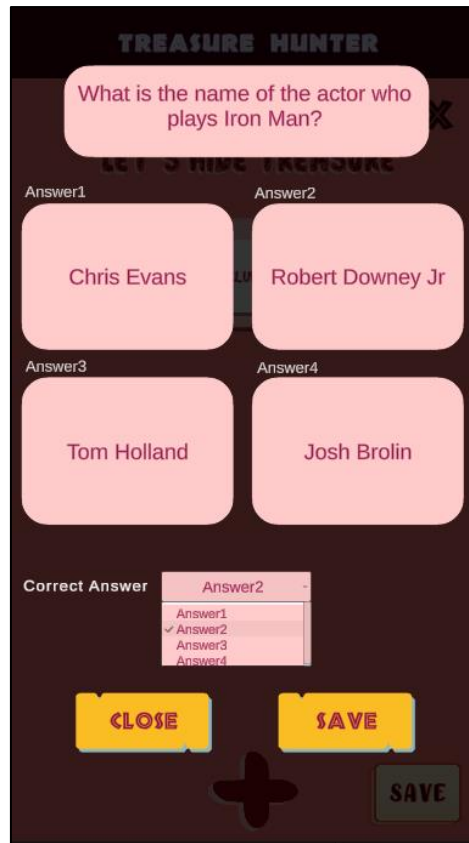


Figure 5.3.2.5 Question and Answer(Q&A) Interface

Everytime when creator has completed setup the component such as “Hide” component, it activates the check image as shown in Figure 5.3.2.6 which indicate that the creator has complete hiding the treasure. This is similar to the “Clue” and “Question” components. Not only that, this check image also used to check whether the creator has properly created all the treasure items. If creator misses one of the components, the system will not let the creator to the save the list of treasure items for the particular treasure hunt game but instead shows an alert message as shown in Figure 5.3.2.7.



Figure 5.3.2.6 Check Images for Components

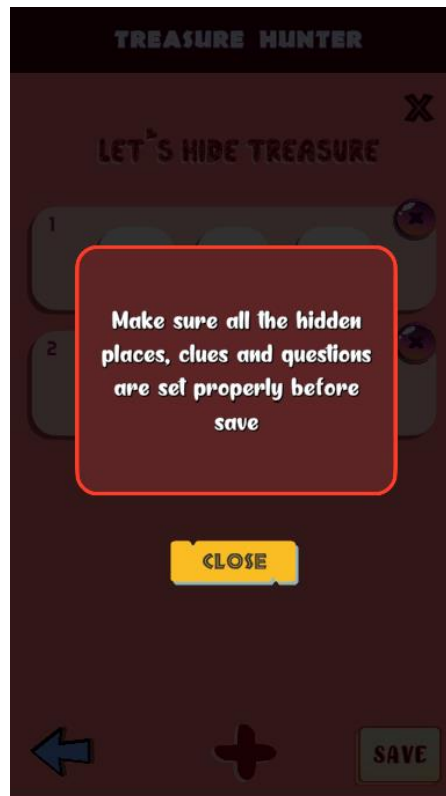


Figure 5.3.2.7 Alert Message

Once the creator clicks the save button, the system saves all the treasure items information including the treasure hidden place image into the database and a successfully save notification pops up as shown in Figure 5.3.2.8. The creator can then click the continue button to back to the main menu page.



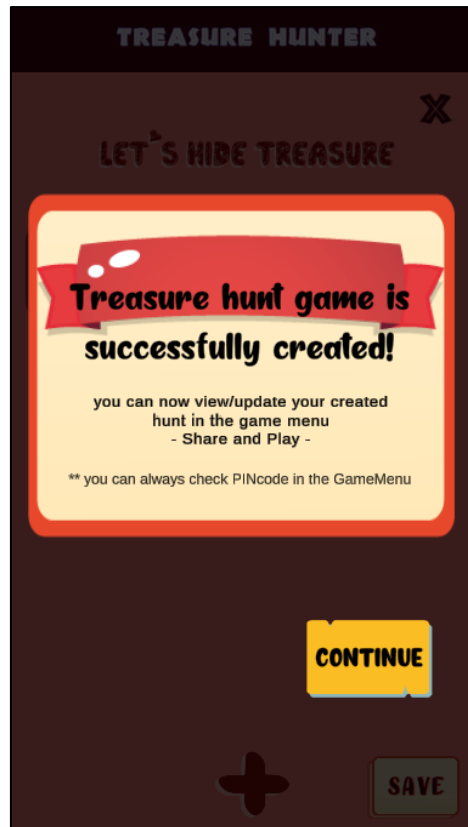


Figure 5.3.2.8 Successful Notification

Once creator successfully created the new treasure hunt game, the newly created game item is shown at the home page of the creator scene with the treasure hunt name as well as the date when this hunt is created as shown in Figure 5.3.2.9. If creator wants to modify the treasure hunt game or to know the game PIN code, the creator can click the game item and all the hunt information are displayed on the screen including the PIN code as shown in Figure 5.3.2.10. The creator can also modify the hunt introduction then save it or even proceed to the treasure item menu list to edit the treasure items. Not only that, the creator can also delete the whole treasure hunt game. However, before delete, a confirmation panel pop out as shown in Figure 5.3.2.11 to ask for double confirmation whether to delete because the action is not revertible.

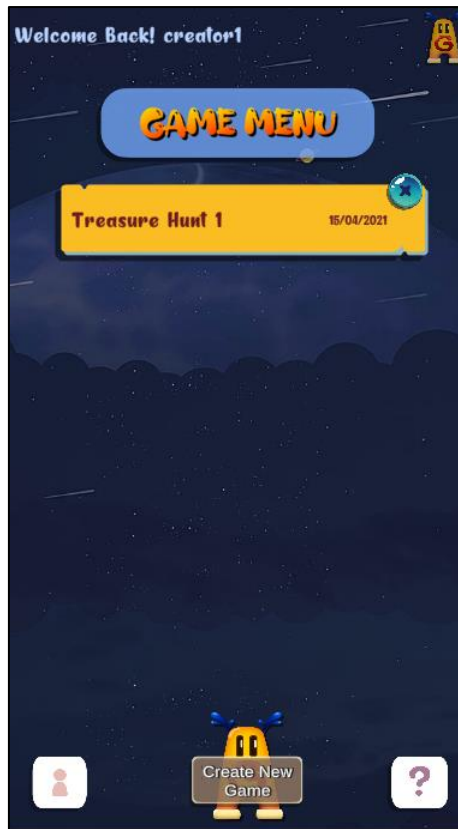


Figure 5.3.2.9 Created Treasure Hunt Game in the List

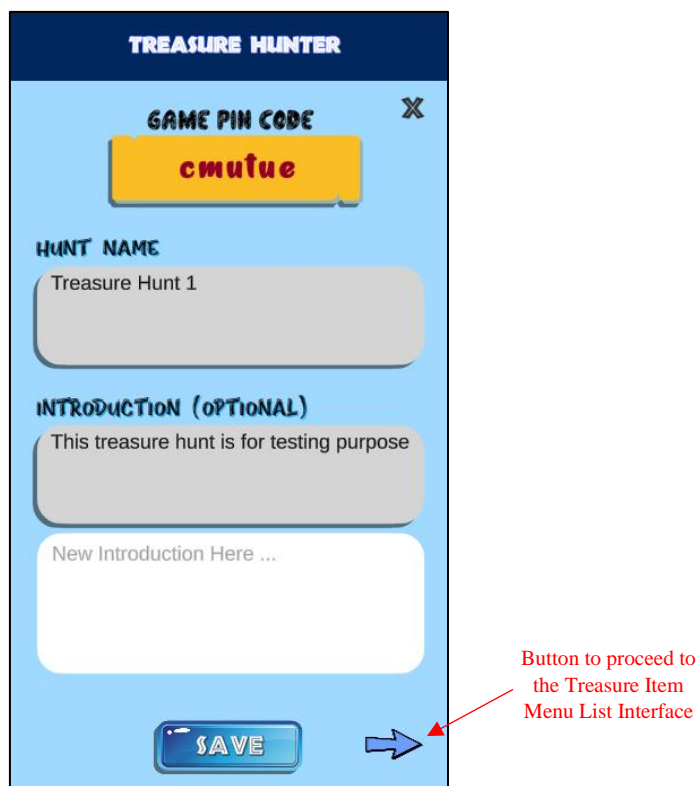


Figure 5.3.2.10 Treasure Hunt Information Interface

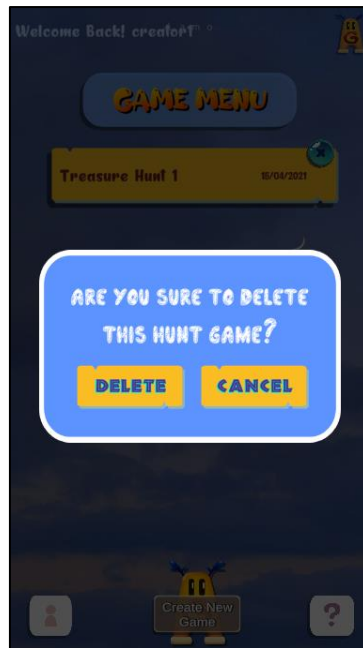


Figure 5.3.2.11 Delete Hunt Confirmation Interface

#### 5.4 Development of Player Scene (Scene 3)

Once player login to the game, the first screen shows to the player is as shown in Figure 5.4.1 which there is a text field for player to key in the game PIN code in order to enter the game. The game PIN code is provided by the creator. There is also a score field at the top right corner that shows the player's total score gained in his/her account.

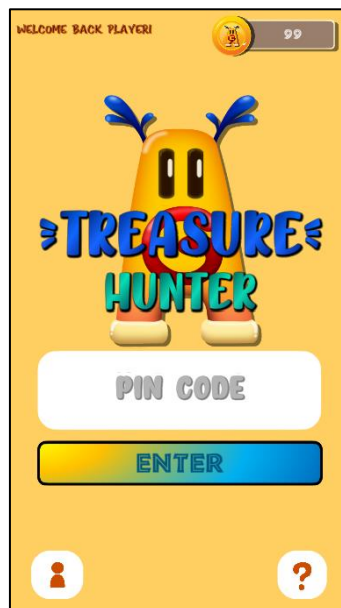


Figure 5.4.1 Home Screen for Player

### 5.4.1 Play Game Mode

After the player keys in the game PIN code, the system will first ask the player to rotate the screen for better performance as shown in Figure 5.4.1.1.

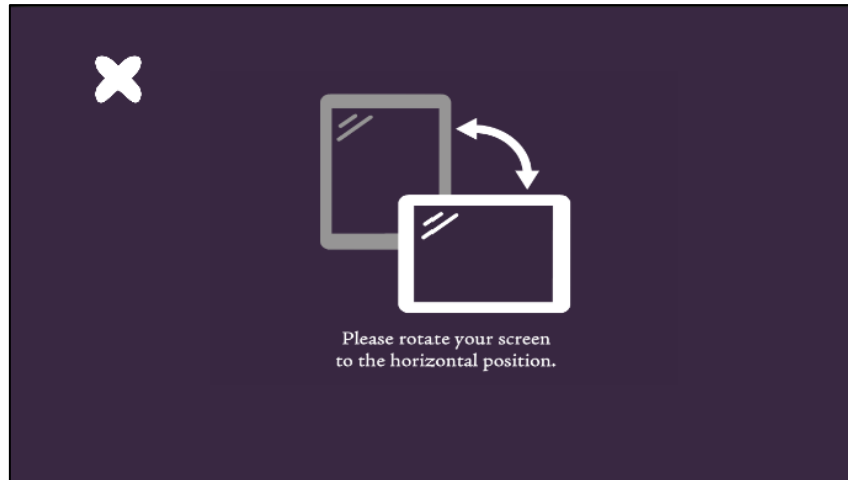


Figure 5.4.1.1 Screen Rotate Notification

After that, the introduction (description) for this treasure hunt game is showed to the player as shown in Figure 5.4.1.2. When the player clicks the next button, it then shows the player the game instruction as shown in Figure 5.4.1.3 to briefly tell the player on how to play the treasure hunt game.

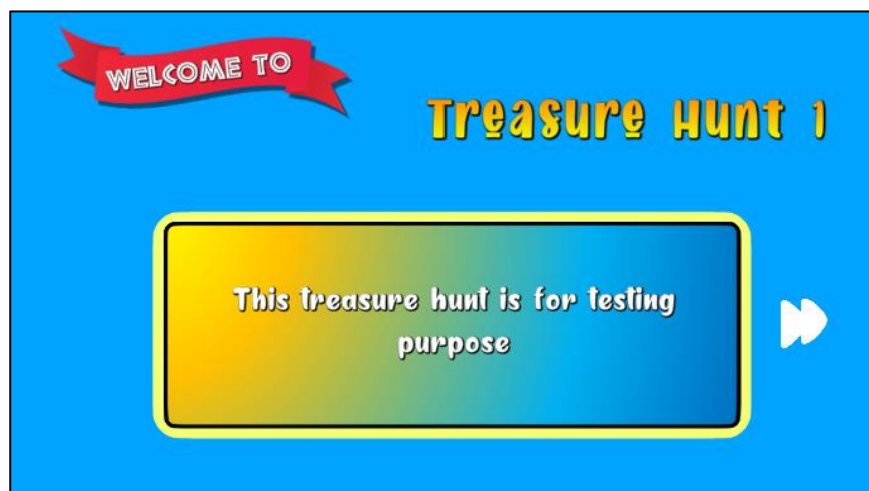


Figure 5.4.1.2 Treasure Hunt Introduction



Figure 5.4.1.3 Game Instruction

Once the player clicks the start button, the player's phone camera is opened up and the clue panel is pop up and showed the player about the treasure's clue as shown in Figure 5.4.1.4. The player needs to find the treasure by following the clue.

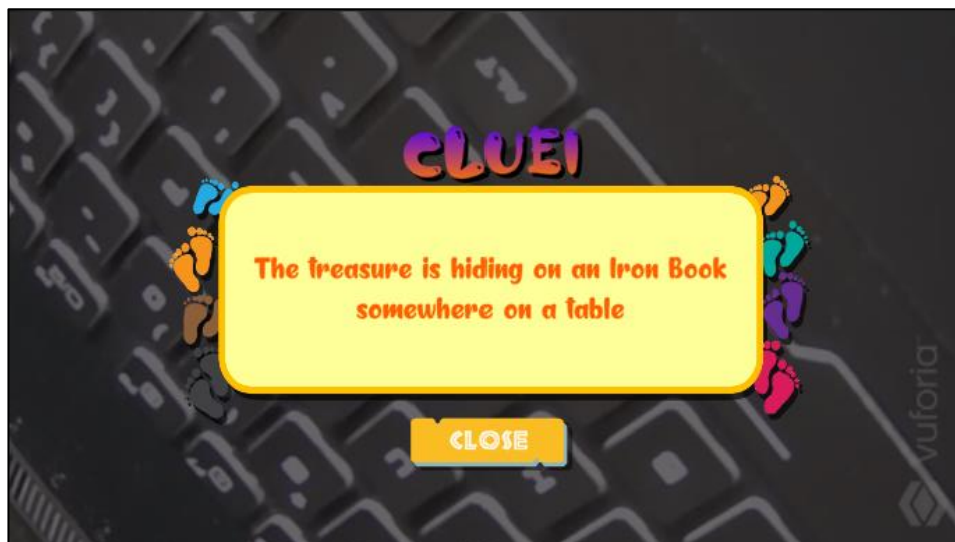


Figure 5.4.1.4 Clue Interface

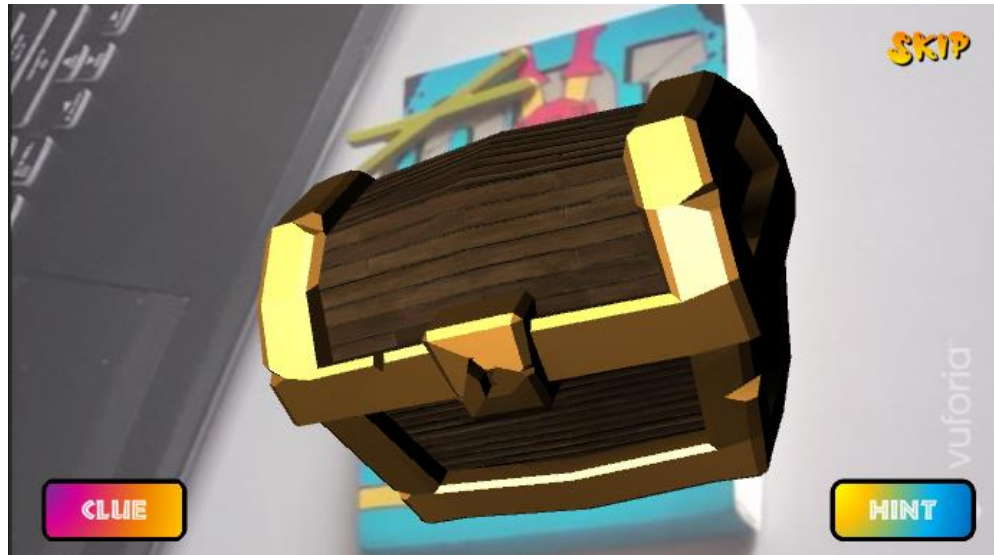


Figure 5.4.1.5 Spawn of Treasure Model on Image Target (AR)

When the player is looking around the surrounding using the camera, the AR engine behind is starting to detect and recognize the area. Once the camera locates the hidden area and the AR engine is able to recognize the image target, the AR engine is then spawned the 3D treasure model on the image target as shown in Figure 5.4.1.5.

To implement this feature, AR technique is applied by using Vuforia library. The computer vision feature provided by Vuforia engine recognizes the image target (image taken by the Creator in create scene) and spawns out the treasure onto the defined image target. The workable code is as shown in Figure 5.4.1.6 which it first looks for the image target (image taken by creator) stored in the phone storage and then creates a trackable (for tracking purpose in real world), a function provided by Vuforia library. Because of this useful feature, it allows the system to track the target in the real world.

```

0 references
public void StartTracking()
{
    VuforiaARController.Instance.RegisterVuforiaStartedCallback(CreateImageTargetFromSideloadedTexture);
}

1 reference
private void CreateImageTargetFromSideloadedTexture()
{
    count = player.getTreasureCount();
    objectTracker = TrackerManager.Instance.GetTracker<ObjectTracker>();
    path = Application.persistentDataPath + "/" + count + ".png";

    // get the runtime image source and set the texture to load
    runtimeImageSource = objectTracker.RuntimeImageSource;
    runtimeImageSource.SetFile(VuforiaUnity.StorageType.STORAGE_ABSOLUTE, path, 0.7f, count.ToString());

    // create a new dataset and use the source to create a new trackable
    dataset = objectTracker.CreateDataSet();
    trackableBehaviour = dataset.CreateTrackable(runtimeImageSource, count.ToString());

    // add the DefaultTrackableEventHandler to the newly created game object
    trackableBehaviour.gameObject.AddComponent<DefaultTrackableEventHandler>();

    // activate the dataset
    objectTracker.ActivateDataSet(dataset);

    // TODO: add virtual content as child object(s)
    cube = Instantiate(TreasureObject);
    cube.AddComponent<BoxCollider>(); //Add box collider for raycast touch event
    BoxCollider collider = cube.GetComponent<BoxCollider>();
    collider.size = new Vector3(0.1f, 0.1f, 0.1f);
    cube.transform.position = new Vector3(0, 0, 0);
    //cube.transform.Rotate(90, 0, 180);
    cube.transform.Rotate(30, 0, 180);
    cube.transform.localScale = new Vector3(15.0f, 15.0f, 15.0f);
    cube.transform.SetParent(trackableBehaviour.gameObject.transform);
}

```

Figure 5.4.1.6 Code Snippet for AR Implementation

Then the player can capture it by clicking the 3D model. Once treasure is being captured, a question panel is opened up and the player needs to answer the question as shown in Figure 5.4.1.6.

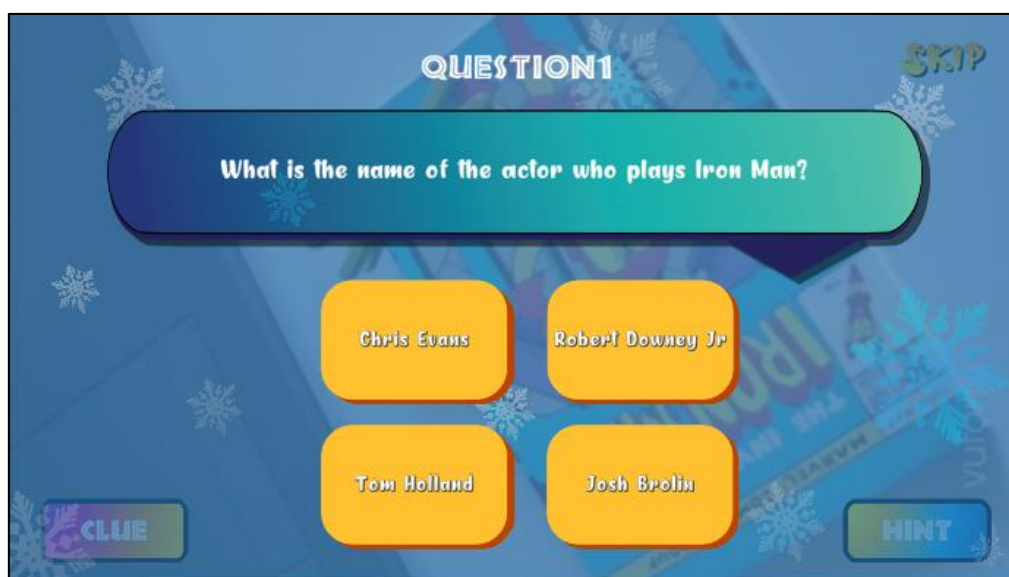


Figure 5.4.1.6 Answer Question Interface

If the player answers correctly, a congratulation message pop up with the animated rainbow confetti as shown in Figure 5.4.1.7. However, if the player answers wrongly, the system alerts the player and comfort the player to keep trying for the next round as shown in Figure 5.4.1.8 below.

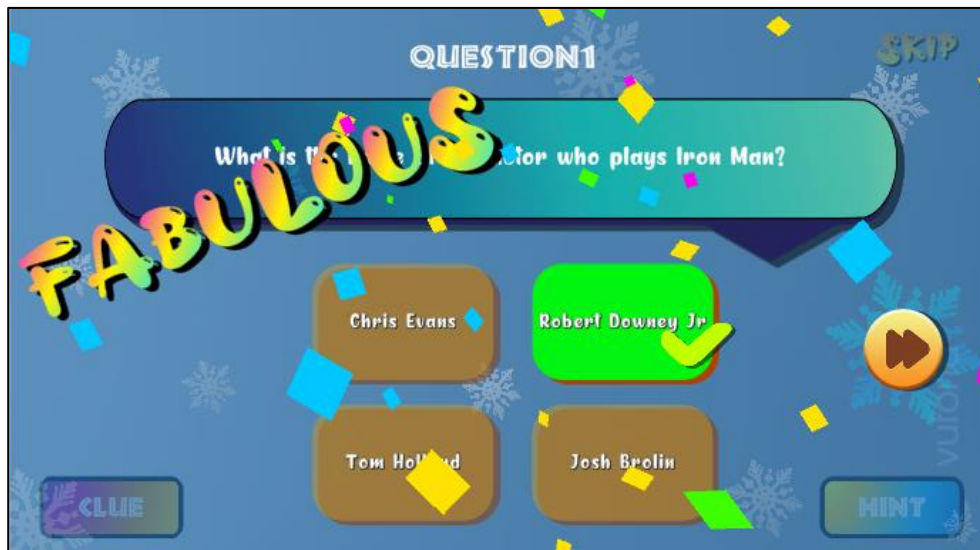


Figure 5.4.1.7 Select Correct Answer



Figure 5.4.1.8 Select Wrong Answer

When player completes the treasure hunt game, a complete screen is opened as shown in Figure 5.4.1.9 which the system records the score obtained during the treasure hunt and then adds into the total player's score. Then, the player can head back to the main page and play another treasure hunt game again with another game PIN code.



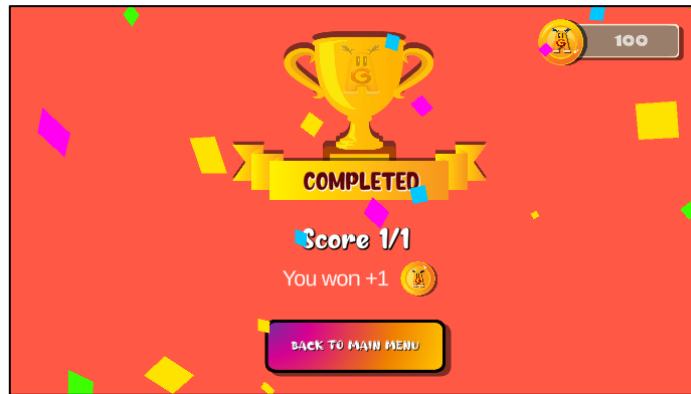


Figure 5.4.1.9 Final Score Interface

### 5.4.2 Unlock Collection

Each player has his or her own collection items. The player can use the score gained during the hunting game to purchase and unlock the item in the collection as shown in Figure 5.4.2.1. For example, in the Figure 5.4.2.1, the player has used the score (coin) to purchase and unlock the characters (items) which are Albert Einstein and Thomas Edison character. Once the player unlocks the item, the player can click into the item to read the introduction as well as the story of the character. Then, the latest score (coin) will be updated in the database as well as the unlock item index list in a text file in the phone storage.

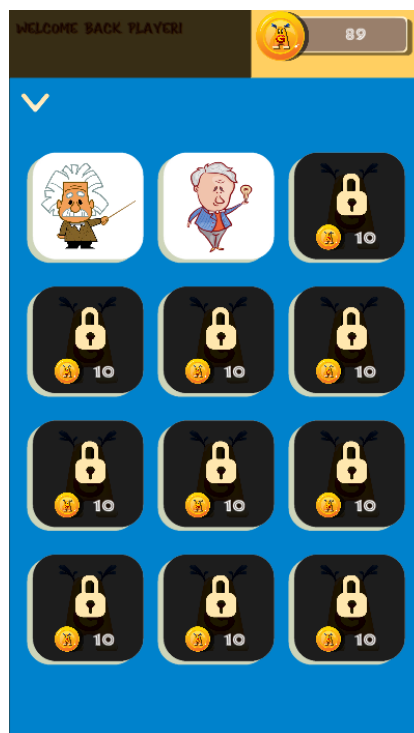


Figure 5.4.2.1 Unlock Item Interface

## CHAPTER 6 CONCLUSION

### 6.1 Project Review, Discussion, Conclusion

With the evolution of technology, variety of technological tools have been created and involved in people life anytime and anyway. Technology is no longer restricted to certain area. Nowadays, most of the schoolteachers have been using technological devices as their teaching tools. It is not just making the teaching process more convenient but also more interesting by changing the way of learning. Therefore, if technological device can be involved in teaching process, so can the game-based learning method. Game should not be treated as an activity that is wasting time and ruining children future. If game is able to utilize appropriately especially in education field, it is able to boost and improve the way of children learning as well as the environment.

Hence, this is the objective for this project which to develop a virtual treasure hunt learning game to improve the interactivity and engagement in learning as well as to improve the teaching method by adopting the current technology trend which is the augmented reality technique to increase the children motivation in learning. Treasure hunt is being chosen as the game feature that acts as the “middleman” to promote learning.

In this project, in order to know more about the treasure hunt game in the current market, review and research have been done. The features, functions and user feedback have been compared and analysed in term of strengths and weaknesses. Then, based on the research, the requirement and features of the application are identified and implemented. In the finalized application, there are 2 roles – creator and player which a user can be a creator or player at the same time. When a teacher is done creating the treasure hunt, the teacher can then pass the game PIN code to the students to play the game. By using this teaching method, students may have a different way of learning.

In conclusion, the main focus for this application is to develop a virtual treasure hunt game with augmented reality feature for education purpose to enhance the learning process.

## 6.2 Novelties and Contributions

This application has used the augmented reality technology in playing game environment to simulate the real treasure hunt game. The real physical treasure hunt game is hiding the real treasure as well as preparing the papercut for the clue. However, for this application, it is trying to get rid of these things by adopting augmented reality which means it is no longer have to hide the treasure at the real place but instead using the phone camera and capture a place to hide the treasure. And even the clue can be set in the application. Not only that, this application is not a general treasure hunt game which its goal to find the treasure. This application has included the Q&A feature as well as the collection item feature which it will let the player to answer the question in order to get the point (score) to unlock the item. Therefore, the goal for this treasure hunt game is becoming to answer the question correctly as much as possible in order to get the maximum point to unlock the item.

## 6.3 Future Work

AR Treasure hunt application still requires some improvement. Firstly, the level of difficulty can be included in the treasure hunt game. For example, a time limit can be included when player tries to answer the question or a time limit when player tries to find out the treasure. This can increase the excitement and the nervousness of the player whenever they play the hunting game as well as increase the difficulty of the whole game.

After that, enhancement can be done at the creator side by adding the statistics or report feature for the creator. For example, whenever player plays the created treasure hunt, the system is able to record the result and show the creator the playing history with the score result. Based on the score result, a report can be generated to the creator so that the creator can know about how well the respondent (player) is able to answer the question.

Last but not least, in the creator side, an evaluation tool can be implemented whenever the creator trying to capture a hidden place for the treasure. Since AR feature is quite sensitive to the surrounding illumination and condition, therefore an evaluation

## CHAPTER 6 CONCLUSION

tool can be created to evaluate the place whether it is satisfied enough to be the hidden place for a treasure. If the satisfying score is achieved, then only the creator can click the capture button to save the hidden place image.

**BIBLIOGRAPHY**

- Ann, J. F., 2019. *Prioritise play in preschools*. [Online] Available at: <https://www.nst.com.my/opinion/columnists/2019/09/517930/prioritise-play-preschools#:~:text=The%20study%2C%20titled%20%E2%80%9CComparing%20the,play%2C%20and%20poor%20parental%20involvement.> [Accessed 26 November 2020].
- Cabral, K., 2014. *Using Minecraft as a Learning Tool*. [Online] Available at: <https://www.scholastic.com/teachers/blog-posts/kriscia-cabral/using-minecraft-learning-tool/> [Accessed 26 November 2020].
- Delhi, N., 2019. *Why are edutainment shows becoming so popular with children?*. [Online] Available at: <https://www.indiatoday.in/education-today/featurephilia/story/why-are-edutainment-shows-becoming-so-popular-with-children-1618850-2019-11-14#:~:text=Edutainment%20shows%20are%20now%20taking,gap%20between%20learning%20and%20playing.&text=This%20not%20only%20> [Accessed 26 November 2020].
- Gamar, 2019. *How to Create an Augmented Reality Treasure hunt*. [Online] Available at: <https://www.gamar.com/blog/how-to-create-an-augmented-reality-treasure-hunt/10> [Accessed 26 November 2020].
- Gamar, 2020. *Welcome to Gamar!*. [Online] Available at: <https://www.gamar.com/> [Accessed 26 November 2020].
- Inspiration Education, 2018. *Why textbooks don't work anymore – and what does*. [Online] Available at: <https://inspirationeducation.co.nz/parent-advice/why-textbooks->

## BIBLIOGRAPHY

[dont-work-anymore-and-what-does/](#)

[Accessed 26 November 2020].

Jevtic, G., 2019. *What is SDLC? Phases of Software Development, Models, & Best Practices*. [Online]

Available at: <https://phoenixnap.com/blog/software-development-life-cycle>

[Accessed 26 November 2020].

Merel, T., 2017. *The reality of VR/AR growth*. [Online]

Available at: <https://techcrunch.com/2017/01/11/the-reality-of-vrar-growth/>

[Accessed 26 November 2020].

QuiverVision, 2020. *World's Leading Augmented Reality Specialists*. [Online]

Available at: <https://quivervision.com/>

[Accessed 26 November 2020].

Rafidi, R., 2020. *Top 3 challenges for students*. [Online]

Available at: <https://www.nst.com.my/education/2020/02/566671/top-3-challenges-students>

[Accessed 26 November 2020].

Revkov, G., 2018. *Catchy Words AR*. [Online]

Available at: [https://medium.com/@rvanie\\_dzinsi/catchy-words-ar-535d14d4d96f](https://medium.com/@rvanie_dzinsi/catchy-words-ar-535d14d4d96f)

[Accessed 26 November 2020].

Scavenger Hunt Ideas, 2018. *Why Scavenger Hunts Are So Important*. [Online]

Available at: <https://medium.com/@aureliatrevett6325/why-scavenger-hunts-are-so-important-1b4e3d88de23>

[Accessed 26 November 2020].

School Advisor, 2020. *The problems with our local education system*. [Online]

Available at: <https://www.freemalaysiatoday.com/category/leisure/2020/02/02/the-problems-with-our-local-education-system/>

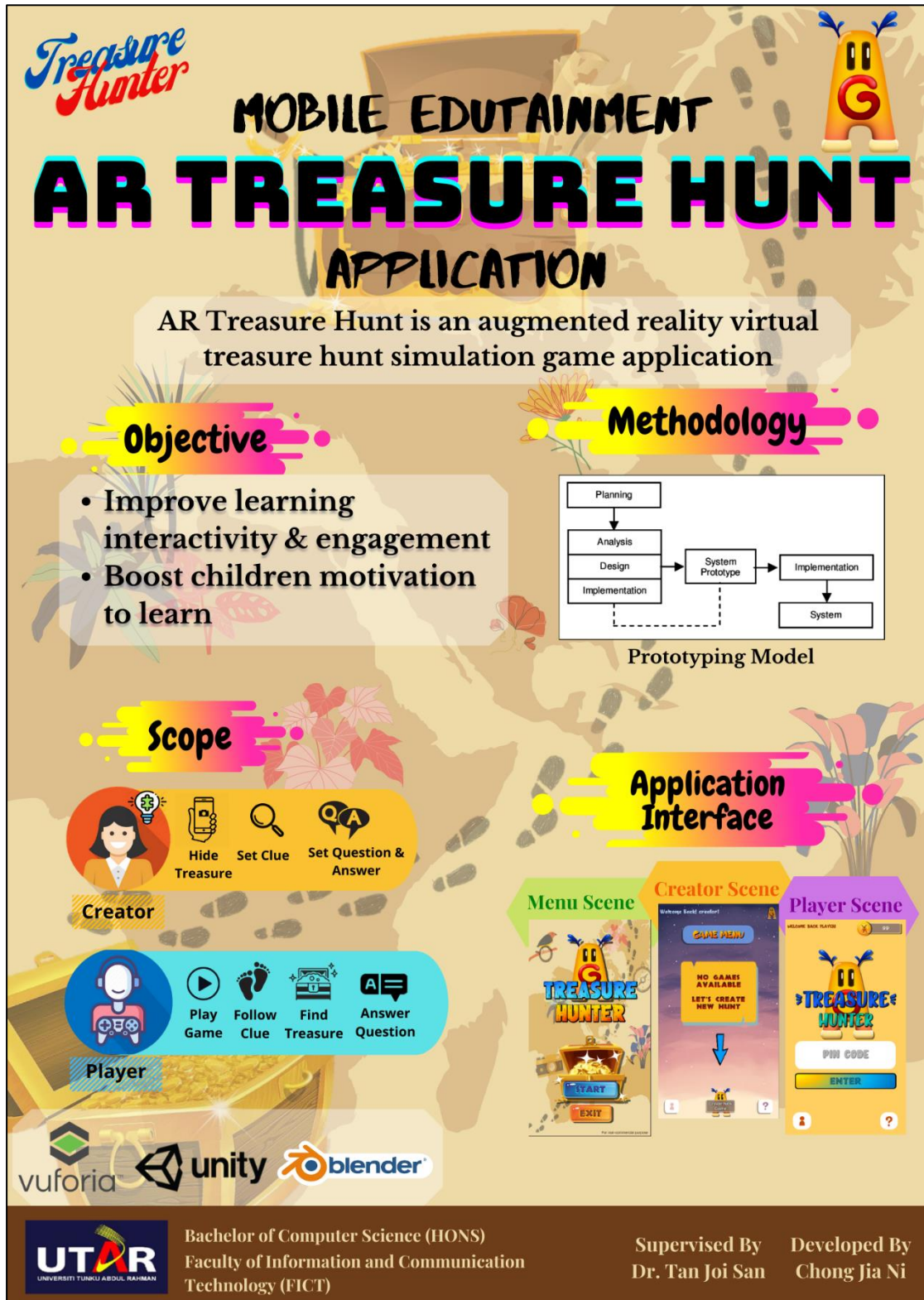
[Accessed 26 November 2020].

## BIBLIOGRAPHY

Simanovics, V., n.d. *App Detail » Catchy Words AR*. [Online] Available at: <https://www.148apps.com/app/1266039244/> [Accessed 26 November 2020].

Soulunii, S., 2019. *Challenges Facing Traditional Education and the Need to Shift to Smart Learning*. [Online] Available at: <https://edtechreview.in/trends-insights/insights/3553-challenges-traditional-education-faces-today-and-the-need-to-shift-to-smart-classroom> [Accessed 26 November 2020].

Sung, H.-Y. & Hwang, G.-J., 2013. A collaborative game-based learning approach to improving students' learning. *Computers & Education*, Volume 63, pp. 43-51.



**Treasure Hunter**

# MOBILE EDUTAINMENT AR TREASURE HUNT APPLICATION

AR Treasure Hunt is an augmented reality virtual treasure hunt simulation game application

## Objective

- Improve learning interactivity & engagement
- Boost children motivation to learn

## Methodology

```
graph TD; Planning --> Analysis; Analysis --> Design; Design --> Implementation; Implementation -.-> Planning; Design --> SystemPrototype[System Prototype]; SystemPrototype --> Implementation; Implementation --> System;
```

Prototyping Model

## Scope

**Creator**

- Hide Treasure
- Set Clue
- Set Question & Answer

**Player**

- Play Game
- Follow Clue
- Find Treasure
- Answer Question

## Application Interface

**Menu Scene**

**Creator Scene**

**Player Scene**

vuforia unity blender

**UTAR** UNIVERSITI TUNKU ABDUL RAHMAN

Bachelor of Computer Science (HONS)  
Faculty of Information and Communication Technology (FICT)

Supervised By  
Dr. Tan Joi San

Developed By  
Chong Jia Ni



## TURNITIN RESULT

## TURNITIN RESULT

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Date: 16th April 2021

Signature of Co-Supervisor  
Name: \_\_\_\_\_

Date: \_\_\_\_\_



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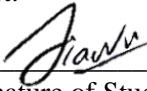

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