USING AR FOR TEACHING SUBJECT RANTAIAN MAKANAN HAIWAN FOR STANDARD 5

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USING AR FOR TEACHING SUBJECT RANTAIAN MAKANAN HAIWAN FOR STANDARD 5

NUR NADIRAH BINTI JAFFRI

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Media Interactive)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2016

DECLARATION

I hereby declare that this project report entitled

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

STUDENT : _____ DATE: 25/8/2016
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SUPERVISOR : _____ DATE: 25/8/2016
(PN NORAZLIN MOHAMMED)

DEDICATION

Praise to Almighty God. For my mother and father, thanks because always support me to complete this project.

ACKNOWLEDGEMENTS

Thanks to the Almighty giving me a good health and strength to finish this project. This report is part of the subject Project I (Undergraduate Project) since I was a final year students, Bachelor of Computer Science (Media Interactive) Universiti Teknikal Malaysia, Melaka (UTeM).

First of all, I would like thanks to Mrs. Norazlin Mohammed as my supervisor, for all the guidance and tutoring that has been given to my project that titled Teaching student animal's food chain via AR.

I would also like to thank both of my parents because give a full of support and advice to me during completing this project. In addition, thanks to my fellow undergraduates who struggled and work together in completing this project. I will not ever forget all the kindness that all of you give to me.

Lastly, thanks to people who are involved directly or indirectly during completing this report and the project until it successfully produced.

ABSTRACT

Animal's food chain is one of the subtopic of animal's life process in Science subjects that will be learned by standard 5 student in primary school. This topic explain about the animals and foods it should eat. Usually, this subject will be learned by using traditional methods of learning such as using print textbooks and simple slide power point prepared by their teacher. Students will be easy get confused to differentiate the animals with the foods it should eat. This is because using this traditional methods, student do not clear about process of animal food chain because do not have any visual or graphic representation same in real environment of the animals life. So, this project is developed to overcome this problem. It is also to help student learnt about topic of animal food chain by enhance a new technique of learning in responsive website and Augmented Reality (AR) technology in mobile devices. This will make easier for student to see process of animal's food chain in 3D images almost same in real environment of animal life. This will make the learning process will be more interactive, creative and fun. The responsive website also has been develop to give information about animal's food chain. There are two foods in 3D images included in this project which is grass and paddy. Meanwhile, there are five animals in 3D images included in this project which is grasshopper, rat, sparrows, snake and eagle. Student also can categorize the foods and animals in their classification.

ABSTRAK

Rantaian makanan haiwan adalah salah satu daripada subtopik proses hidup haiwan dalam mata pelajaran Sains yang akan dipelajari oleh pelajar Tahun 5 di sekolah rendah. Topik ini menerangkan tentang haiwan dan makanan yang ia makan. Biasanya, topik ini dipelajari dengan menggunakan kaedah pembelajaran secara tradisional seperti menggunakan buku teks yang bercetak dan mengguna *slide powerpoint* yang disediakan oleh guru mereka. Pelajar akan mudah keliru untuk membezakan haiwan dengan makanan yang ia makan. Ini kerana menggunakan kaedah tradisional, pelajar tidak jelas mengenai proses rantaian makanan haiwan kerana tidak mempunyai apa-apa representasi visual atau grafik yang sama di dalam persekitaran sebenar kehidupan haiwan itu. Jadi, projek ini dibangunkan untuk mengatasi masalah ini. Ia juga adalah untuk membantu pelajar belajar mengenai topik rantai makanan haiwan dengan meningkatkan teknik pembelajaran baru dalam laman web responsif dan teknologi Augmented Reality (AR) dalam peranti mudah alih. Ini akan membuat lebih mudah bagi pelajar untuk melihat proses rantaian makanan haiwan dalam imej 3D hampir sama dalam persekitaran sebenar kehidupan haiwan. Ini akan menjadikan proses pembelajaran akan menjadi lebih interaktif, kreatif dan menyeronokkan. Laman web responsif juga telah membangunkan untuk memberi maklumat mengenai rantaian makanan haiwan. Terdapat dua makanan dalam imej 3D termasuk dalam projek ini iaitu rumput dan padi. Sementara itu, terdapat lima haiwan dalam imej 3D termasuk dalam projek ini iaitu belalang, tikus, burung pipit, ular dan helang. Pelajar juga boleh mengkategorikan makanan dan haiwan dalam klasifikasi mereka.

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LIST OF ABBREVIATION

AR	Augmented Reality
RAD	Rapid Application Development
VR	Virtual Reality
QR	Quick Response
HMD	Head-Mounted Display
GPS	Global Positioning System
2D	2 Dimensional
3D	3 Dimensional
4D	4 Dimensional
SDLC	System Development Life Cycle
SDK	Software Development Kit
HTML	Hypertext-Markup Language
PNG	Portable Network Graphic
CMS	Content Management System
UAT	User Acceptance Testing

CHAPTER I

INTRODUCTION

1.1 Introduction

Animal's food chain is one of the subtopic of animal's life process topic in Science subjects that will be learned by standard 5 student in primary school. This topic explained about the animals and foods it should eat. Usually, this subject learned by student at school using traditional methods of learning such as using print textbooks and simple slide power point done by their teacher. With this, students will be easy get confused to differentiate the animals with the foods it should eat. This is because using this traditional methods, student do not clear about process of animal food chain because do not have any visual or graphic representation same in real environment of the animals life.

So, this project is developed to overcome this problem and to make student learnt about topic of animal food chain by enhance a new technique of learning in responsive website and Augmented Reality (AR) technology in mobile devices. This will make easier for student to see process of animal's food chain in 3D images almost same real environment in animal life. The potential of using augmented reality learning application as techniques for learning process among students accepted in the community.

This project also developed to help student to improve their understanding about animal's food chain using augmented reality technology and make the learning process will be more interactive, creative and fun. This project also will develop a responsive website that give information about animal's food chain. This website also will provide the simple 2D simulation about process of the animal's food chain. There are link in this website to download the Augmented Reality application in mobile devices about this topic. User can download it and it's also available for free in PlayStore. The link to download the images of animals and foods in the form of flash card also provided in this website

1.2 Problem statements

Before this project developed, there are several problems have been identified. Among which are, before this, the topic of animal's food chain has been taught in traditional methods by using textbooks and simple slide power point. Not more than 10 pages explained about the animals categories based on three groups according foods eaten which is herbivores, carnivores and omnivores. This traditional learning method will make student easy to feel bored and hard to understand the process involved.

Second, traditional teaching and learning methods will make student easy confused to differentiate groups of animals according to food eaten and not all students can memorize, imagine and understand the process of animals food chain same in real situation. In addition, nowadays children or students difficult to see and feed the animals like cow or monkey by themselves unless they go visit this animals at the Zoo.

Third, teacher does not have enough materials to give the real visual or graphic representation to students. Even though, the teaching technique in school have improvement like teacher get sources from the internet about animals food chain but the technique is not effective because do not have visual and graphic representation in real environment of animals life.

1.3 Objective

The objective for this project are:

i. To produce marked-based learning via AR mobile application about the subject Rantaian Makanan Haiwan for standard 5.
ii. To develop responsive website for animal's food chain.
iii. To evaluate effectiveness of learning using mobile devices via augmented reality compared to traditional methods of learning.

1.4 Scope

This project is primarily designed for children that age ranged from 7 to 12 years old. But focused on the 11 years old student which is learned this topic in their primary school. This is because difficult to them to feel by themselves the real environment give feed to the animals. So this project was develop to give the real visual and graphic representation of the animals and the food that it should eat.

The animal's food chain is the subtopic from animal's life process in Science subject for standard 5 .There are two subtopic that are almost similar to this topic namely sun, producers and consumers and foods web topic.

Other than that, this project is focused on mobile device only and apply the augmented reality application. The responsive website are also will be develop to give information about the animal's food chain topic. There are link in this website to download the animals food chain learning in mobiles devices via AR and also the animals and food images in form of flash card. Since Augmented Reality technology is applied on this project, hence identification (ID) marker type is chosen and implemented within a flash card named Animal's World card.

Next, there are simple animal's food chain process that will be included in this application. So, this small animal food chain process are chosen to use and test for the effectiveness of this mobile learning application via AR.

1.5 Project Significance

This mobile learning application via AR is suitable for the standard 5 students who get confused or hard to identify the animals and food that it should eat. All the animals and food in this application will be displayed in 3D images. So, this helps them to understand the real process happen in animal's food chain.

The responsive website and mobile application via AR also will help teacher to deliver the knowledge and important element about this topic to student will be more interactive, creative and fun. Teacher also can give real visual and graphic representation of animal's food chain in real environment of animal's life.

This learning application can be used directly in mobile devices and it can be downloaded for free from the website provided and in the PlayStore. The animals and food images in form of flash card also need to be downloaded to test the successfully of the learning methods using mobiles devices via AR.

1.6 Conclusion

In conclusion the aims for this project is to develop an Augmented Reality mobile learning application which named Animals Food Chain that implement ID marker within the animals and food flash card provided in responsive website about Animals Food Chain to deliver this Science topic focus to standard 5 students. In this website will show to first time user what phases included in this animal's food chain topic. There are simple 2D simulation about animals food chain also will be included in this website. The mobile application learning via AR will give visual or graphic representation same in real environment to them about the animals and foods that it should eat. So, this can increase their understanding about this topic compare to traditional methods of learning.

CHAPTER II

LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

Literature review and project methodology for developing Animals Food Chain via Augmented Reality (AR) in mobile application would be discussed in this chapter. Literature review is an important role in developing this project. It is about collecting, analyzing and conducting the reading and do the research about the related topics of the project that implemented. The reading sources for the literature review are from the books, articles, journal, and Internet. The literature review will be done by searching articles about animal's food chain, reference book about Augmented Reality (AR) in library, and others information about the technology and tools that is going to use during developing this project.

Project methodology that used to develop this project is Rapid Application Development (RAD). RAD models consist of 4 phases, which is requirement planning, user design, construction and cutover phases. Each phase in this models is important

during the process of this projects and it needs to be followed to avoid project failure and as a framework to tell developers what have to do, and to manage the project from beginning to end of the project. Software and hardware requirements are listed also will be explained in detail in this chapter. Milestone of the project is also provided at the end of this chapter to demonstrate the whole progress of the project and duration of the task to be done.

2.2 Domain

Domain for this project is about Augmented Reality and used mobile devices as a platform to view this AR application. Marked-based AR application are choose to develop this project using printed flash cards of several animals and food it should eat in animal's food chain topic. According to Sanni Siltanen (2012) a marker-based approach solves the problem using visual markers, example 2D barcodes, detectable with computer vision methods. The database to store all the image target is using Vuforia. AR platform are chosen in this project because it can give visual graphic representation of animal's food chain same in the real environment of animal life.

2.3 Facts and Findings

Facts and findings for this project include the definition of food chain and evolution of AR, what kind of existing methods to teach student about animal's food chain in school, the existing mobile learning applications using AR and the comparison between it.

2.3.1 Food Chain

A food chain indicates what feeds on what, it also shows how energy flows from one living thing to another. A chain will always start with a plant (a primary producer). In any habitat, lots of different food chains will be present and many will be interlinked forming food webs. Food chains show the relationships between producers, consumers,

and decomposers, showing who eats whom with arrows. According to Susan H. Gray (2008), food chain follow single path example which is start with a plant, eaten by a grasshopper, fish eat the grasshopper and bear eats the fish. The arrows show the movement of energy through the food chain.

Plants make their own food through process called photosynthesis. Since they make or produce their own food they are called producers. Organisms which do not create their own food must eat either plants or animals. They are called consumers. Primary consumers is the animals that feed only on plants, Susan H. Gray (2008). Some animals get their energy indirectly from plants by eating other animals that already ate the plants. Animals that eat only plants are called herbivores. Animals that eat both plants and other animals are called omnivores. Animals that eat only other animals are called carnivores. Some animals eat only dead or decaying materials and are called decomposers.

2.3.2 Augmented Reality (AR)

According to Margaret Rouse (2016), Augmented Reality (AR) is integration of user's environment with digital information system that enhances the real world by use existing system computer generated information and overlays new info on top of it. It is also allow developer to do animation and digital information in computer programs to an augmented reality 'marker' in real world, Margaret Rouse (2016). Augmented Reality is a live, copy, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. AR is related to Virtual Reality (VR). VR's concept is to create an entirely artificial environment which generated in 3D by digital technologies that allow users to experience and interact through their sense of vision. AR is implements an interactive experience but aims to supplement the real world. It is an advanced technology that allows computer generated virtual imagery information which must be registered in 3D and overlaid onto a live direct or indirect real-world

environment in real time. AR used computer-aided graphics to add an additional layer of information to aid understanding and interaction with the physical world.

AR also provides sub immersive feeling for user which allows interaction occur between the IT and virtual world. According to Jack E. Gold (2015), user can have an experience with the real environments with this Augmented Reality technology. However, AR needs an accurate scene registration so that the virtual world can be aligned properly to the real world to produce this illusion. There are many papers have widened the definition of AR and researcher has defined that an AR system requires all of the three characteristics which is combines real environment and virtual objects, interactive in real time and registered in 3D. Augmented reality is hidden content, most commonly hidden behind marker images that can be included in printed and film media, Dat Studio (2008). AR platform can be define as a system that combines real and virtual objects in real environment, runs interactively and real time and registers real and virtual objects with each other. According to Dat Studio (2008), educational reading materials at school such as textbooks and flashcards can contain embedded 'markers' that when it is scanned by AR devices can produce supplementary information to student with text, video and audio that can superimposed into a student's real time environment.

2.3.2.1 Types of AR

The performance of an AR system are depend on the highly tracking method which is visual marker detection, pose estimation, and also depend on the application, Jose Dolz (2012). There are two type of AR which is can be marker- based or marker-less. Marker-based augmented reality is when the tracked object is black-white square marker. Most of the nowadays AR apps dealing with image recognition are marker-based because it much more simple to detect things that are hard-coded. A marker-based application works by having software to recognize a particular pattern, such as the Quick Response (QR) code, two-dimensional (2D) black and white pattern or 2D picture marker, when a camera points at it, and 2D or 3D images will be display on the

screen and it is shown in Figure 2.1 . It also can recognized by computer webcam or mobiles devices which are superimposed in real time multimedia contents such as video, audio or 3D objects.

Instead, in the marker-less AR system the software application catches the user's positional and orientation data through GPS and compass device adding the virtual contents in an accurate position on or in the real environment. Marker-less augmented reality is when the tracked object can be anything else such as picture, human body, head, eyes, hand or fingers and on top of that you add virtual objects. There are 4 types of interaction that can be included creating the augmented reality learning application such as automatically detecting real environment, gesture interaction, multimodal input and intelligent interface. This marker-less technology as shown in Figure 2.2. The example of the Markerless AR is the Google glass, AR spec, sixth sense device and etc. Therefore, marker-less application has wider applicability that marker-based application as it is functional at anywhere and anytime without the need for special labelling or reference points. According to Jos Dolz (2012) markerless are much better application because they use normal images or objects as targets and no invasive like marked-based.

Figure 2.1: Marked-based application

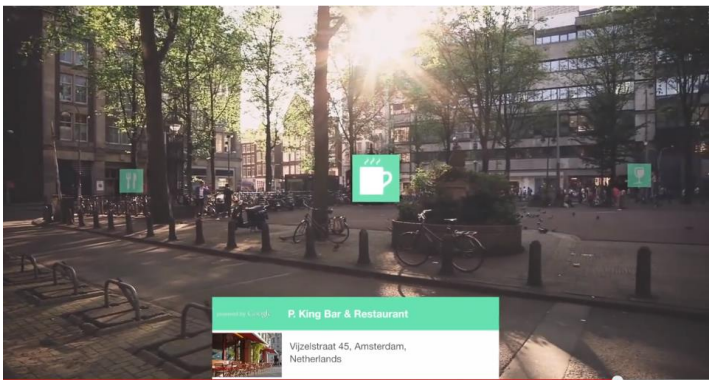


Figure 2.2: Markerless application

Table 2.1 Marked-based VS Markerless AR

Type of AR	Advantages	Disadvantages
Marked-based AR	1. Easily to identify the object. 2. Low cost because not require high capacity of camera. 3. Easy to implement.	1. It provides accuracy in 2D image or shapes only.
Markerless AR	1. Can identify 3D or real object. 2. Can be used anywhere because does not require marker.	1. Hard to implement. 2. Not cost effective.

2.3.2.2 Hardware Components for AR

AR requires four main hardware components which are display, tracking, input devices and computer. Traditionally, Augmented Reality (AR) application have used Head-Mounted Display (HMD) for visual output. The example HMD component show

in Figure 2.3. Using a HMD allow user's visual field to be completely immersed in the augmented environment making any virtual objects seem present and persistent in the real world. Second, AR display technique is handheld display. The first hand held display configured as a magic lens where user sees what is directly behind the display. The second hand held display is configured to be used at waist level (commonly like hold a tablet computer) but the view is still of the scene in front of user. Figure 2.4, show the example of hand held display in AR. Other than that, the portable computing device needs some automatic way of finding out the locations such as digital cameras, optical sensors, Global Positioning System (GPS) and other technologies.

Figure 2.3: Oculus HMD

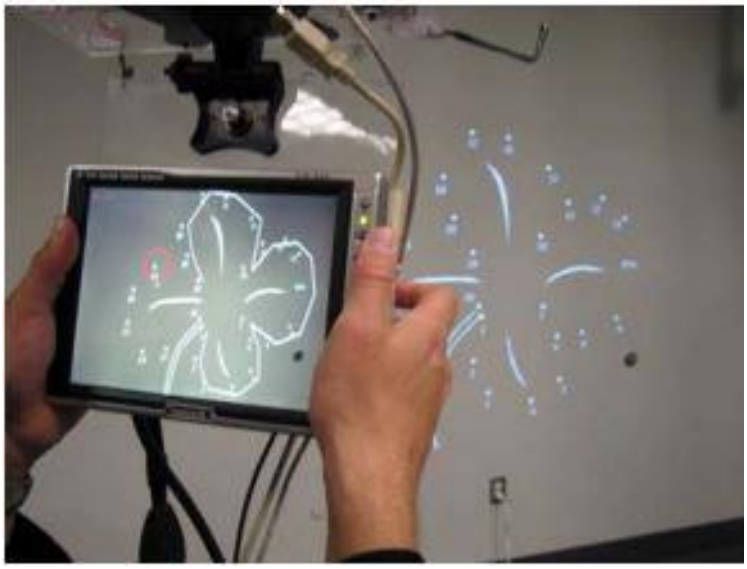


Figure 2.4: Hand held display

2.3.2.3 Application of AR

Nowadays, AR is widely used in every field and there are different kinds of application have been developed in those fields such as medical, education, interior design, tourism and sightseeing, navigation, entertainment and other fields. For example, interior design where the IKEA catalogue uses augmented reality to give a virtual preview of furniture in a room. For example the furniture shown in Figure 2.5. This application allows the users to arrange the placement of the furniture as they like before purchasing it. Besides that, users can move around the marker at the desired destination to see how the room or house looks after the arrangement of furniture. With this application, users do not worry about the placement of the furniture and can help them save the time as well.

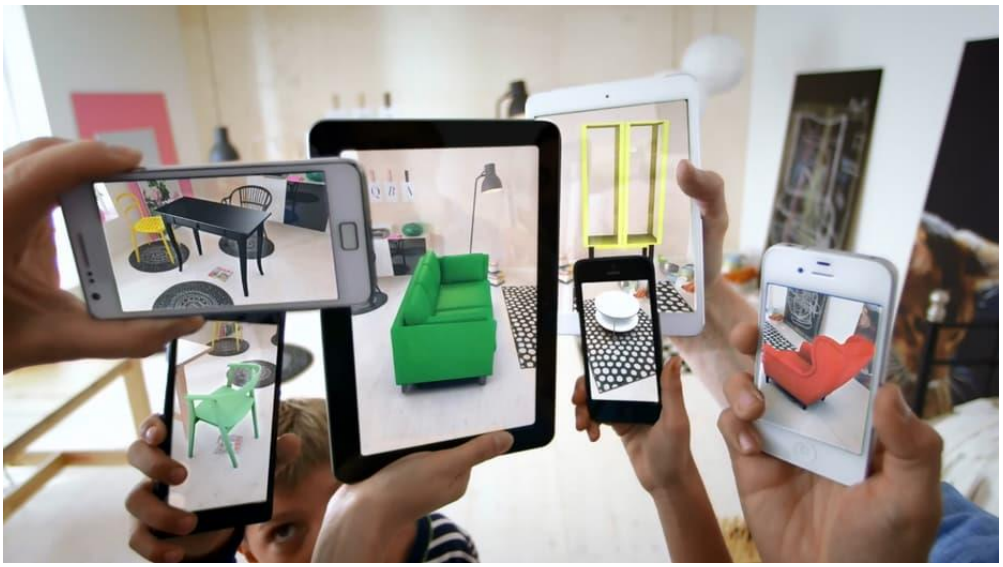


Figure 2.5: A virtual furniture appear in living room

Another example of AR application is in education. Nowadays, many magazines, textbook, flash card or any subject reference book has attached marker inside it. Students just need to point their mobile device's camera on the marker provided, the hidden content will overlay on the screen in 2D or 3D images. Student can enjoy to play with it. This learning application using AP will make student easier to understand the contents and information that want to deliver to them. Figure 2.6 is one of the examples that applied AR in education.

Figure 2.6: A giraffe is appeared on screen after detect the marker.

2.3.3 Existing System

The existing method that use for children to learn about animal's food chain is using traditional method which is printed textbooks. With this student easy getting bored and hard to understand the topic because students cannot see the visual graphic representation same in real environment of animal life. According to Harriet and Arthur(1989), textbooks fail to interest student in a subject that many critics see as there is no interesting even exciting for student. Textbooks also provide minimum requirement for student to really understand about the subject they learned, Harriet and Arthur (1989).

There are different types of mobile application for learning animals are available in App Store or Google Play Store which allow user to download and learn animals through their devices. Animal4D+, AR-ANIMALS and AR Flashcards-Animals Alphabet are the examples of mobile application for learning animals.

2.3.3.1 Textbooks

Every school using traditional methods of learning which is using printed textbooks. Students easy to get bored and lose their focus during learning session in classroom because textbooks do not give any visual representation what has been learned. Animal's food chain topic is included in the Science Textbooks for Standard 5. Figure 2.7 show the image of the textbooks.

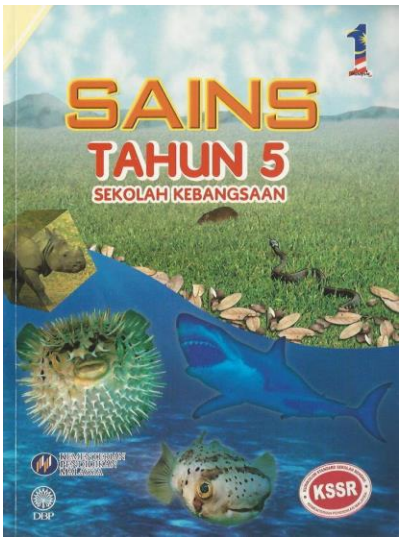


Figure 2.7: Image of Textbooks

2.3.3.2 Animal4D+

Animals 4D+ is one of the product produce by Octagon 4D+ Studio. It is a pack of cards, with 26 illustrations of animals, representing each alphabet letter from A to Z. Anyone with a phone or tablet can bring this Augmented Reality circus to life by just downloading 'Animal4D+' app from the App Store or Google Play for free.

Animal4D+ is a marker-based application. It has its own special marker. It show virtual animals in Augmented Reality. There are 26 illustration of animals in 4D. Many animals can be viewed simultaneously. Users of all ages could enhance their learning abilities through fun, interactive media. User can use this application by point their mobile device's camera to detect the marker on the flash card. If the camera can recognizes the marker, a 4D images of the animals will view on the screen. The animals will moving around and also will produce sound. Octagon 4D+ Studio also provided interaction between animals and food it should eat. User need to detect marker of the animals and foods. Animals will moving from static position and go to foods it should eat. The example of Animals 4D+ and foods flash card show in Figure 2.8 and Figure

2.9. Figure 2.10 show the interaction between animals and foods using augmented reality application in mobile devices.

Figure 2.8: Marked-based Animal4D+ flash card

Figure 2.9: Marked-based foods flash card

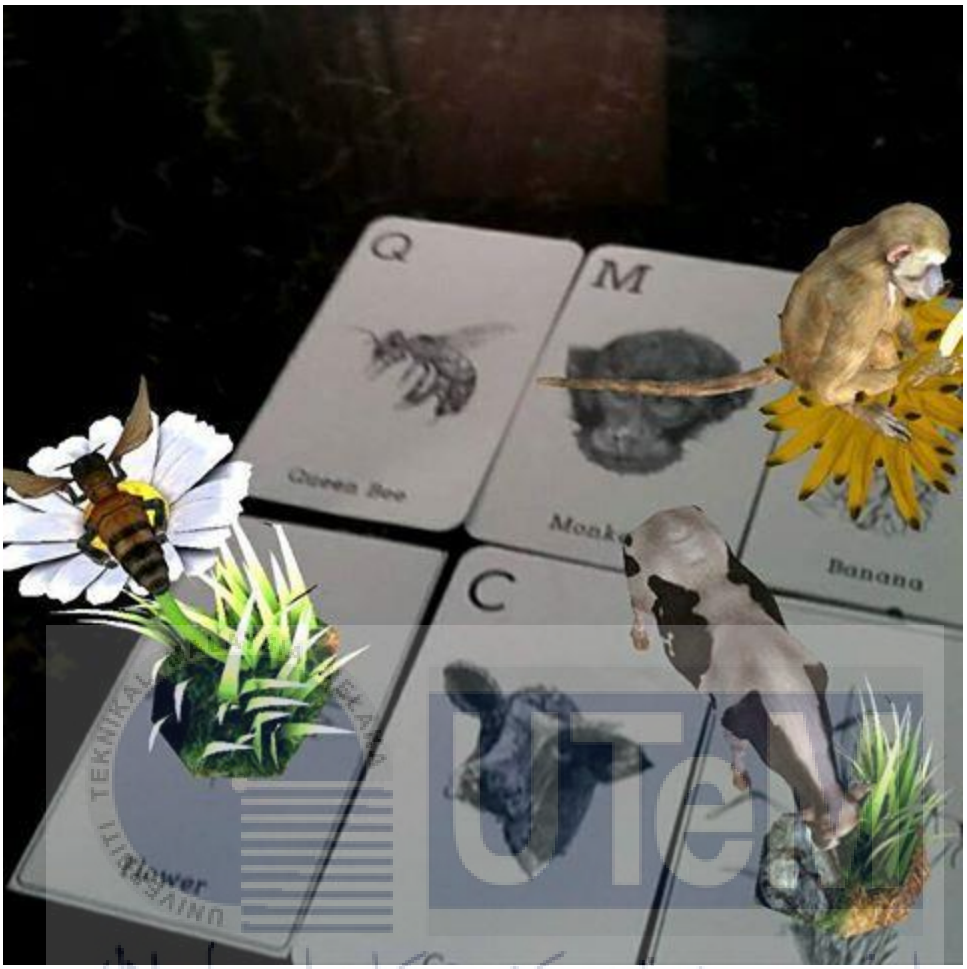


Figure 2.10: Animal4D+ interaction between animals and foods.

2.3.3.2 AR-Animals

AR-Animals is the application that allow users to explore the animals' world. There are 34 animals consist of farm animals, forest animals, jungle-wild animals and Dinosaur. With this AR-Animals, children between 2-7 can learn how to different the animals walk or even how they move, how they eat, what they eat, if they are vegetarians or carnivores, and the sounds they make. Children also can learn to distinguish different animals, and how to spell them.

This AR-Animals application is marked-based application. When mobile devices or tablet's camera scans the specific photo (marker), 3D animal alive in front (through the device) like a hologram. This animals can move from static position and also can

produce sound. This application also provide interaction between animals and food it should eat.

Figure 2.11: Marked-based AR-Animals.

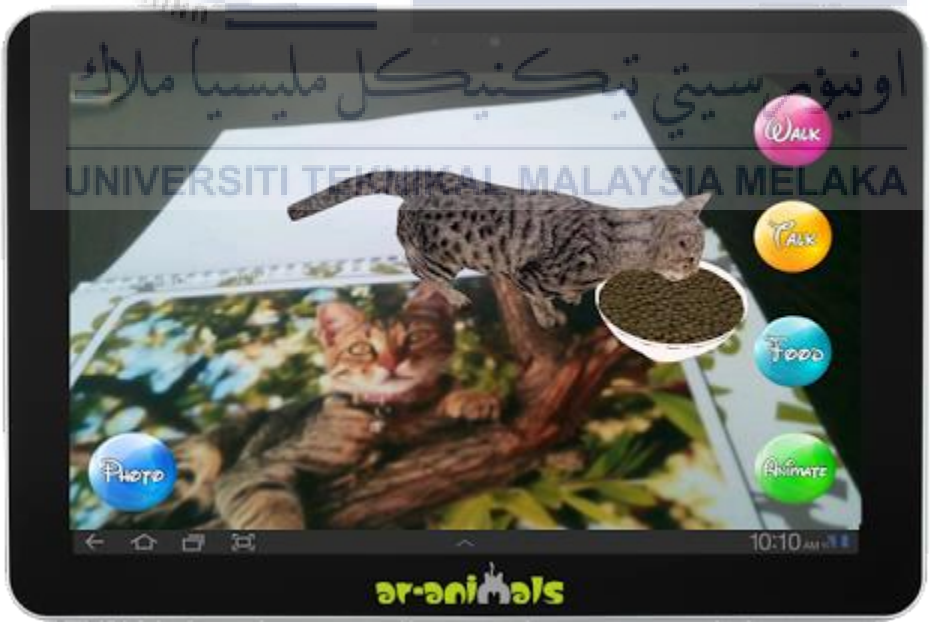


Figure 2.12: AR-Animals interaction with food they should eat.

2.3.3.3 AR Flashcards - Animal Alphabet

Animal Alphabet is one of the application that used flash cards and have AR-marker on it. Users can scan the marker on the flash card to see the 3D animals. The limitation of cards on one screen, seems to be by around 10 cards, which is extremely remarkable. User can simply print out the AR-cards. There are 26 animals in represent each alphabet.

The white boarder on the flash card should not be cut of, as this helps for AR-detection. Another fantastic feature is the audio response to each letter and animal. As with all flashcards, press on each animal on screen, to get a response to either the letter or animal. This is a really great educational use and feature for children. Users can view and arrange animals from all angles.

Figure 2.13: Example of Animal Alphabet's AR-Cards

2.3.4 Comparison of the Existing Application

Table below showed the comparison of the existing application which related to animals. Categories that compared among three existing mobile application are technology applied, AR's SDK used, tracking method, price, platform, content creation, numbers of content, pros and con.

Table 2.2: Comparison of the existing application

Categories	**Science Textbook for Standard 5**	**Animal4D+**	**AR-Animal**	**AR Flashcards-Animal Alphabet**
Technology applied	No technology applied	AR	AR	AR
Tracking method	No	Marker printed flash cards	Printed cards	AR Flashcards
Price	RM13.20	Free	Free	Free
Price of marker printed cards	No marker	RM 45.00	RM 34.97	Free
Platform	No	Android 4.1 and up and iOS	Android 2.3 and Up and iOS	iOS
Content creation	Printed images of the animals and foods	3D animation of animals and foods, audio and interaction between animals and foods.	3D animation of animals and foods, audio and interaction between animals and foods	3D animation of animals and audio.
Numbers of content	2-10 animals	26 animals and 4 foods	34 animals	26 animals represent each alphabet and 6

				beautifully rendered Dinosaurs.
Pros	• Easy to bring anywhere	• User can use the AR mobile application provided everywhere. • User can download the example animal4D+ flash card and foods flash card.	• Free download the application for Android and iOS mobile devices.	• User can download the 26 animal's alphabet flash card.
Cons	• Students easy to get bored.	• User need to buy the flash card to test the interaction between animals and foods	• User need to download and print the cards at $1,99	

2.4 Project Methodology

Rapid Application Development (RAD) models consist of 4 phases, which is requirement planning, user design, construction and cutover phases. The first phase, which is requirement planning phase, combine elements of the system planning and systems analysis phase. Second phase is user design process, which is analyst and develop models and prototypes that represent all the project process, input and outputs and also determine learning process based on audience need. Next, construction phase which is focus on program and application development task. Lastly, is cutover phase which is including data conversion, testing, changeover to new system and user training.

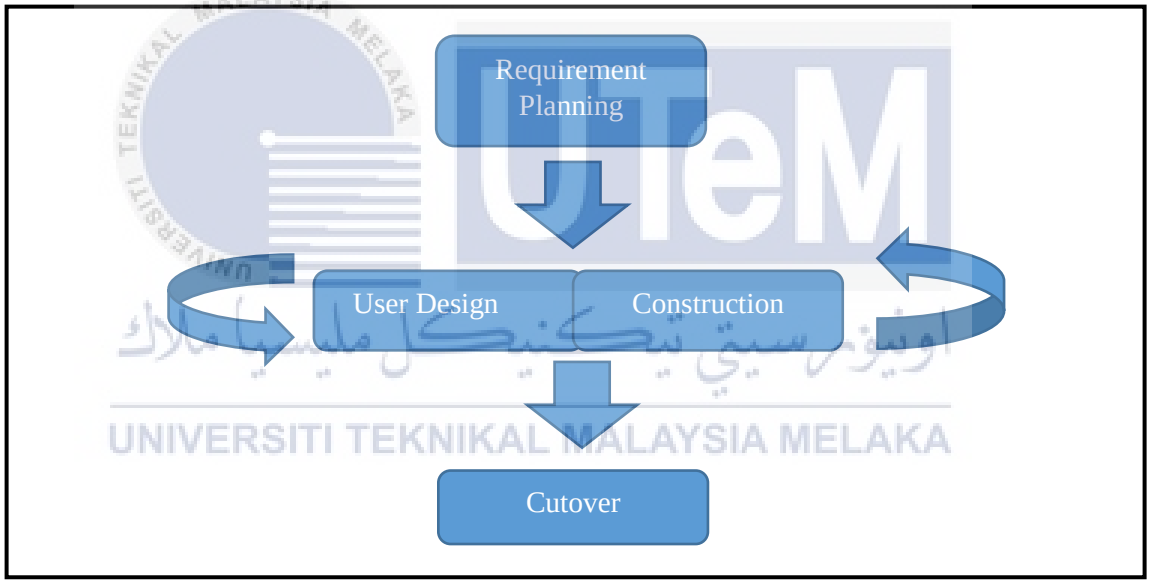


Figure 2.14: Multimedia Production Process

Requirement Planning

- **Planning and analysis phase**

During this phase, system requirements for the system need to be stated. When the supervisor agree and give approval on the title of project and the subject matter,

obtain management authorization to continue. Planning to analyse the level knowledge of the user about this augmented reality technology whether they have use this technology or not before this. In addition, study on what age of student that learn about the animal's food chain and state the requirement needed.

User Design

- **Development Phase**

This phase is about analyst and develop models and prototypes that represent all the project process, input and outputs and also determine learning process based on audience need. Create a mobile devices learning application using augmented reality technology and focus on animal's food chain topic for Science subject for standard 5.

- **Implementation Phase**

Modelling the animals and foods character using Autodesk Maya to make it become 3D images. Produce sound of the animals and create the interaction between the animals and food that it should eat. Develop responsive website about animal food chain. Create a simple 2D illustration about this topic and display it in this website. Create the example of animals and foods images in form of flash card, so user can download it at the link provided in the website. The flash card is marker-based that be captured when using AR application that have been developed in Unity3D.

Construction

The construction phase which is focus on program and application development task similar to the SDLC. In RAD, user can participate in this phase and can still suggest changes or improvement as actual output. Its task are programming and application development, coding, unit- integration and system testing.

Cutover

- **Testing Phase**

Once the coding of the application complete, the testing will be carried out to check whether the contents have any errors in the designed application and the designed software has been designed as per listed specifications. Besides that, this mobile application is also tested on multiple version of Android mobile device. In addition, make sure the application can be run smoothly and the effectiveness of the learning process using this technology can be achieved. After successfully testing the application, it is delivered to user.

- **Evaluation phase**

This phase determine whether this project fulfilled the earlier objective or not. In this phase, questionnaire session will be conducted to selected student's age ranged 7 to 12 years old and also their teachers to answer question that has been stated. They also will try out the mobile application that developed. Developer will collect the data from the questionnaire from the students and teachers.

2.4.1 Instructional Design

Instructional design is about the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. This instructional design will discuss about the educational goal, expected output, detailed course content and also the test questions for the project.

2.4.1.1 Educational goals

Teaching student animal's food chain via AR will make students easy to understand because have the visual representation about food chain same in real

environment of animal life. Student will also be able to categorize the animals with their classification after using this AR application. According to Dat Studio (2008), student also can learn through experience, besides when they were so young, they need see to learn. For example students can learn about astronomy which is usually difficult to acquire them. But using AR application they can have better understanding about the solar system because will able to see it in 3D. Mobile application using augmented reality also suitable in classroom environment, Dat Studio (2008).

2.4.1.2 Expected Output

The expected output for this project is can develop responsive website to give information about the animal's food chain. In this website will show simple 2D simulation about the animal's food chain topic. The mobile learning application named Animals food chain via AR can install successfully in Android mobile device with version 4.0 or higher at link provided in the responsive website and also for free at PlayStore. Next, to produce marked-based learning application via augmented reality in this application. Besides that, this mobile learning application can function well with the ID marker provided.

For the first time user, they can download this application for free in Play Store and it only can be function and used if the user downloaded the animals and food images in form of flash cards that has been created. There are two type of elements in this flash card which is animals and foods. When user scan the animals and foods picture in this card using the application that has been downloaded, the animals will move from static position and go to the foods that it should eat.

2.5 Project Requirements

Project requirements are discussed about software and hardware requirements that used for developing the application.

2.5.1 Software Requirement

Software requirement is divided into two categories which are development tools and documentation tools.

2.5.1.1 Development Tools

Developments tools that use to develop this project is:

i. Unity3D
ii. Android SDK
iii. Vuforia
iv. Autodesk Maya 2012
v. Adobe Photoshop CS6
vi. Adobe Illustrator CS6
vii. Adobe Dreamweaver CS6.

2.5.1.2 Documentation Tools

Developments tools that use to develop this project is:

i. Microsoft Office Word 2013
ii. Microsoft Visio 2010
iii. Microsoft Office PowerPoint 2007

2.5.2 Hardware Requirement

i. Laptop
ii. Android Smartphone

2.5.3 Other Requirements

i. Printer

2.6 Conclusion

This chapter discussed about the literature review and methodology for this project. The literature review is done by collecting, analyzing and conducting the reading and do the research about the related topics of the project that implemented and concluding the technology and technique of learning that being applied at the school for student learn animal's food chain. From the observation, animal's food chain has been taught in traditional methods by using textbooks and simple slide power point. This traditional learning method will make student easy to feel bored and hard to understand the process involved. Teacher also does not have enough materials to give the real visual or graphic representation to students about this topic.

Rapid Application Development is chosen as the project methodology for developing this application. It includes consist of 4 phases, which is requirement planning, user design, construction and cutover phases. All activities are divided and listed in the stage respectively. Besides that, the required hardware and software that used to develop this application have been listed and explained in detail in this chapter. Other than that, milestone of the project is stated and provided as a guide for developer.

The next chapter will be discuss about analysis in detailed. This chapter is analysis the product by identifying the requirement of the product and how it will be accomplished. It also will includes user requirement, functional requirement, non-functional requirement, and system architecture of this project.

CHAPTER III

ANALYSIS

3.1 Introduction

This chapter will explained further about the system by identifying the requirement and how it will be accomplished. Analysis phase is one of important phases as the best solution to solve the existing system's problem that stated previous. There are two parts of analysis phase which is current scenario analysis and requirement analysis. Current scenario analysis is about the generic flow of existing scenario representation and the information about the existing system. Besides that, in the requirements analysis part, it will describe the problems of the traditional methods of learning, the functional requirements that will be included in the current application and defines the ways of gathering information.

3.2 Current Scenario Analysis

Current scenario analysis is identified the flow chart and architecture of the three current existing mobile applications that has been stated on the previous chapter. Different types of SDK for AR in mobile are available to download such as Metaio

SDK, Vuforia SDK, String, Wikitude and others. Hence, in order to understand the architecture and flow process of the current existing mobile applications, the types of the AR SDK that used by the current exiting mobile applications will be identified and explained in sub-section.

3.2.1 Science Textbooks Standard 5

Science textbooks standard 5 is a printed textbooks. Food chain is one of the topic are includes in this textbooks. This topic show the example of animal's food chain which is at different habitat at paddy fields and oil palm plantations. This example are presented in printed images in this textbooks. Students easy confused to differentiate animals and habitat they should live. Figure 3.1 show the flow of student learn using printed textbooks.

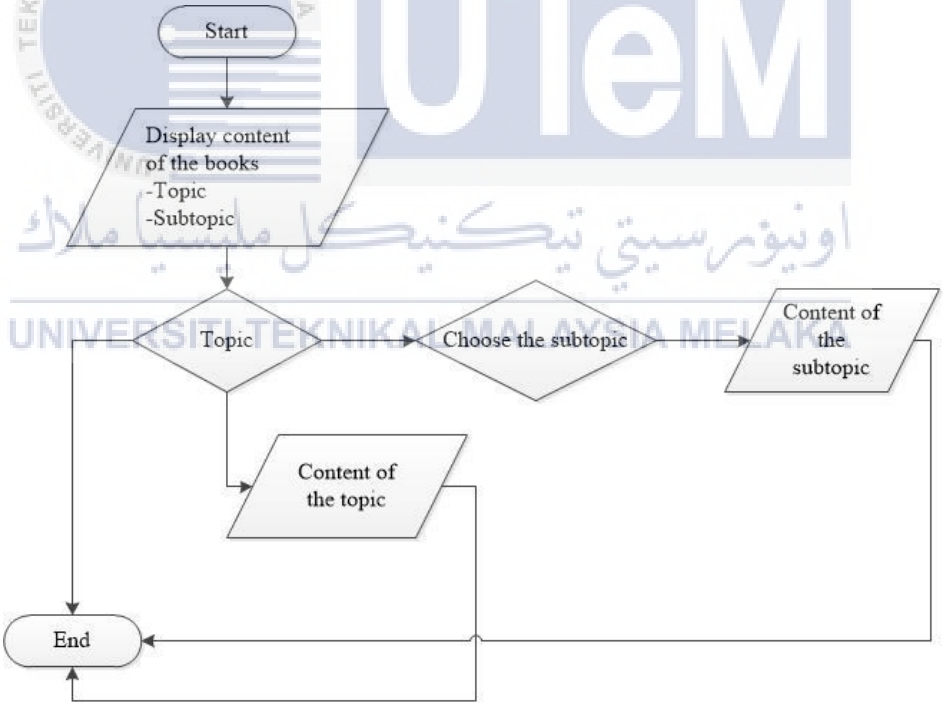


Figure 3.1: Flow process using textbooks

3.2.2 Animal4D+

Animals 4D+ is one of the product produce by Octagon 4D+ Studio. It is a pack of cards, with 26 illustrations of animals, representing each alphabet letter from A to Z. Anyone with a phone or tablet can bring this Augmented Reality circus to life by just downloading 'Animal4D+' app from the App Store or Google Play for free. Animal4D+ was using Vuforia SDK to implement AR technique. Vuforia SDK is another well known AR SDK for mobile devices that enables the creation of AR applications. Vuforia provides API in C++ language, Java, Objective C and the .Net languages through an extension for the Unity game engine. Vuforia supported for iOS and Android platform.

There are simple instruction how to use this application at the front menu. There are three options provided in this Animal 4D+ application. Table 3.1 explained each function of options in this application. Figure 3.2 is explained the flow of the mobile application of Animal4D+. 4D animals will appear in the screen if mobile devices scan the 4D flash card that need to buy. Besides that, there menu to see the simple interaction between animals and food it should eat.

Table 3. 1 : Options Menu in Animal4D+

Options	Description
VR Mode	There are two separate mode.
Interaction	There are three type of simple interaction between animals and food it should eat. Example like monkey and banana.
Tools	There are three option of tools which is capture, swap camera and rotate.
Instruction	Simple description the way how to use this application

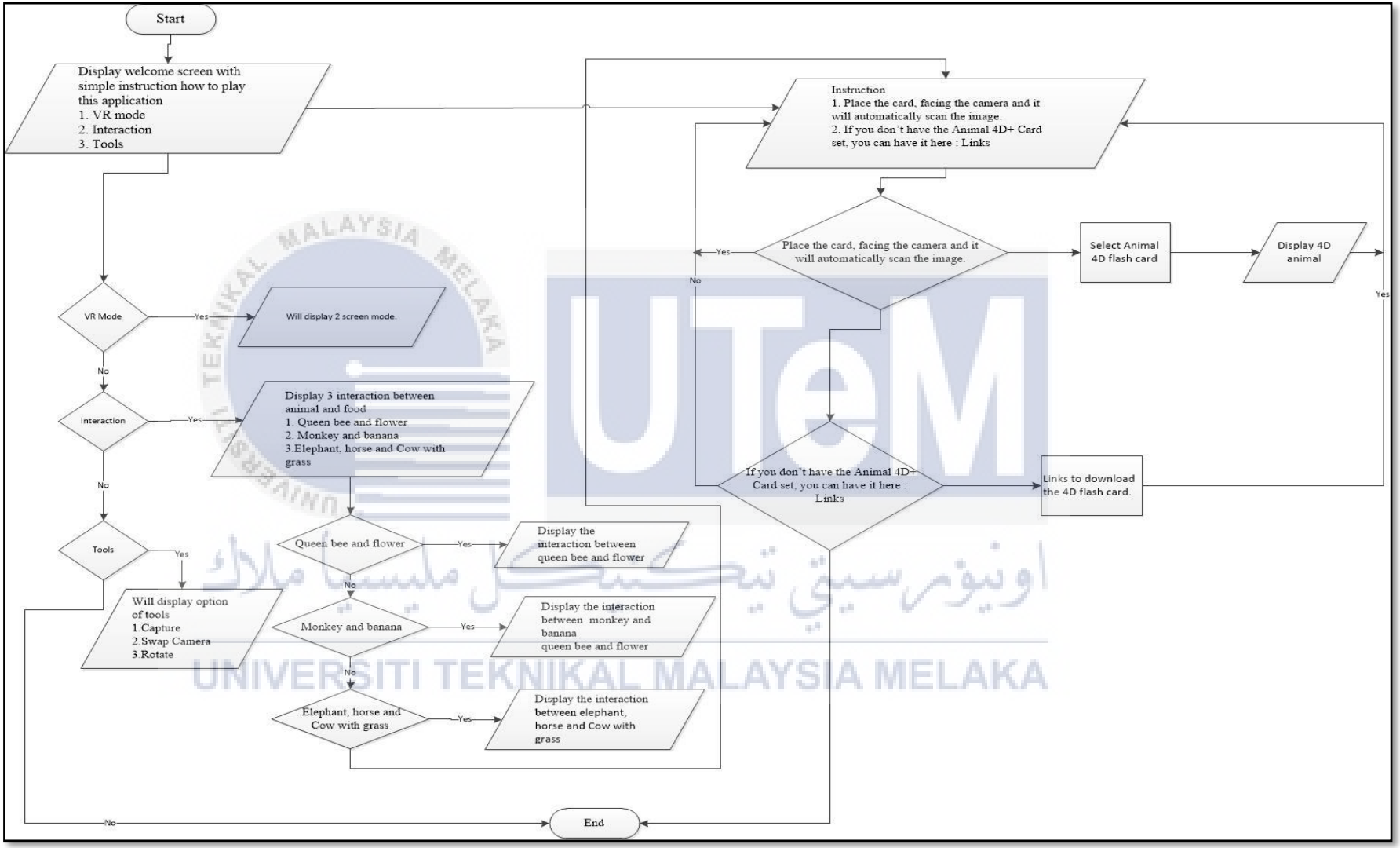


Figure 3. 2: Flow Process of Animal4D+ application

3.2.2 AR-Animals

AR-Animals is the application that allow users to explore the animals' world. There are 34 animals consist of farm animals, forest animals, jungle-wild animals and Dinosaur. With this AR-Animals, children between 2-7 can learn how different animals walk or even how they move, how they eat, what they eat, if they are vegetarians or carnivores, and the sounds they make. Children also can learn to distinguish different animals, and how to spell them. Table 3.2 explain all the options menu in AR-Animals application and Figure 3.3 describe all the flow process included in this application.

Table 3. 2 : Options Menu in AR-Animals application

Options	Description
Instruction	Simple instruction how to use this application
What is AR	Simple explanation about Augmented Reality
Download Marker	Will go to page to download the flash card marker
Play	Can start scan the flash card and there are four option for animals which is walk, talk, food and animate.

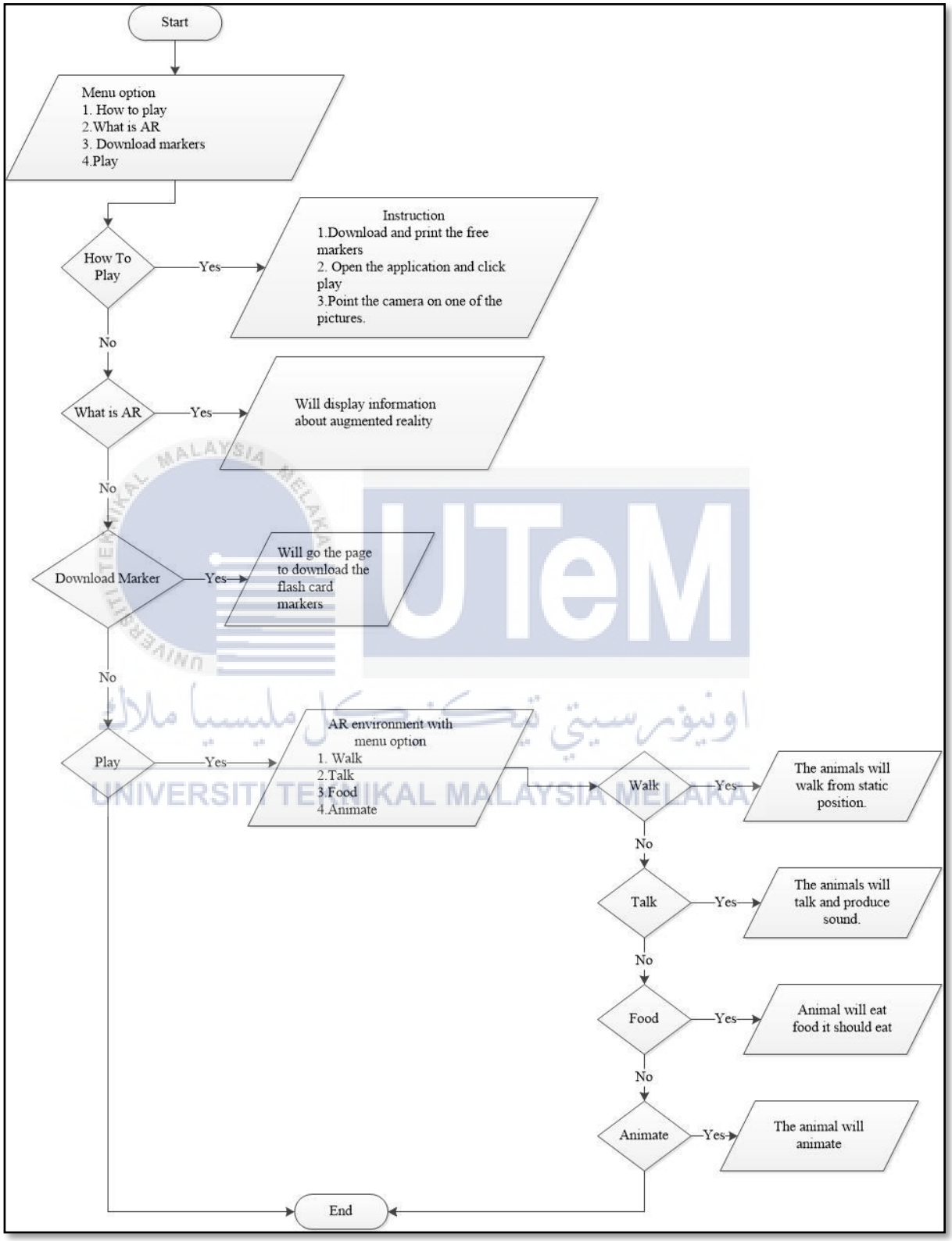


Figure 3.3: Flow Process of AR-Animals application

3.2.3 AR Flashcards - Animal Alphabet

Animal Alphabet is one of the application that used flash cards and have AR-marker on it. Users can scan the marker on the flash card to see the 3D animals. The limitation of cards on one screen, seems to be by around 10 cards, which is extremely remarkable. User can simply print out the AR-cards. There are 26 animals in represent each alphabet. The white boarder on the flash card should not be cut of, as this helps for AR-detection. Another fantastic feature is the audio response to each letter and animal. Table 3.3 show the option menu in AR-Flashcard application and Figure 3.4 show the flow process included in this application.

Table 3. 3 : Options Menu in AR-Flashcards application

Options	Description
Get started	Start scan the animals
AR Flashcard	Animal Alphabet
AR Flashcard	Dinosaurs

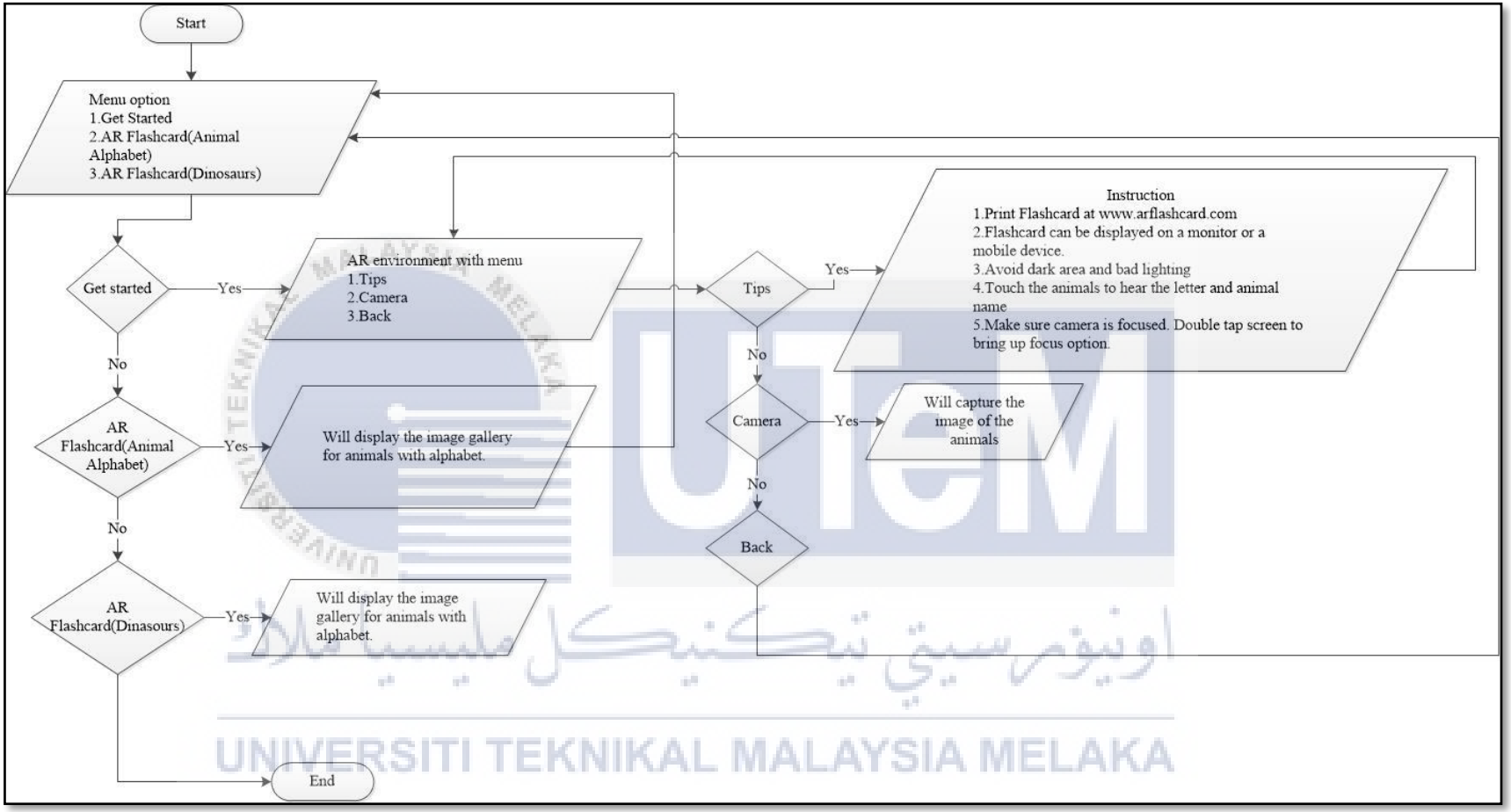


Figure 3. 4: Flow Process of AR Flashcard- Animal Alphabet

3.3 Requirement Analysis

Project analysis are divided into five categories which are need analysis, user analysis, technical analysis, resource analysis and requirement gathering.

3.3.1 Project Requirement

3.3.1.1 Need Analysis

From the three of the existing AR application that have been compared in the previous chapter, there are one application, students need to pay for purchase the flash card. Therefore, in order to let students can access the AR without any burden, a free mobile application will be develop for students to experience the AR environment. Besides that, this Animals food Chain via AR is develop with animal and food in a form of flash card. Student can learn this topic with new method of learning.

When student scan the images of animals and food, they will be able to know further about the object that has been scan by click an info button. There are also interaction between animals and food it should eat. Simple animation in AR environment also included in this project.

3.3.1.2 User Analysis

This project is developed for Android platform only and every user especially students that possesses an Android device is able to install this mobile application for free. In addition, the aim that this mobile application is being developed for Android device is because of the frequency of users use mobile device is higher compare to others. Mobile device will always bring along by them no matter where they went and all the information that they required or want are obtain from the Internet are through mobile device rather than using Desktop. Thus, it can conclude that AR mobile

application that is developed for student learn about animal's food chain that implemented in mobile device will attract the students to learn about this topic. Student also will attract to learn about other topic in Science subject if this AR environment if the AR is used as the learning method in primary school. It is also to increase the understanding about this topic among student and children 5-7 years old.

3.3.1.3 Requirement Gathering

For this part, the AR application that has been develop in mobile devices allow student to explore by their own self about animal's food chain. They also will be able to categorize the animals in their classification. The interaction provided in this AR application which is student can see the interaction between animal's and food it should eat. The responsive website that has been developed included the information about animal's food chain. There a link to download all the flash card for free. The AR application also can be downloaded for free in AppStore or PlayStore. The target user for this animal's food chain via AR is for Standard 5 students that learn this topic in their Science subjects. Students also will be able to see the simple animation of animals.

All the animals and foods are developed in this AR application are in form of 3D images. Every 3D models took about 2-3 weeks to complete it. The storyline for this project is based on animal's food chain via AR and the responsive website also based on this animal's food chain. There are four 3D animals models with texture included in this project which is eagle, rat, sparrows and snake. For eagle and sparrows, the harder part during completed do this 3D model is on the foot parts.

Methods of questionnaire have been done and distributed for the students to collect the basic information about animal food chain and other needed information. Student need to answer the set of question that consist three part which is Part A, Part B and Part C.

A. Research Tool and Data Collection

The questionnaire (refer to Appendix F) consists of 24 questions which were separated into two parts. Part A is about background of students, Part B is about the general information of students about Augmented Reality (AR) and the last part, which is Part C covers the issues of animal's food chain among students.

It is distributed randomly to 35 student age 11 years old, at primary schools which are Sekolah Kebangsaan Pulau Sebang (SKPLS). There have a short briefing about AR and explanation for the questionnaire before the questionnaire is distributed.

The result that collected with the questionnaire was analysed and displayed in pie chart form. Other than that, the result that obtained was calculated based on percentage to show a clear statistical view of the issues of animal's food chain.

Table 3.4 shows the profile of the respondents. Among the 35 students, 100% of them are belongs to the age 11 years old. Almost of the students are came from same backgrounds, age, and ethnic group.

Table 3.4: Background of students

	Gender		Ethnic		
Age	**Female**	**Male**	**Malay**	**Chinese**	**India**
10	20	15	34	0	1

Besides background of the respondents, this questionnaire has designed to understand the basic information of the students (refer to Appendix F: Questionnaire Part B, question 1 until 10).

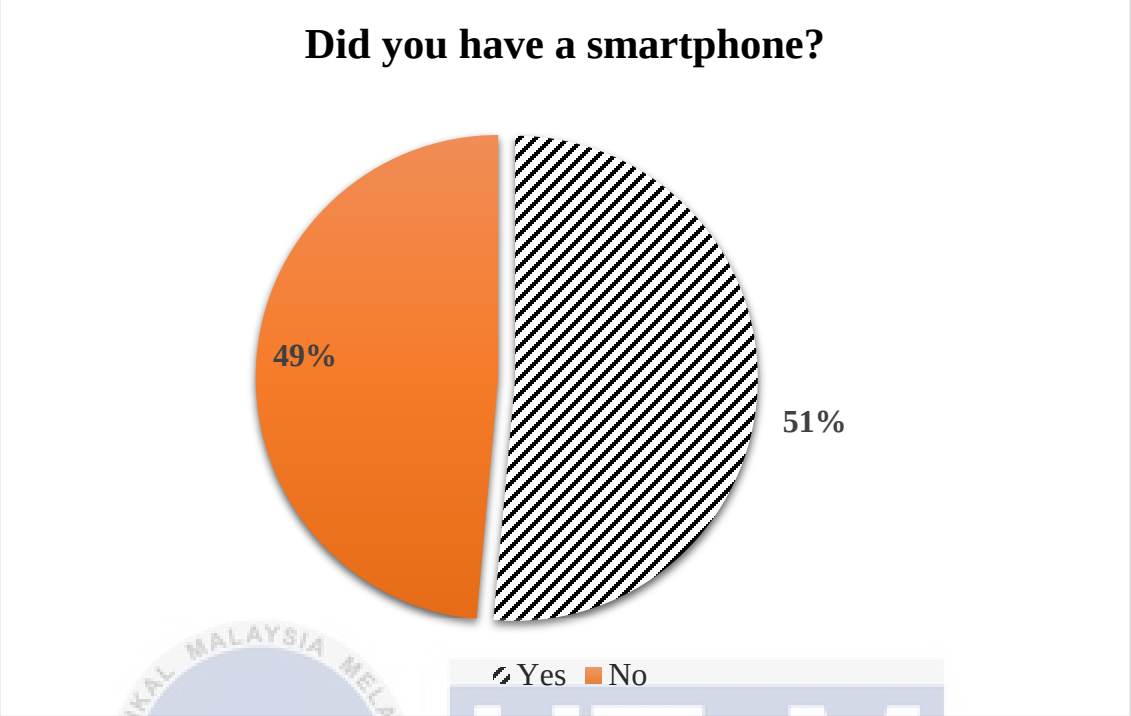


Figure 3.5: Statistic whether students have a smartphone or not.

In this era of globalization, smartphone is one the tools that used to communicated with others. Smartphone's issue is another main point that the developer will be focused on. Figure 3.5 shown that 51% of students have a smartphone and 49% do not have a smartphone. Total of student have a smartphone more than do not have it, so this animals food chain via AR is suitable to develop, because this project will be implemented in mobile devices.

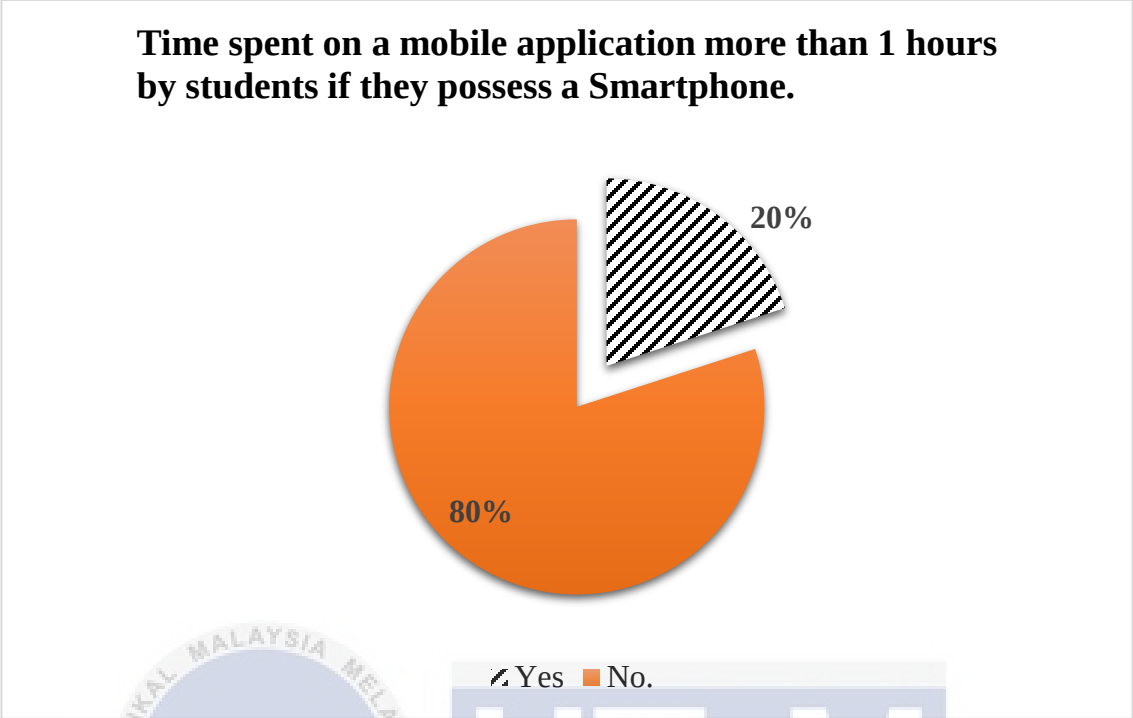


Figure 3.6: Statistic of time spent on a mobile application more than 1 hours by students if they possess a smartphone

As shown in Figure 3.6 as above, this result showed only 20% of the students spent more than 1 hours to play the application in smartphone and 80% of the students spent less than 1 hour on a mobile application. From the result, it is proved that students 10 years old do not spent much of the time on playing a mobile application.

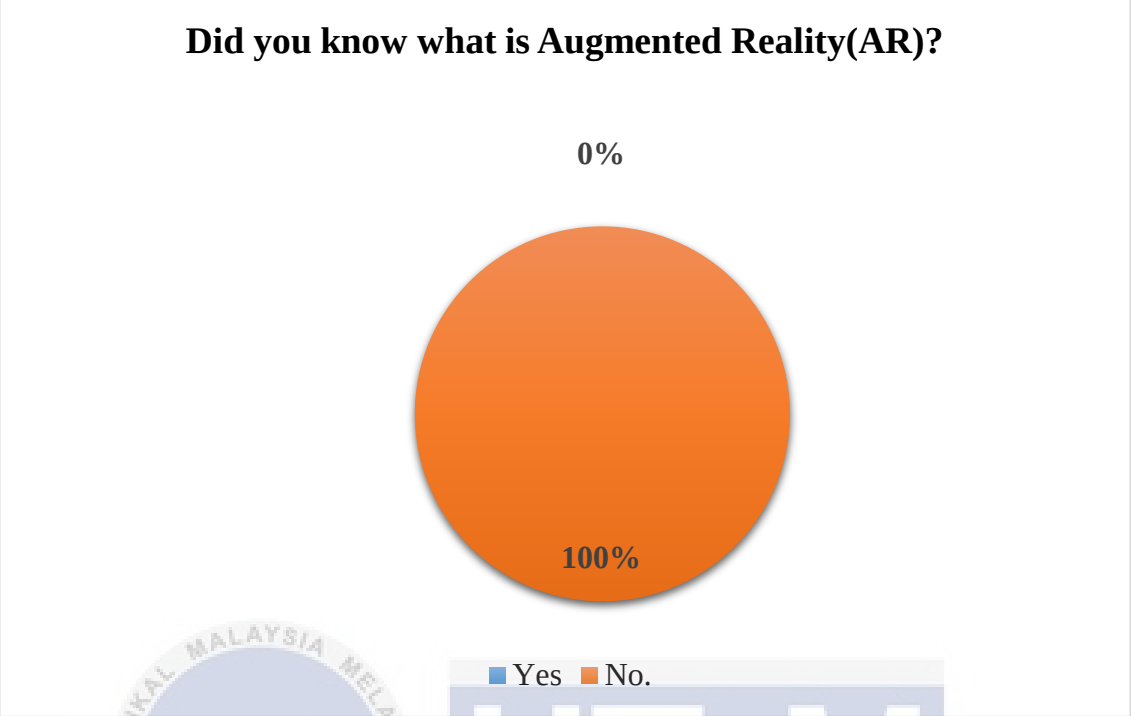


Figure 3.7 Statistic of awareness of AR among students.

As shown in Figure 3.7 as above, this result proved that 100% of students do not know about Augmented Reality (AR). This is also conclude that they do not ever used AR application in mobile devices, so this will be a new knowledge and new thing for them to discover.

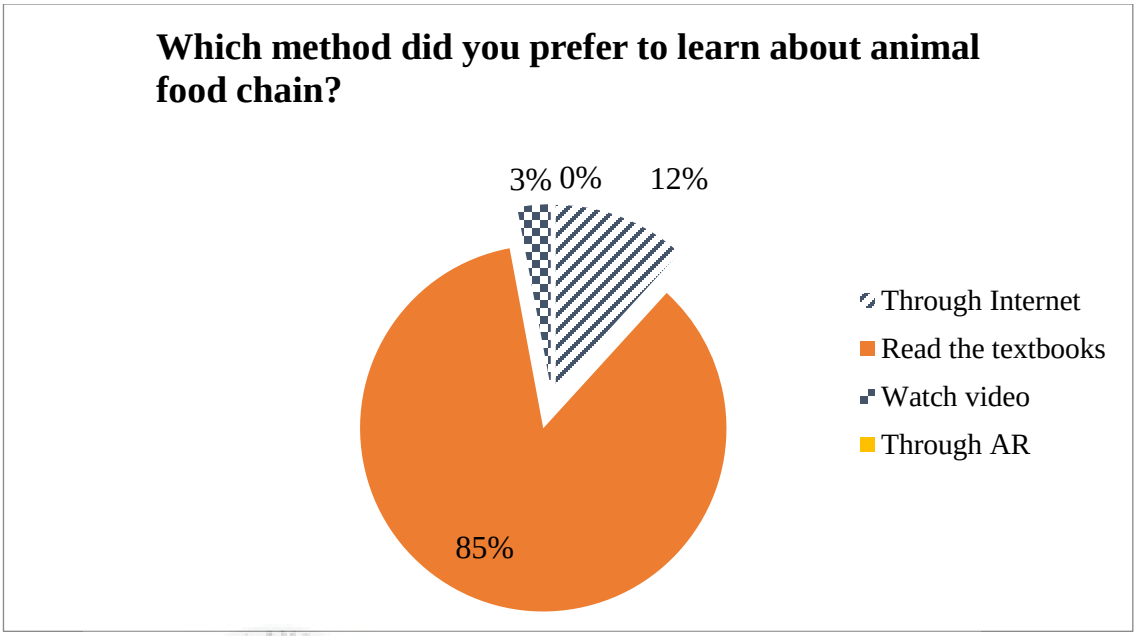


Figure 3.8: Main platform used to obtain information

Nowadays, there have different types of methods of learning in order to let students to obtain the information easily. As shown in Figure 3.7, 85% from the 35 students revealed that they preferred towards read the text to learn and obtain information about animal's food chain because this textbooks already provided to them for free. While, it consists 12% of them expressed that they preferred learn animal food chain through the internet and there are small portion preferred through watching video about it. Other than that, there is no portion of students preferred use another new technology AR, because they do not clear what is Augmented Reality (AR). So they preferred choose other methods that they know to obtain the information about animal food chain. For more understanding of the question asked, refer to Appendix B: Questionnaire Part B, question 10.

B. Findings

The aim of this project was to determine the issues of animal's food chain among 10 years old student. All this question are included in Part C and it have a 5 range of answer which is strongly disagreed, disagreed, not sure, agreed and strongly agreed. The first issue that analyzed is their basic information about animal's food chain as shown in Figure 3.9.

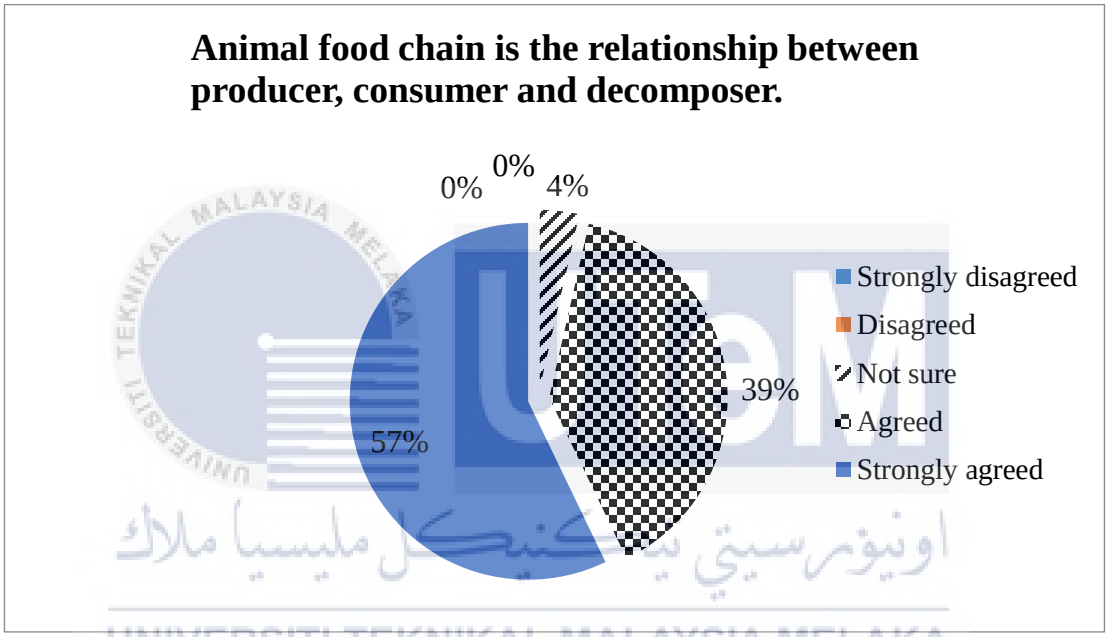


Figure 3.9 Basic information about animal's food chain.

Figure 3.9 demonstrated the question 1, 2 and 3 in Appendix F: Questionnaire Part C. From Figure 3.8, it is obviously showed that 57% of students strongly agreed that animal food chain is the relationship between producer, consumers and decomposers. 39% of them agreed with this statement. Besides that, there are 4% not sure about this statements and 0% of them disagreed and strongly disagreed about animal food chain is the relationship between producer, consumers and decomposers. This result proved that almost of them really know the basic meaning of animals food chain that their learned.

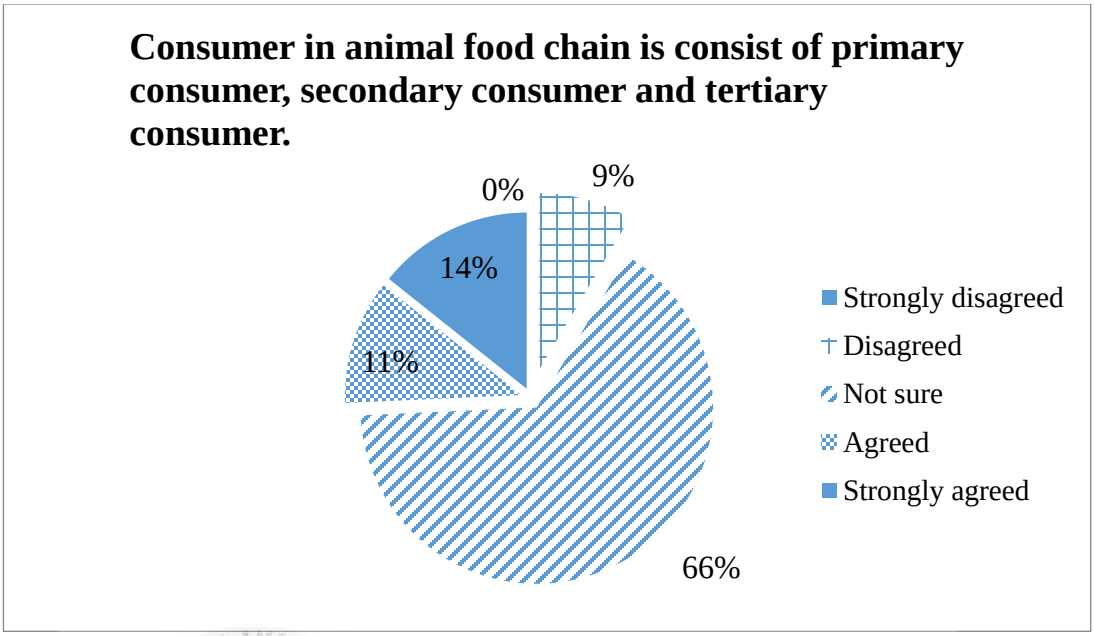


Figure 3.10: Basic information about animal food chain.

Figure 3.9 above, it is the result of another basic question about animal food chain 66% of students not sure that consumer in animal food chain is consist of primary consumer, secondary consumer and tertiary consumer. Hence, 14% and 11% of students strongly agreed and agree to this statement respectively. There is no portion by students strongly disagreed with this statement. This result proved that many of them really not sure basic information about consumer in animals food chain that their learned. Refers to Appendix B: Questionnaire Part C, question 5 for the clear understanding question that being asked.

There are animals that can be categorize as a primary consumer, secondary consumer and tertiary consumer. Figure 3.11 show the simple question about primary consumer.

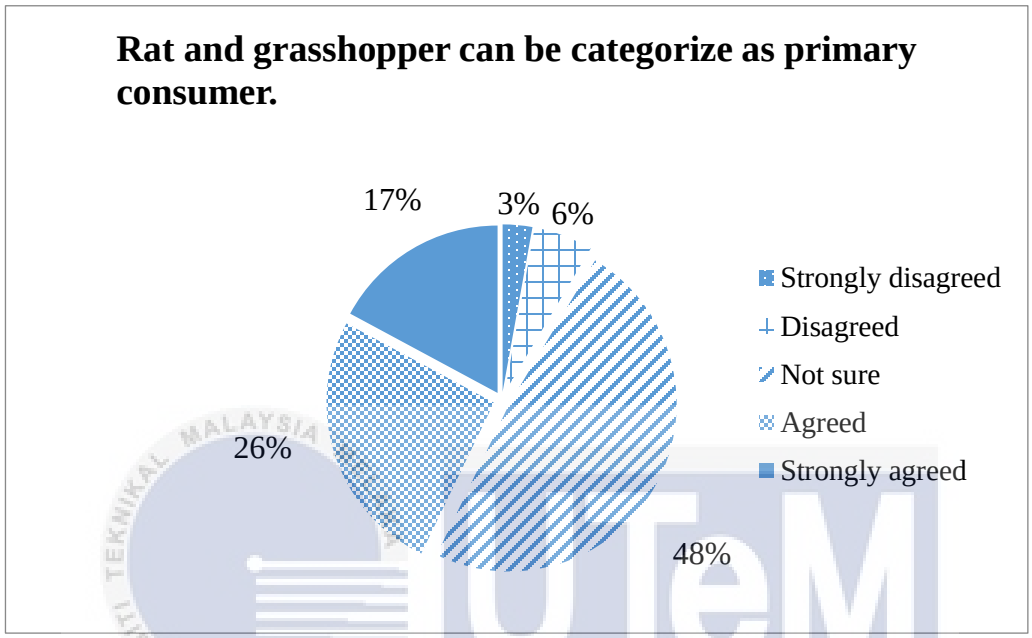


Figure 3.11: Basic information about consumer

From the data collected, it is obviously showed that 48% of the students are not sure rat and grasshopper can be categorize as a primary consumer or not. Besides that, there are 6% and 3% of students disagreed and strongly disagreed respectively, rat and grasshopper can be categorize as primary consumer.

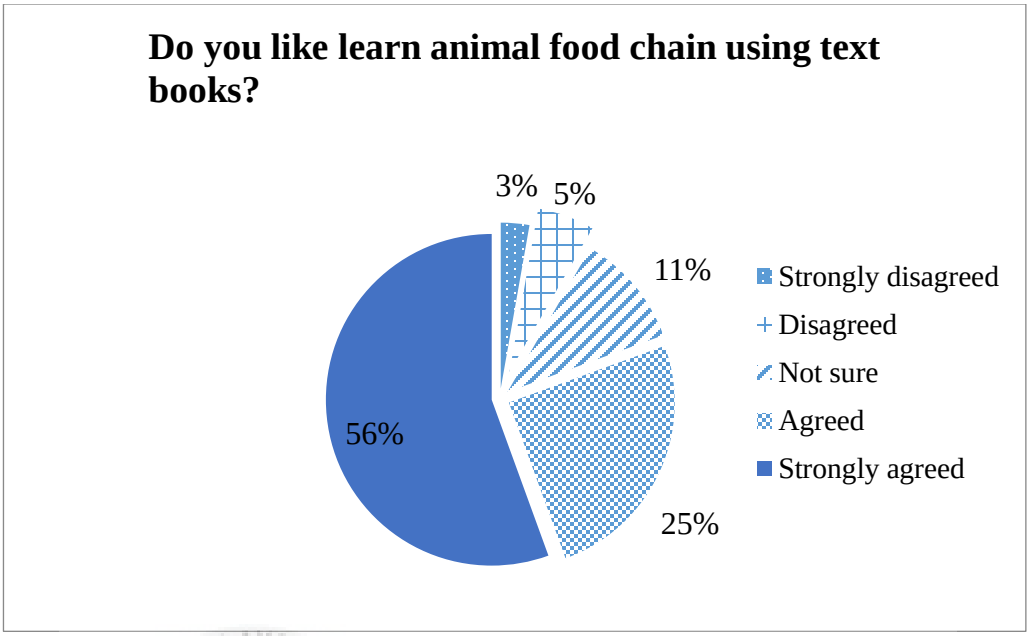


Figure 3.12: Learn animal's food chain using textbooks

Figure 3.12 show the result weather students like learn about animal food chain using text books or not. From the pie chart, it shown that 56% of 35 students 10 years old strongly agreed like to learn animal food chain using textbooks. It is because, this textbooks already provide for free to them in school. There are small portion which is 3% of student strongly disagreed and do not like learn animals food chain using text books because it does not provide any real visual graphic representation.

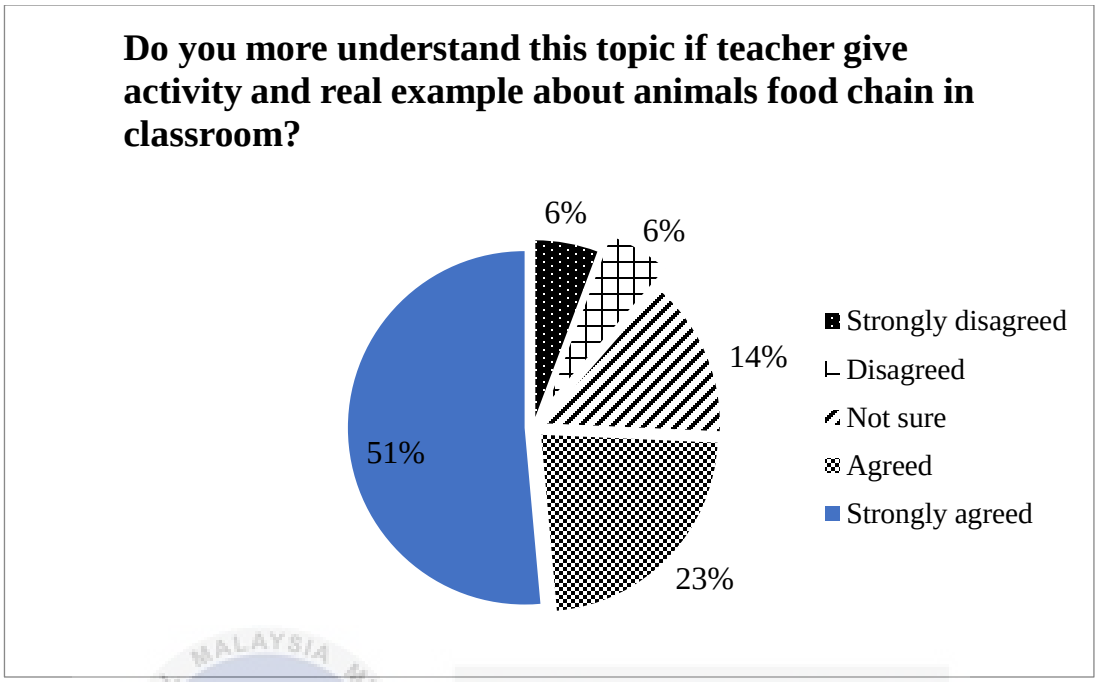


Figure 3.13: Method of learning animal food chain in classroom by students.

In the Figure 3.13, approximately 51% of the students strongly agreed if teacher give activity and real example about animal food chain in classroom and not only based on text books provided. While, it consist of 23% and 14% of them agreed and not sure if they will be more understand this topic based on this statement. From this result, it can proved that they are really interest and will be more understand this animal food chain topic if teacher give them activity and real example related to this topic. This statement can be verified from the result in Figure 3.13 and refer to question 12 in Part C of the questionnaire.

3.3.1.4 Summary of findings

The questionnaires that distributed and filled by the students provide a lot of important information for developer. The information that gathered from students is AR is still new for them because the result obtained from questionnaire has showed that they do not have any knowledge and experience of using the AR application. Hence, AR will be the main element in this project and learn animal food chain via AR

in mobile application will be developed to attract the students to understand of this topic. They also need other activity and real example given by teacher related to this topic, so it will make them really clear about this topic.

As a summary, AR in mobile application is a new technique and new types of platform which can attract the students and helps to solve the problem that students faced such as not really clear about the process included in animal food chain because does not have real graphic representation

3.3.2 Software Requirement

There are software requirement that quite important during developing this project. Software requirement is divided into two categories which are development tools and documentation tools.

3.3.2.1 Development Tools

i. Unity3D

Unity3D is a powerful cross-platform 3D engine and a user friendly development environment. Easy enough for the beginner and powerful enough for the expert. Unity should interest anybody who wants to easily create 3D games and applications for mobile, desktop, the web, and consoles. This software is used to develop an AR application.

ii. Android SDK

Android SDK is a SDK that allows developers to build a mobile application for Android platform. Android SDK includes a debugger, emulator, documentation, development tools, and supported libraries.

iii. Vuforia

Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of Augmented Reality applications. Offers the ability to recognize and track nearly any real world image, object or environment, supports HTML5 & JavaScript development, support major 3D formats as well as allow developer to import his/her own CMS.

iv. Autodesk Maya 2012

Autodesk Maya is 3D computer graphic software that enables developers to create object or character in 3 dimensional. In this project, this software is used to create animals and foods in 3D with texture. This software is used to create 3D objects for animals and foods.

v. Adobe Photoshop CS6

Adobe Photoshop is one of the professional graphic editing software that provides various types of effects and technique to edit the original image. This software is used to edit any original images that obtained from internet or capture and require used in the responsive website.

vi. Adobe Illustrator CS6

Adobe Illustrator CS4 is vector graphic editor or creator that allows developer to create a new logo or graphic. In this project, this software is used for trace the original image that would be use in the responsive website.

vii. Adobe Dreamweaver CS6

Adobe Dreamweaver is a tool that commonly used in web design and develops application. This software allows developers design and create the layout of HTML element systematically and faster than using other tools such as Note Pad. Therefore, the flow of the interface in mobile application is designed using this software. This software use to develop responsive website about animals food chain.

3.3.2.2 Documentation Tools

i. Microsoft Office Word 2013

Used to prepare the documentation of proposal, report and questionnaire.

ii. Microsoft Visio 2010

Used to draw the flow chart of the overall progress of the project and used to prepare the Gantt chart for the project in proposal and report.

iii. Microsoft Office PowerPoint 2007

Used to prepare the presentation slide for presentation.

3.3.3 Hardware Requirement

i. Laptop

Used to install the software that required for developing this project such as Unity3D, to create 3D objects, to edit the original image, to develop and design the responsive website design the flash card and act as a platform to connect with smart phone.

ii. Android Smartphone

Used to install the application and test the application and make sure it produce correct output.

3.3.4 Other Requirements

i. Printer

Used to print the proposal, report and questionnaire.

3.4 Project Schedule and Milestones

Project schedule one of the important roles in developing project, systems or products. It includes the tasks that needed to do and need to be done within a certain time period. The existence of the project schedule is to ensure that the process of developing the product is work according to the time that planned and to make sure the product is completed in time. Table 3.5 show the project schedule and milestones. Gantt Chart refer to Appendix G.

Table 3.5: Project Schedule and Milestones

Animals Food Chain via AR	*Start*	*Finish*
Proposal Submission	2/22/2016	2/26/2016
Proposal Correction and Improvement	2/29/2016	2/29/2016
Requirement Planning	3/1/2016	3/2/2016
Analyze the target user	3/2/2016	3/4/2016
Report Chapter 1 and Chapter 2	3/2/2016	3/4/2016
User Design	3/7/2016	3/8/2016
Analyst and develop models and prototypes	3/9/2016	3/19/2016
Determine learning process based on audience need	3/20/2016	3/21/2016
Report Chapter 3 and Chapter 4	3/22/2016	3/24/2016
Construction	3/25/2016	3/26/2016

Programming and application development	3/27/2016	4/3/2016
User testing	4/4/2016	4/4/2016
Finishing the project	4/5/2016	4/28/2016
Report Chapter 4	4/29/2016	5/2/2016
Cutover	5/3/2016	5/15/2016
Data Conversation, testing and changeover	5/16/2016	6/2/2016
Project Demo and PSM Report	6/3/2016	6/7/2016
Presentation	6/8/2016	6/8/2016
Report Correction	6/9/2016	6/9/2016
Continue do the report Chapter 5 for PSM 2	6/27/2016	7/1/2016
Do the correction on the product for PSM 2	7/2/2016	7/29/2016
Do testing product at the target user and expertise	8/2/2016	8/5/2016
Do the report for Chapter 6 and Chapter 7	8/6/2016	8/10/2016
Presentation PSM 2	8/11/2016	8/11/2016

3.5 Conclusion

As a conclusion, this chapter consists of two main part that been discussed which are current scenario analysis and requirement analysis. The current scenario analysis analyzes the current existing mobile applications which Animal4D+, AR-Animals and AR Flashcard-Animal Alphabet.

For the next chapter, the activities that will be developed are design phase. Design phase is related to the architecture and flow included in the mobile application that want to develop. Other than that, the user interface design of the mobile application will also be included in the next chapter.

CHAPTER IV

DESIGN

4.1 Introduction

This chapter will explained further about system architecture, preliminary design and user interface design. The requirement for design process are gathered from analysis phase that has been conducted. Animals Food Chain mobile application is develop for children that age ranged from 7 to 12 years old but focused on Standard 5 student because this topic included in their Science subject. The design of interface and content will be discussed based on student's needs. The overall flow of this mobile application will be explained in details.

4.2 System Architecture

System architecture is important to define overall process included in the mobile application that has been develop. The main platform that used to develop this mobile application is Unity3D and it will integrated with Vuforia. Vuforia have a free version and it can store image targeted in its own database. It also support for android platform. This Unity3d used to develop this mobile application also integrated with Android SDK.

Other than that, this AR mobile application is marked-based application. Students will not be able to use the mobile application if they do not have the flash card that has been design because the markers are printed in the flash card. They can get the flash card by download it from the animal's food chain's websites after the flash card is published. Figure 4.1 show the system architecture of the Animals food chain via AR.

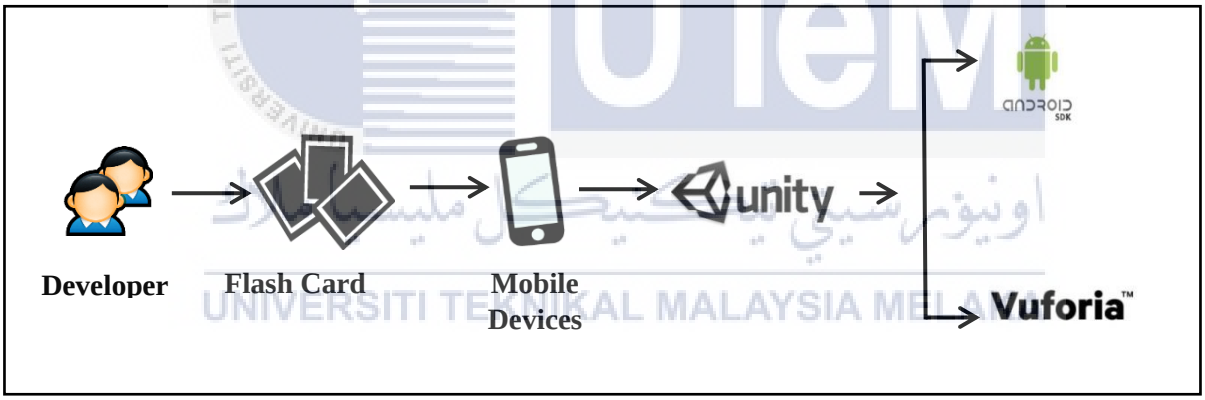


Figure 4. 1 : System Architecture

4.3 Preliminary Design

Preliminary design is a storyboard which contains sketch process developing the system. This early stage will included the sketch content of AR application, flowchart of the mobile application and interface of the website. This is to ensure developer develop the mobile application that meets the requirements of students and based on the multimedia element stated. All of this idea can be change again when it comes to implementation phase.

4.3.1 Flow Chart

Flow chart shown the flow included in mobile application. Flow chart that designed can guide developer to understand the conceptual flow of the system. It also shows the process and the content displayed that are included in the AR mobile application. Flowchart also can be as reference for developer on how each process are done. It also help developer to improve the system.

This mobile application is started by displaying a menu screen with three buttons which are Start button, about button and How button. After user click the Start button, they will go to AR environment and they can start scan the animals and food flash card and do some interaction between it. If the user done with the application they can click Exit button. Table below explain in details the functionality each process, button and content in Animals food chain via AR in mobile application.

Table 4. 1 : Functionality of Buttons

Interface	Buttons	Functionality
Main Menu	Start button	Bring users to the AR environment and can start scan the flash card.
	About button	Describe the basic information about animals food chain of this mobile application
	How button	Navigate to interface How To Use which provides the instruction to use the mobile application.
	Exit Button	Option for user to close the application
	Back button	Navigate to the Main Menu

Animals Food Chain	Description button	Will go to next interface where there are information about the flash card that has been scan.
	Exit Button	Option for user to close the application
Description	Back button	Navigate to the Animals Food Chain AR environment
Interface of How To Use	Back button	Navigate to the Main Menu
	Exit Button	Option for user to close the application

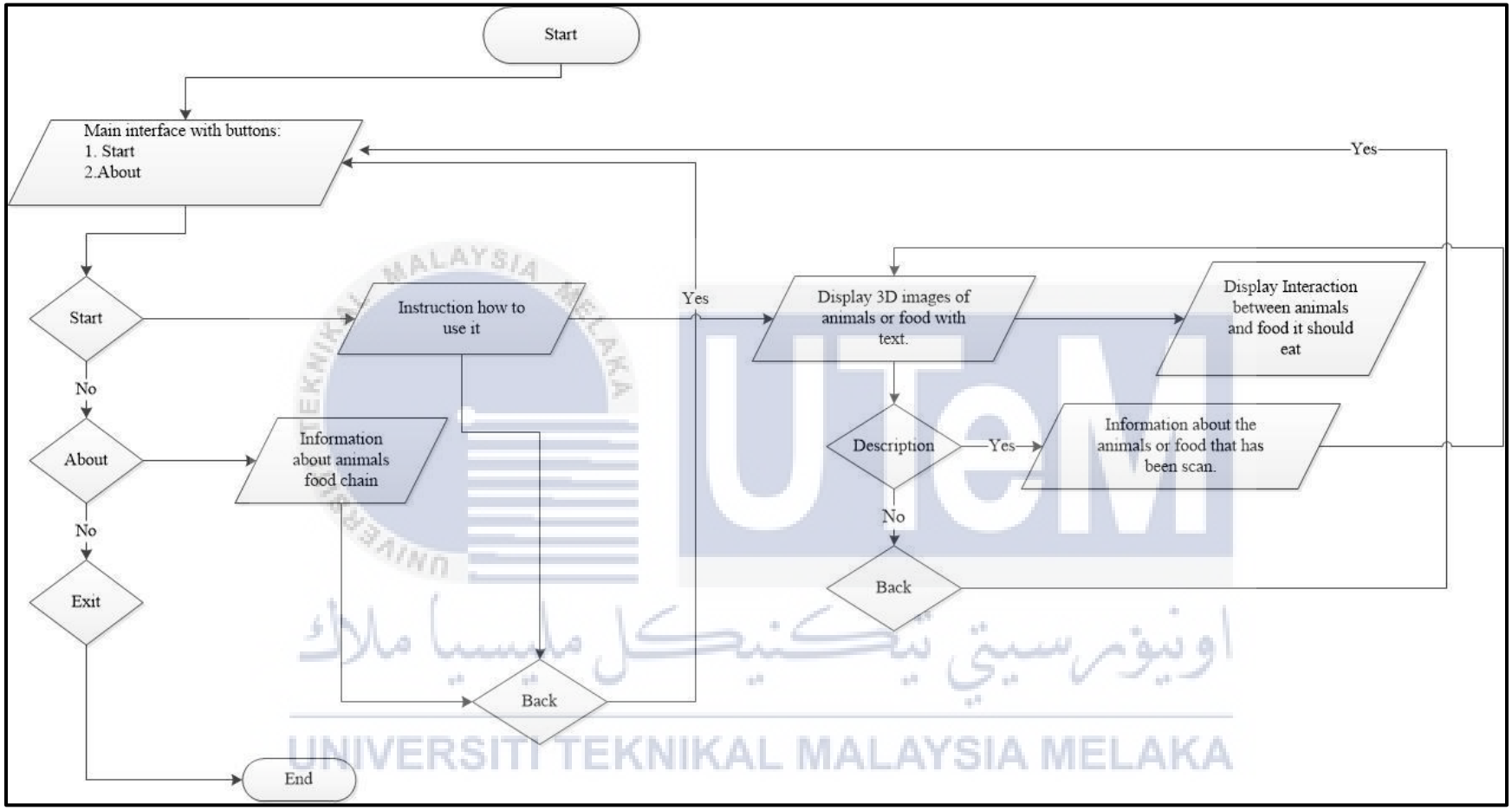


Figure 4.2: Flow Chart Animal's Food Chain via AR

4.3.2 Storyboard Design

Storyboard is graphic design that contain form of illustration or images used as visual representation that displayed in sequence to help developer sketch out overall final product will look like. For mobile application and responsive website, storyboard was produce for developer to know what the action during user interaction with the application

4.3.2.1 Animal's food chain via AR in mobile devices

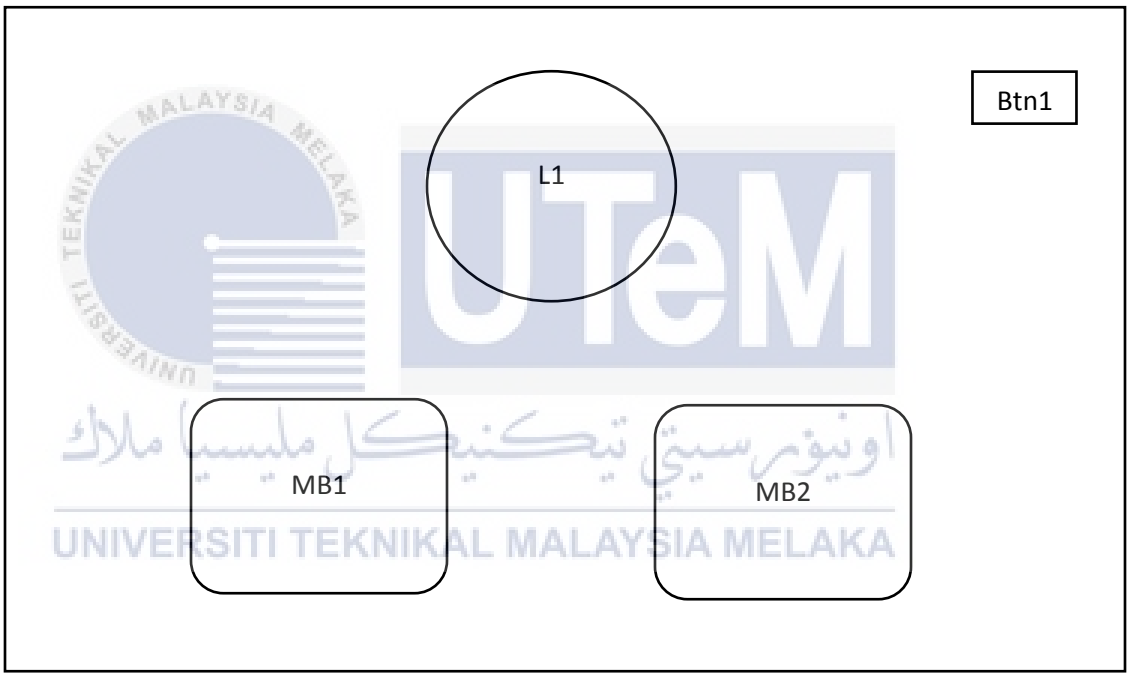


Figure 4.3: Main menu scene AR in mobile devices

Table 4.2: Main menu scene

No.	Items	Description
1.	Btn1	Click to exit from this application
2.	L1	Application icon
3.	MB1 and MB2	MB1 – Start button link to instruction scene. MB2- About button link to about scene.

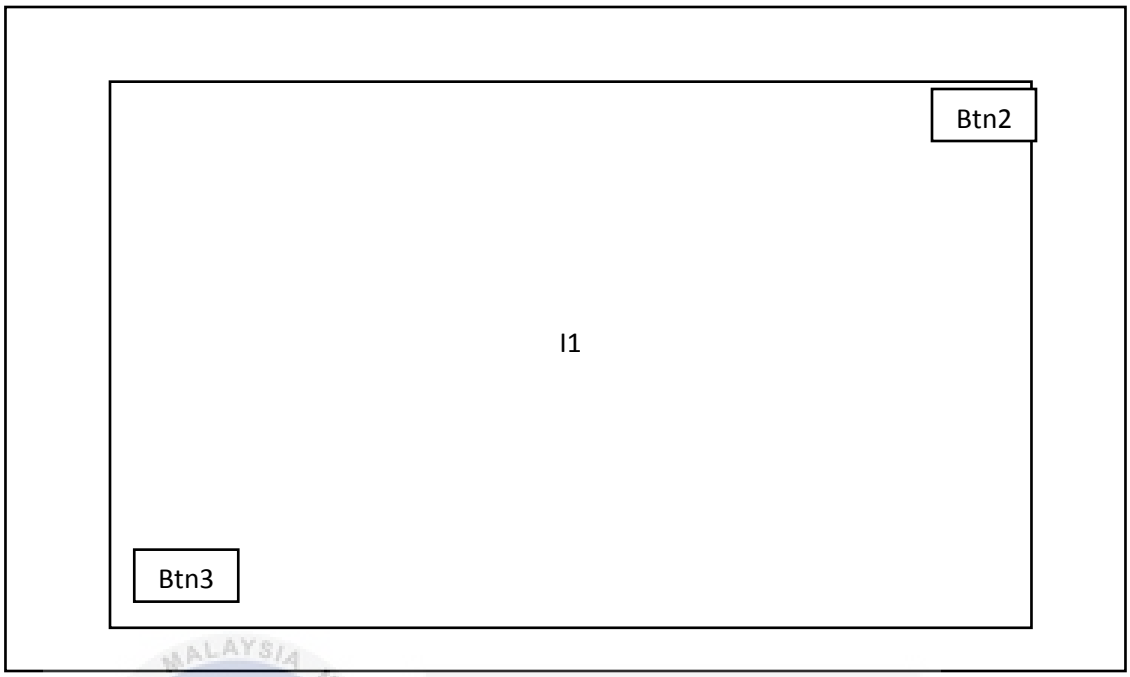


Figure 4.4: Instruction scene

Table 4.3: Instruction scene description

No.	Items	Description
1.	Btn2	Click to go to animal's food chain AR environment.
2.	I1	Instruction
3.	Btn3	Back button link to Main menu scene.

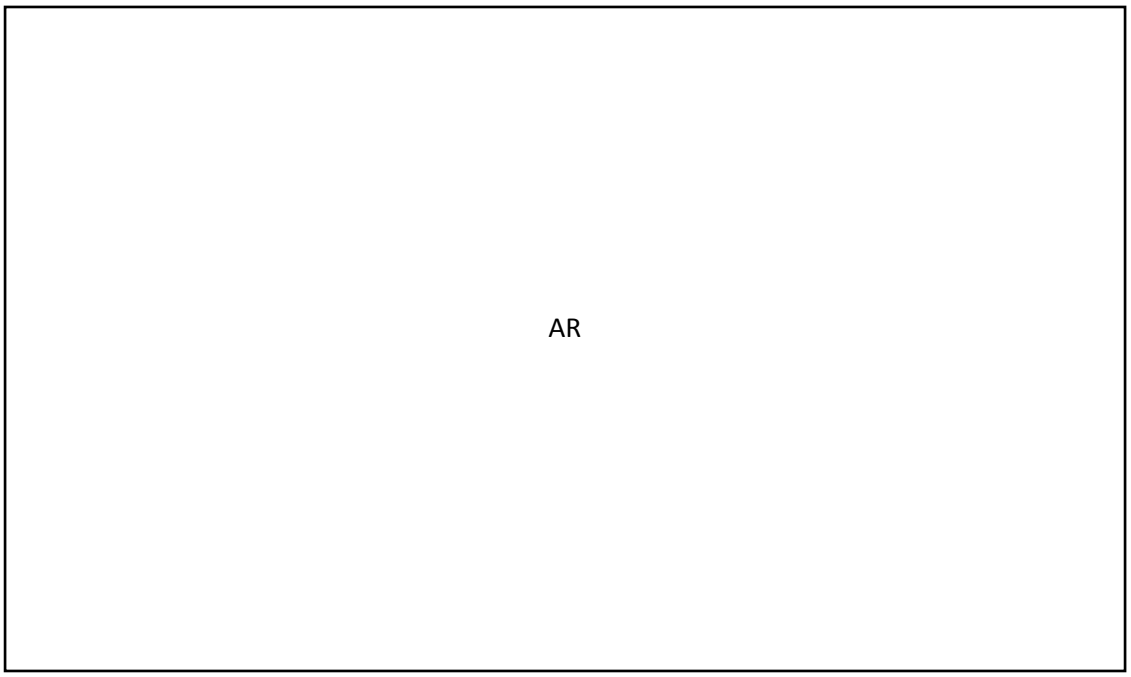


Figure 4.5: Animal's Food Chain AR environment

Table 4.4: AR environment description

No.	Items	Description
1.	AR	Animal's food chain AR environment

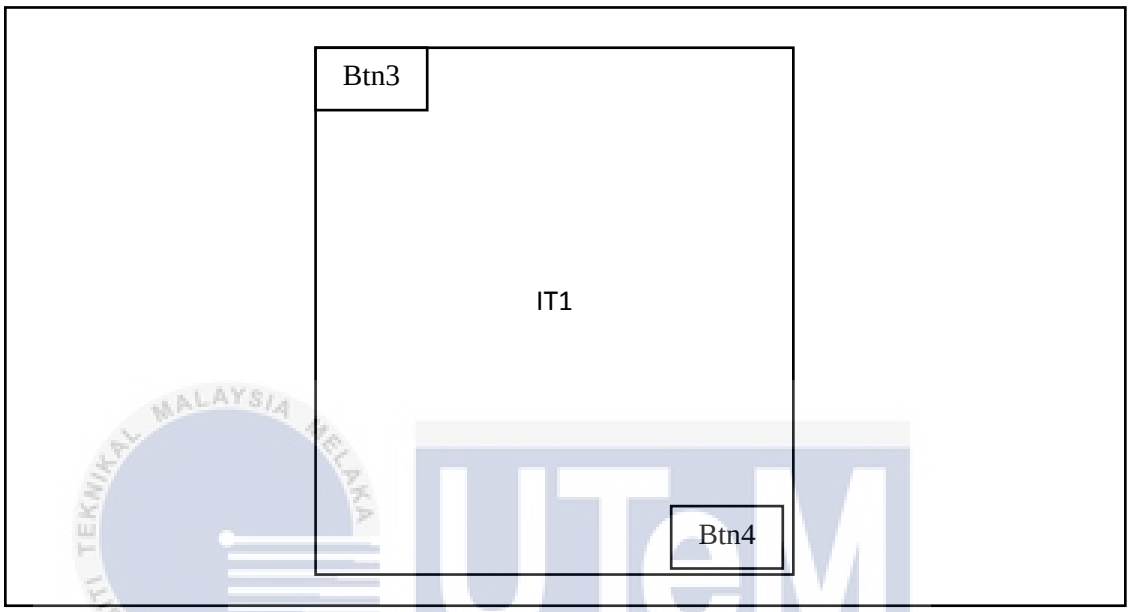


Figure 4.6: Animals Info Scene

Table 4.5: Animals Info Scene description

No.	Items	Description
1.	IT1	Image target 1
2.	Btn3	Back Button to Animal's Food Chain AR environment
3.	Btn4	Click to go to animal's info scene

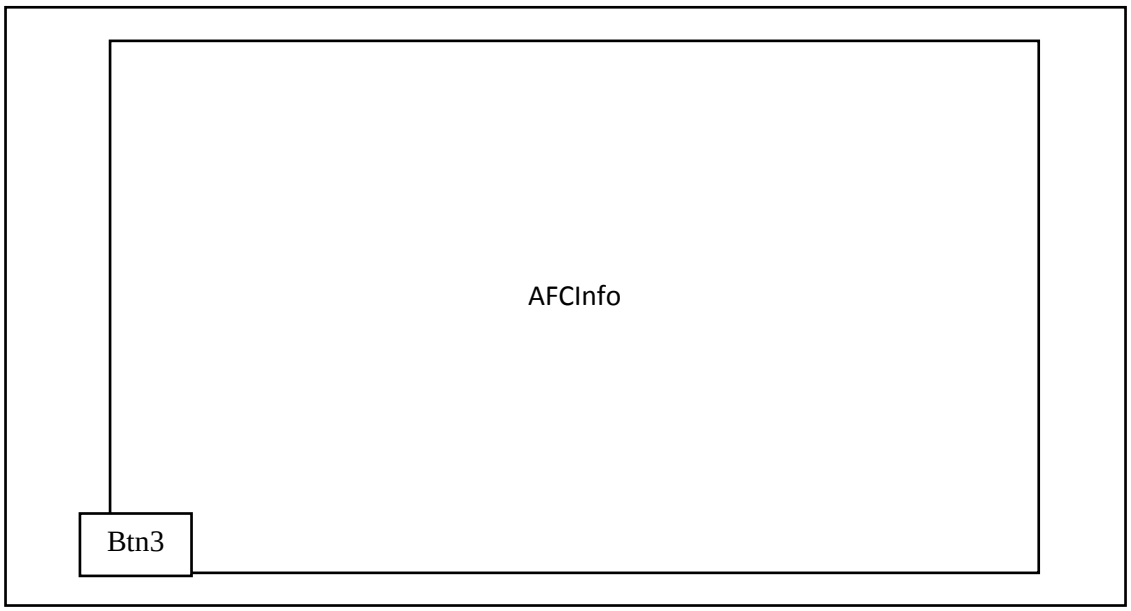


Figure 4.7: Animals food chain info scene

Table 4.6: Animals food chain info scene description

No.	Items	Description
1.	AFCInfo	Animal's Food Chain information
2.	Btn3	Back Button to Main Menu

4.3.2.2 Animal's food chain website

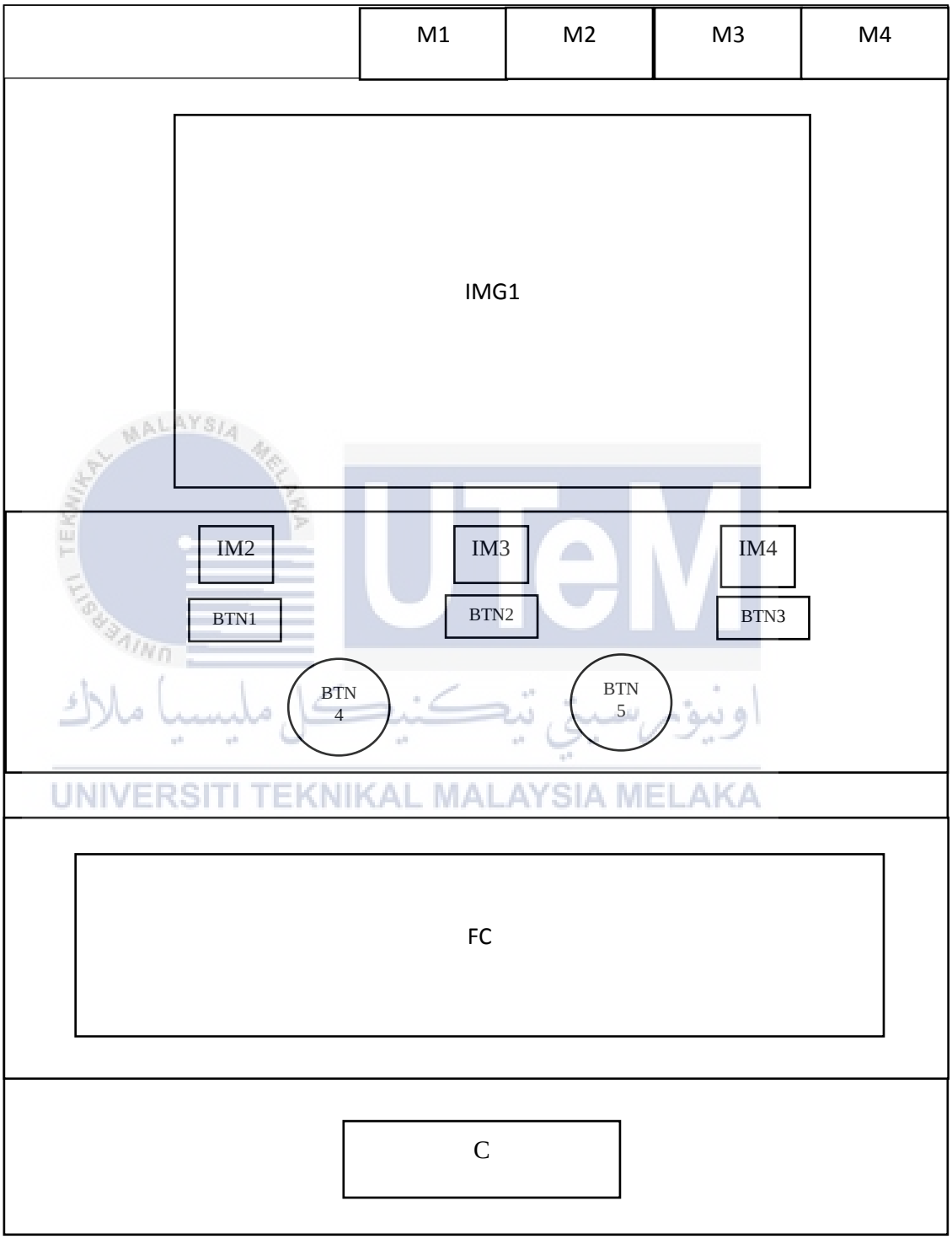


Figure 4.8: Homepage website

Table 4.7: Homepage description

No.	Items	Description
1.	M1, M2 , M3 , M4	M1- Homepage link to *index.php* M2 – About food chain link to *about.php* M3 - Contact Us link to *contact.php* M4 - Category link to *pengeluar.php, pengguna.php* and *pengurai.php*
2.	IMG1	Image of food chain
3.	IM2, IM3 and IM4	Animals image of category
4.	BTN1, BTN2 and BTN3	BTN1- link to *pengeluar.php* BTN2- link to *pengguna.php* BTN3- link to *pengurai.php*
5.	FC	Image of animals and food flash card
6.	C	Contact Us

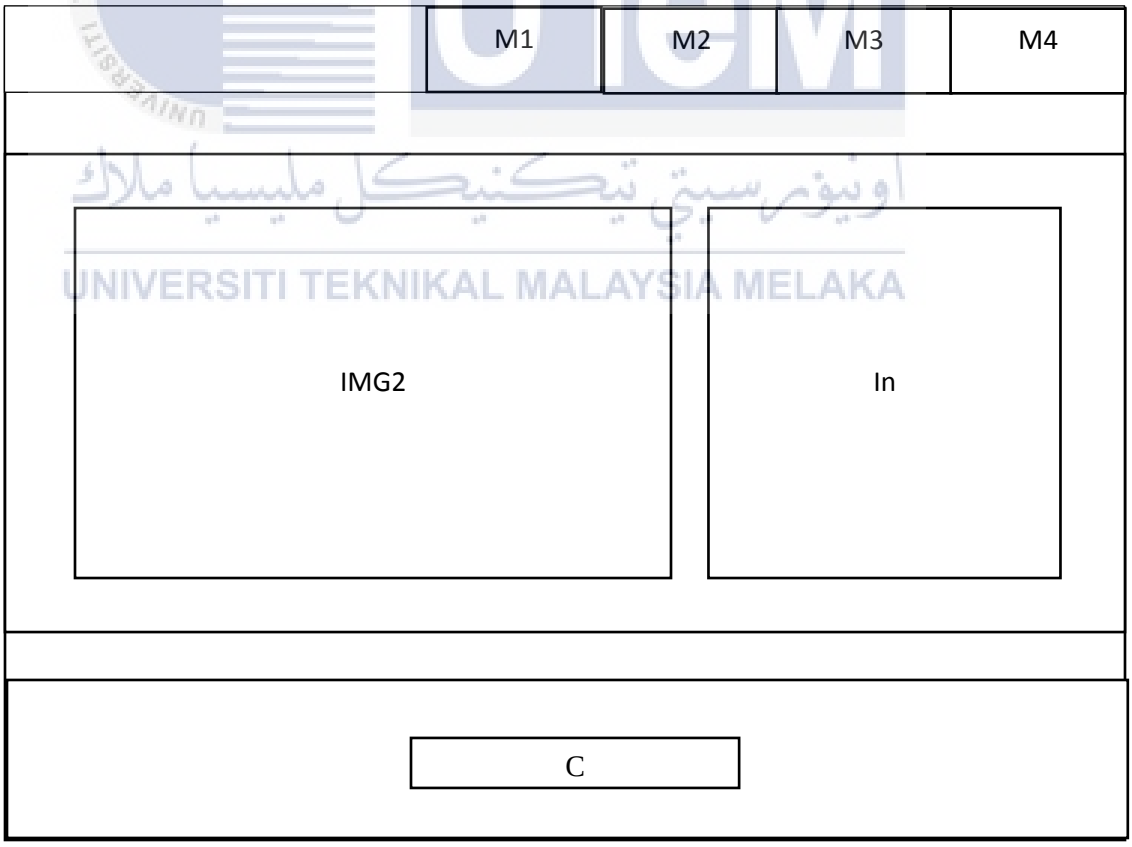


Figure 4.9: About page

Table 4.8: About description

No.	Items	Description
1.	M1, M2 , M3 , M4	M1- Homepage link to *index.php* M2 – About food chain link to *about.php* M3 - Contact Us link to *contact.php* M4 - Category link to *pengeluar.php, pengguna.php* and *pengurai.php*
2.	IMG1	Image of food chain
3.	In	Animal's food chain information
4.	C	Contact Us

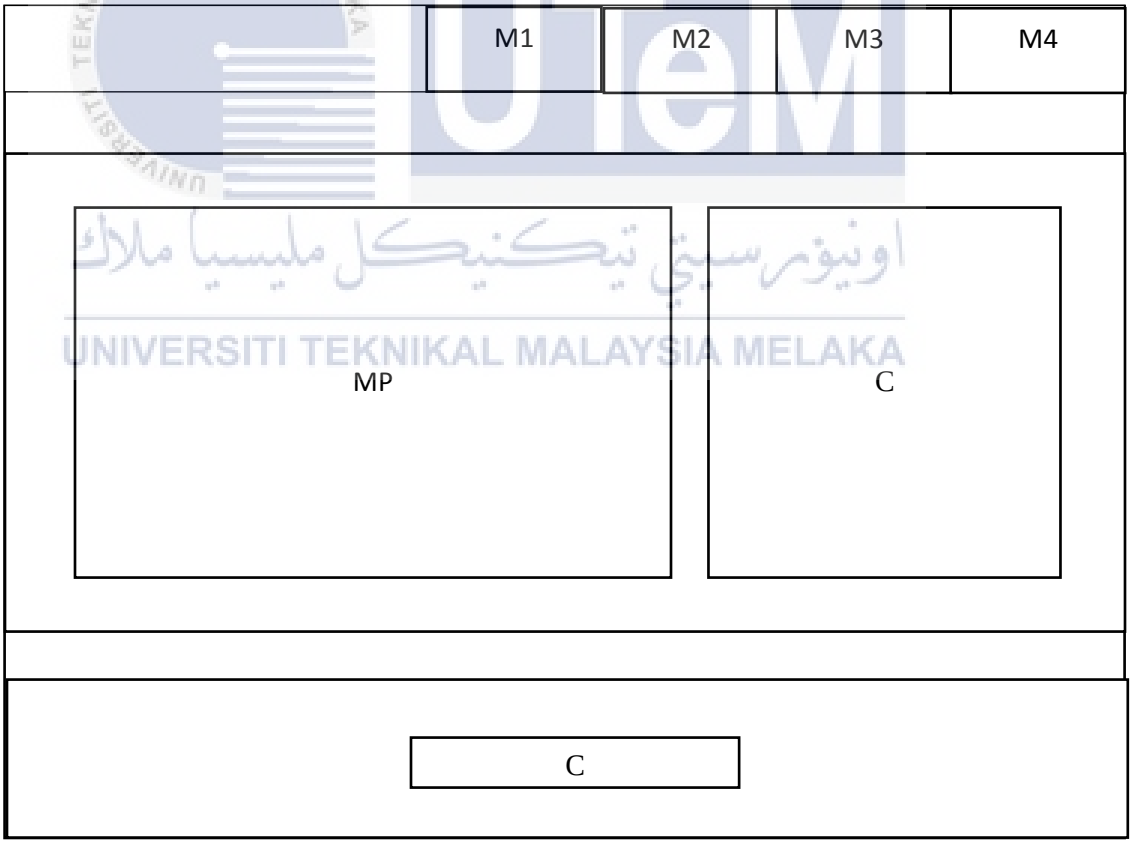


Figure 4.10: Contact us page

Table 4.9: Contact us description

No.	Items	Description
1.	M1, M2 , M3 , M4	M1- Homepage link to *index.php* M2 – About food chain link to *about.php* M3 - Contact Us link to *contact.php* M4 - Category link to *pengeluar.php, pengguna.php* and *pengurai.php*
2.	MP	Maps
3.	C	Contact Us

4.4 User Interface Design

In this user interface section, it is divided into several designs which are navigation design, input and output design and the icon design.

4.4.1 Navigation Design

Navigation design is a basic flow that provides a logical flow of the whole application. This Improve English using Mobile Educational Games is a mobile application platform which is provides the interactivity for user to access the information of the game. Figure below show the navigation of the Improve English using Mobile Educational Games.

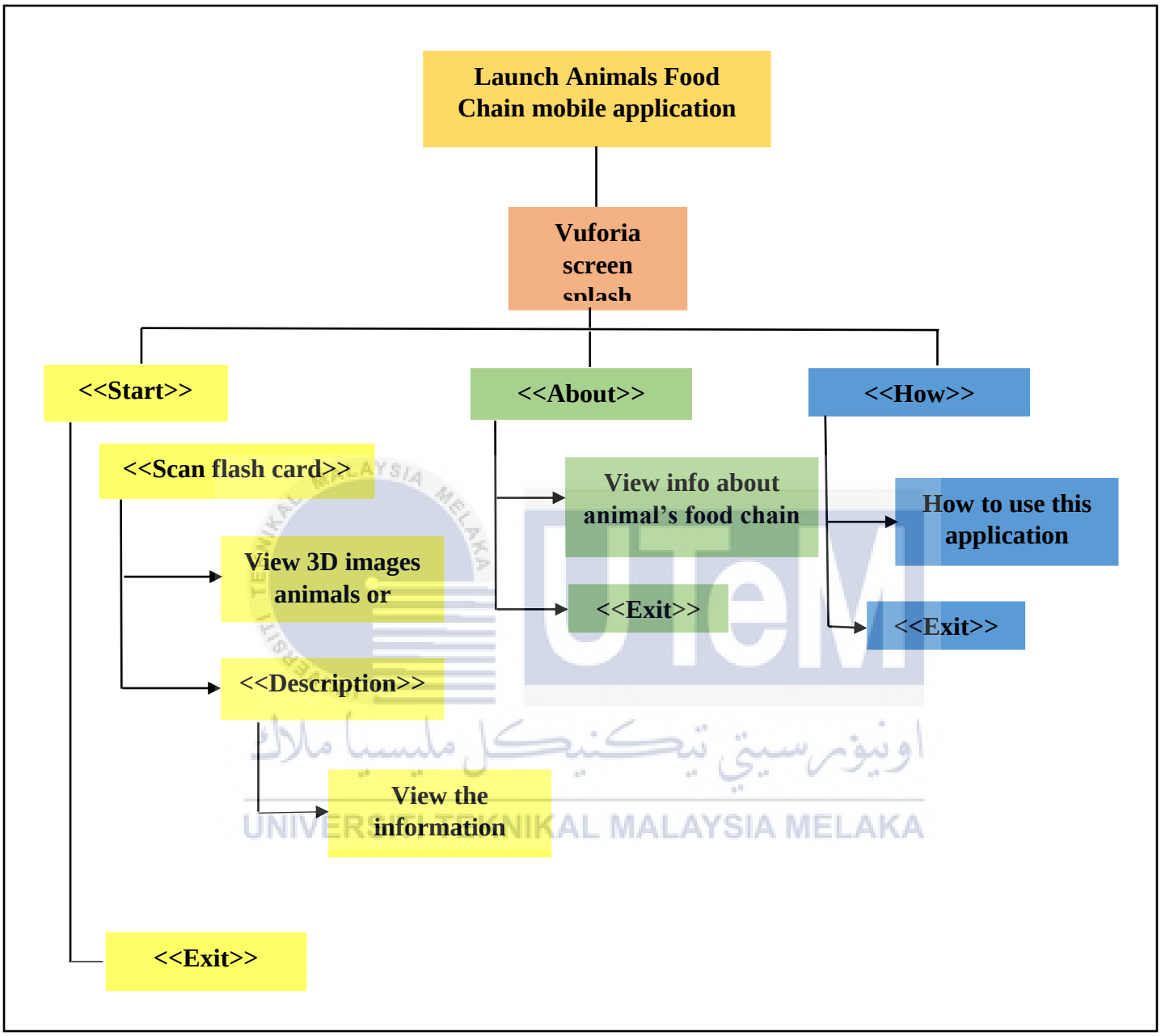


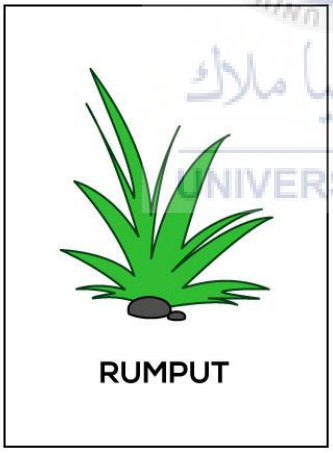
Figure 4.11: Navigation Design

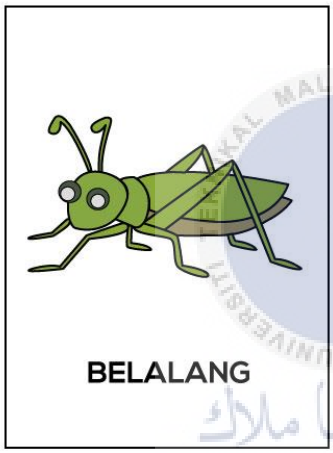
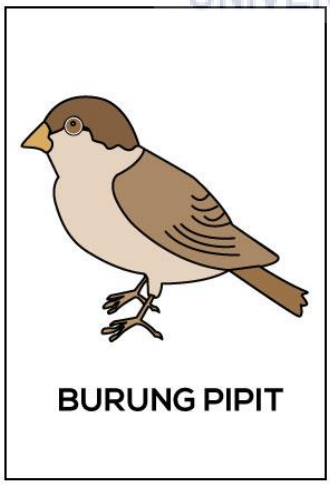
4.4.2 Input Output Design

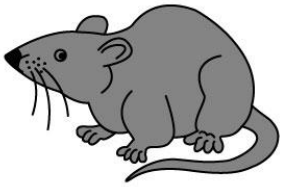
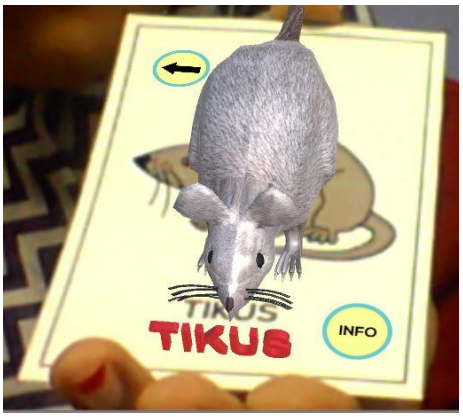
The input design used for this animal's food chain AR mobile application is the image target that save in Vuforia database. The image target size with height 433 pixels and width 333 pixels in black and white colour.

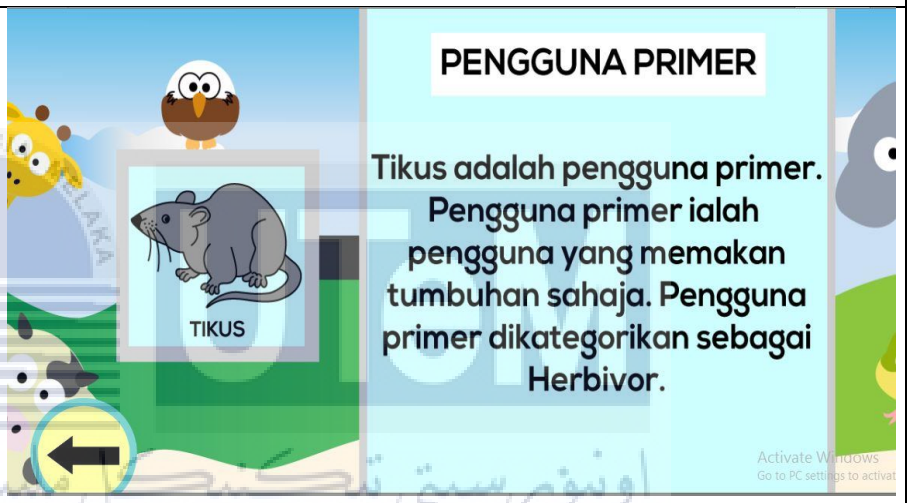
The output of this animal's food chain mobile application are 3D animals and foods with text. There are also 2D image that contains information about animal's food chain and the information about flash card that has been scan. The information provided is very simple and easy to understand. Figure 4.8 and Figure 4.9 display more details about input output design.

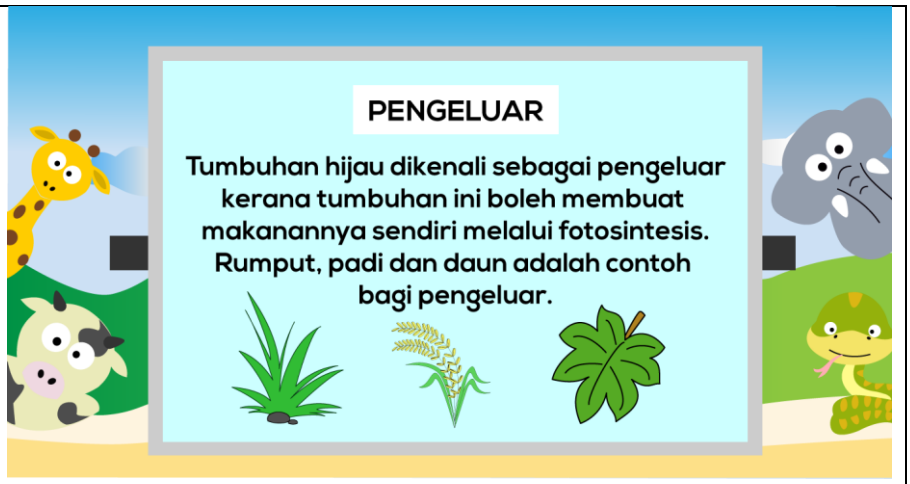
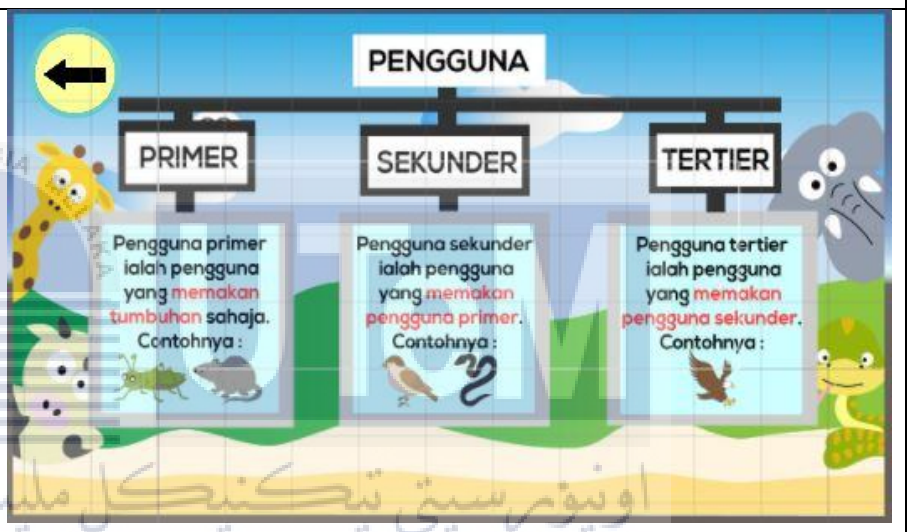
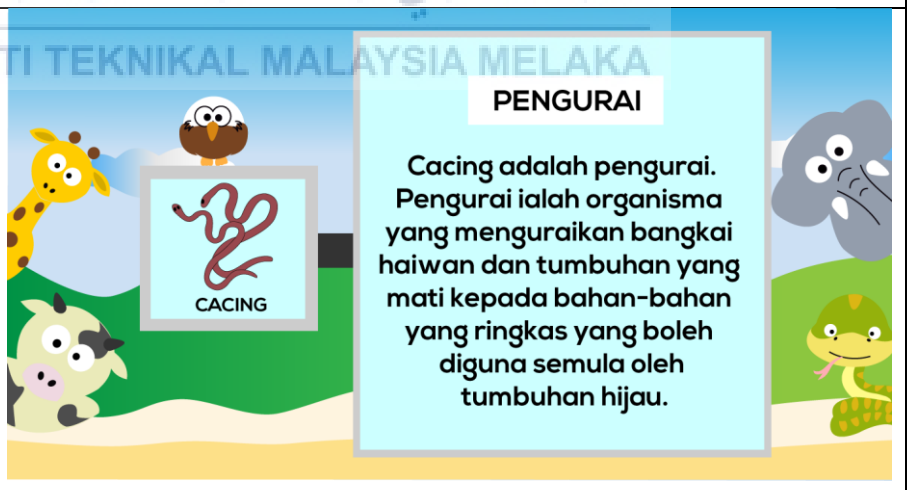
Table 4.10: Input and Output Design

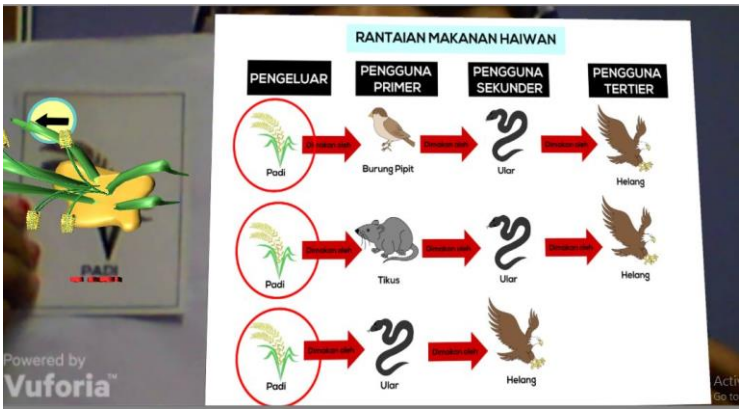
Input Design(Flash card marker)	Output Design
	

 TIKUS	
 ULAR	
 HELANG	



PENGELUAR	
PENGGUNA	
PENGURAI	

CONTOH RANTAIAN MAKANAN HAIWAN	

4.4.3 Icon Design

An application that is installed on the smartphone has its own representative icon to let the user differentiate which icon is belongs to the application. In addition, in this project, there has an icon design to represent the animal's food chain.

Figure 4. 2 : Icon Design

4.5 Conclusion

This chapter summarizes the design used to develop this animals food chain mobile application via AR includes system architecture, web interface design, mobile application interface design, flash card design, navigation design, storyboard design, input and output design. Each design have their own important to developer to develop this system with successful. It also help developer to see the whole system based on the user needs and requirements.

Furthermore, navigation design show the clearly layout with the navigation control in this mobile application. Other than that, input and output design help developer to generate possible output for the mobile application and give clearly information for student learned animal's food chain. For the next chapter, will discussed about the implementation phase of this system. It will describe about all the activities that will be included to define the configuration setup and progress during the development process of this mobile application.

CHAPTER V

IMPLEMENTATION

5.1 Introduction

This chapter will discuss about implementation phase. It is deals with issues of quality of the media creation. There are several activities that will include in this chapter such as media creation, media integration, product configuration management as well as the implementation status. Media creation is all about the content creation for the system and media integration is determine the process of integrating the created content. Next, product configuration management will discuss about the configuration setup of the system and lastly describe the progress of the development status of the system.

5.2 Media Creation

Media creation is the process that focus on the text production, graphic production and animation production.

5.2.1 Text production

Text is an important element to let user understand the information about animal's food chain and want to it deliver to user especially Standard 5 student that learn this topic in their Science subject at school. A consistent and dynamic of the font family, font size and font color will let students feel comfortable to read. The production of text plays important roles when developing this AR mobile application. The target user for this project Standard 5 student's in primary school, so the selection of text must be easier to read and clear to see by them. Table 5.1 shows the details of the production of text.

Table 5.1 Productions of text

Material	Type of Text	Font Color
Flash Card		
• Animal's name	Serif: Nexa Bold	Black
• Food's name	Serif: Nexa Bold	Black
Interface Animal's food chain AR		
• Main Menu		
○ Icon name	Serif: Nexa Bold	White
○ button MULA	Serif: Nexa Bold	Black
○ button APA	Serif: Nexa Bold	Black
• Interface for Instruction	Serif: Nexa Bold	Black
○ Content	Serif: Nexa Bold	Black
○ button OK		
• AR Interface		
○ Virtual button INFO	Serif: Nexa Bold	Black
• Info Interface		
○ Content	Serif: Nexa Bold	Black

In this AR mobile application, there are 3D text included. The 3D text represent the name of animals and foods. There are simple process that need to do before the 3D text was created. The text is create in Autodesk Maya 2012 and exported to fbx file. Figure 5.1 explained the process of production of 3D animals and food's name.

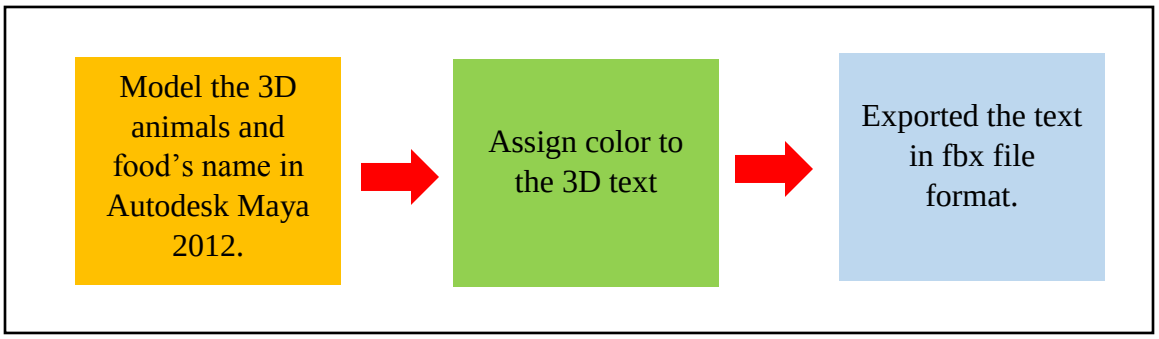


Figure 5.1: Process of productions 3D animals and food's name.

5.2.2 Production of Graphic

In this project, the source image for the flash card is downloaded for free on the internet. After download it, edit the image by tracing it again in Adobe Illustrator CS6. After done the editing part, this file format for flash card are all save in JPEG format to easy for use it in mobile application. The image of the flash card are successfully save in Vuforia database as an image target to create the AR mobile application. The image of the flash card can be referred in the previous chapter.

In addition, there are five virtual buttons in this mobile application which created using Adobe Illustrator CS6. After done design all the button, it is exported to PNG file format. Figure 5.2 is shows the process of graphic production for this AR mobile application.

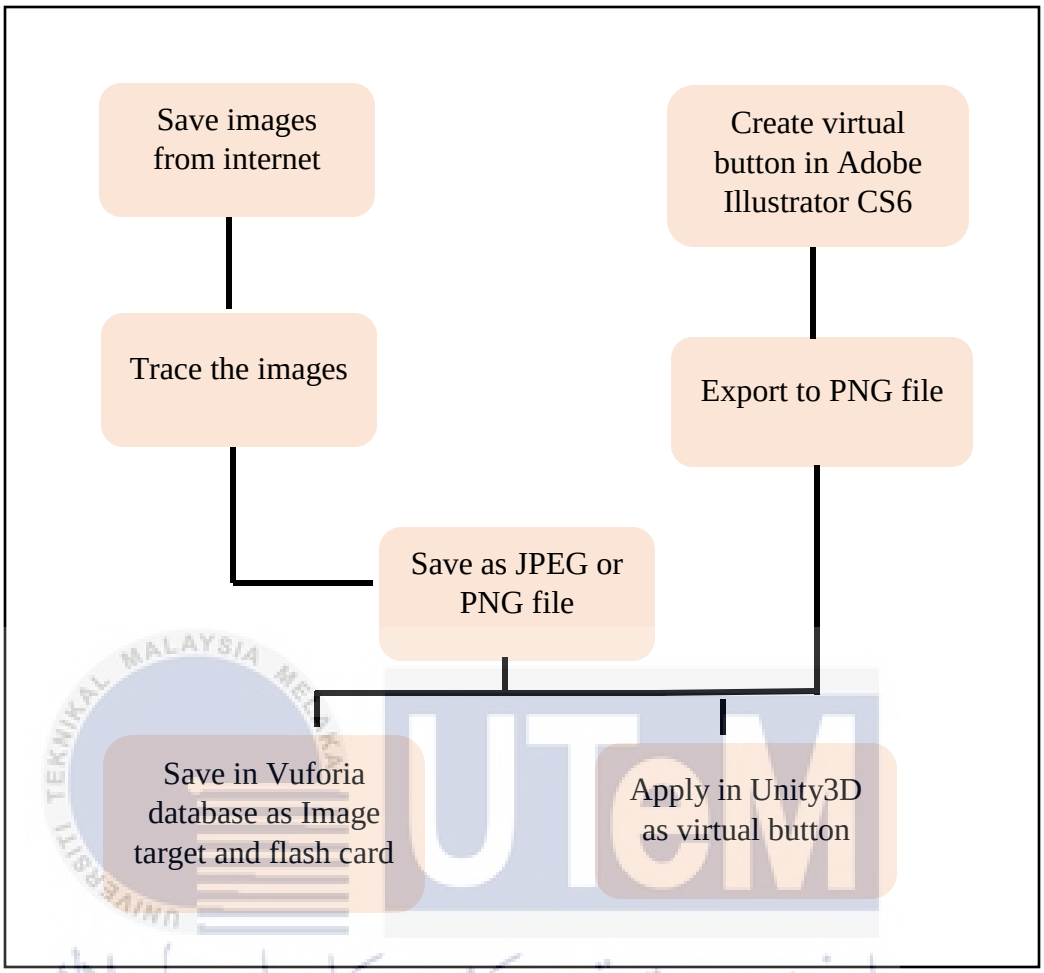


Figure 5.2: Process of graphic production

The 3D modeling object is one of the main process in the production of graphic. There are several 3D object that included in this animal's food chain project. The animals 3D that has been develop which is grasshopper, sparrows, rat, snake and eagle. 3D food also included in this project such as grass and paddy. All of the 3D animals and foods are modelled using Autodesk Maya 2012 and some of them also animate in Maya and exported to fbx file. This process is clearly demonstrated in Figure 5.3.

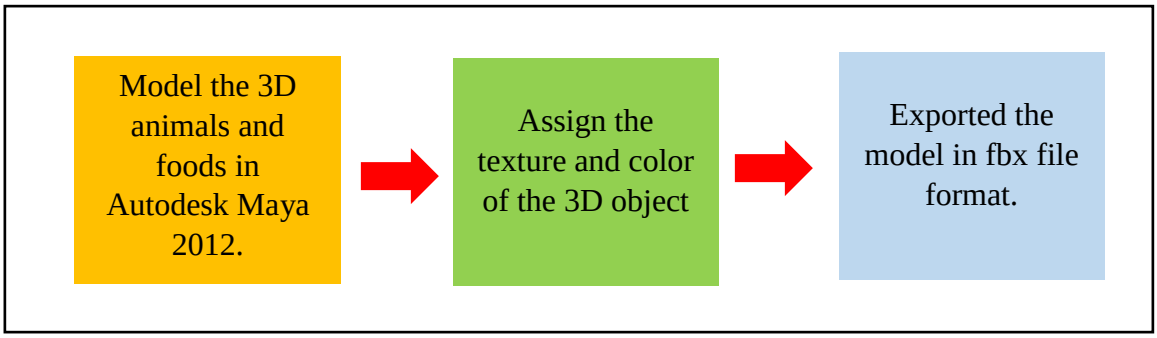


Figure 5.3: Process of modelling the animals and foods

5.3 Media Integration

Media integration is the process that integrates all the media creation such as texts, graphic and animation with Unity3d. In the previous chapter, the system architecture design of Animals food chain via AR mobile application has been explained. So, this section will explained how to integrate all components of this mobile application.

Developer develops the mobile application by using Unity3D. While in this mobile application, C sharp the language that use for this mobile application. Other than that, the implementation of AR is using Vuforia where it is used to store the image target, handles all the importing image target into AR environment.

Figure 5.18 will show the process of integration of Animals food chain via AR mobile application. The integration of the process will start after the production of text, graphic and animation are done. The integration process for this mobile application is through importing, arranging and scripting by using Unity3D to combine all the image target, 3D text and linking the main menu.

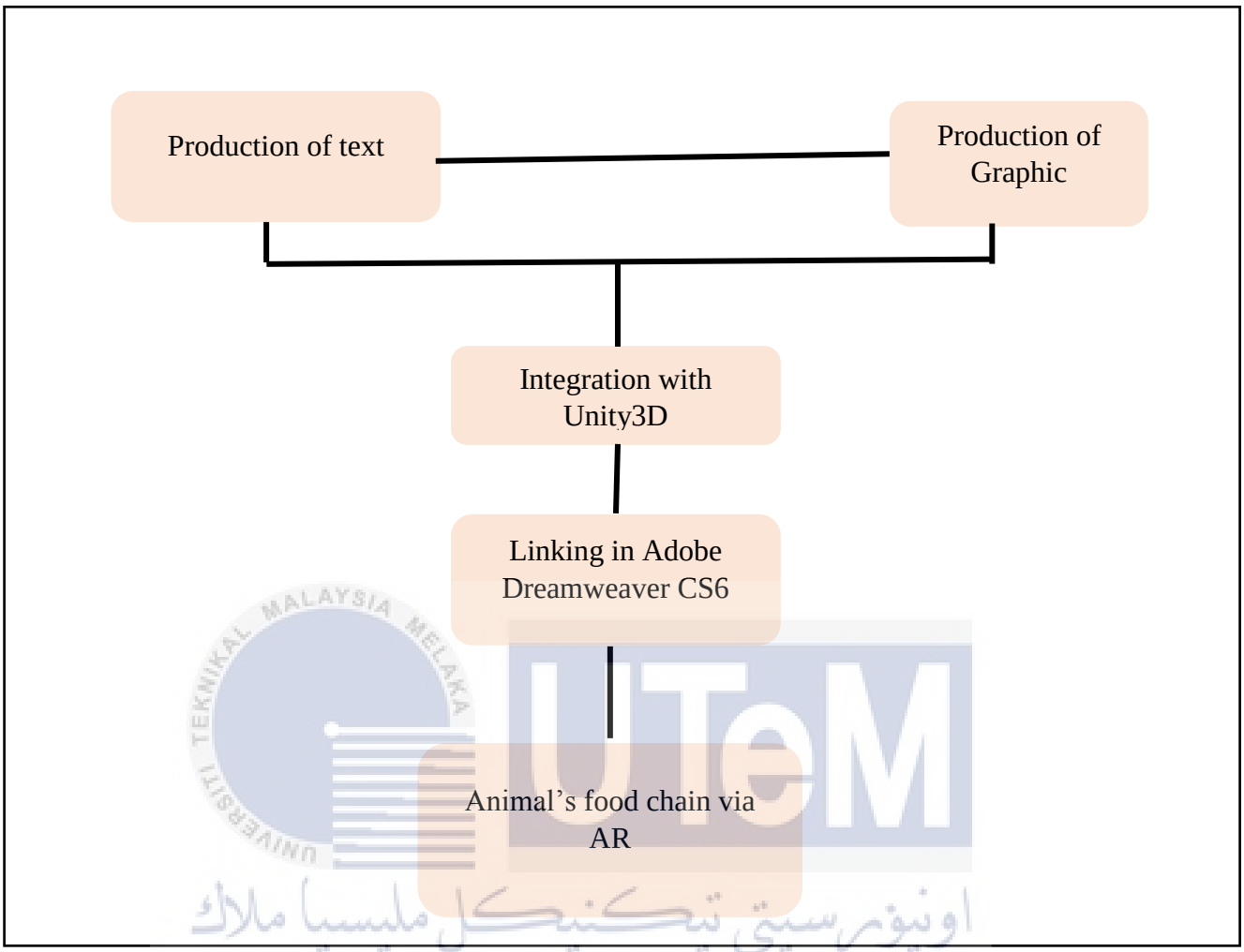


Figure 5.4 Process of integration

5.3.1 Integration Process

All the components such as images and 3D animals, food and text that required render in this animal's food chain mobile application needed to save in the folder of Assets which inside the folder of RantaianMakananHaiwan folder, as shown in Figure 5.5.

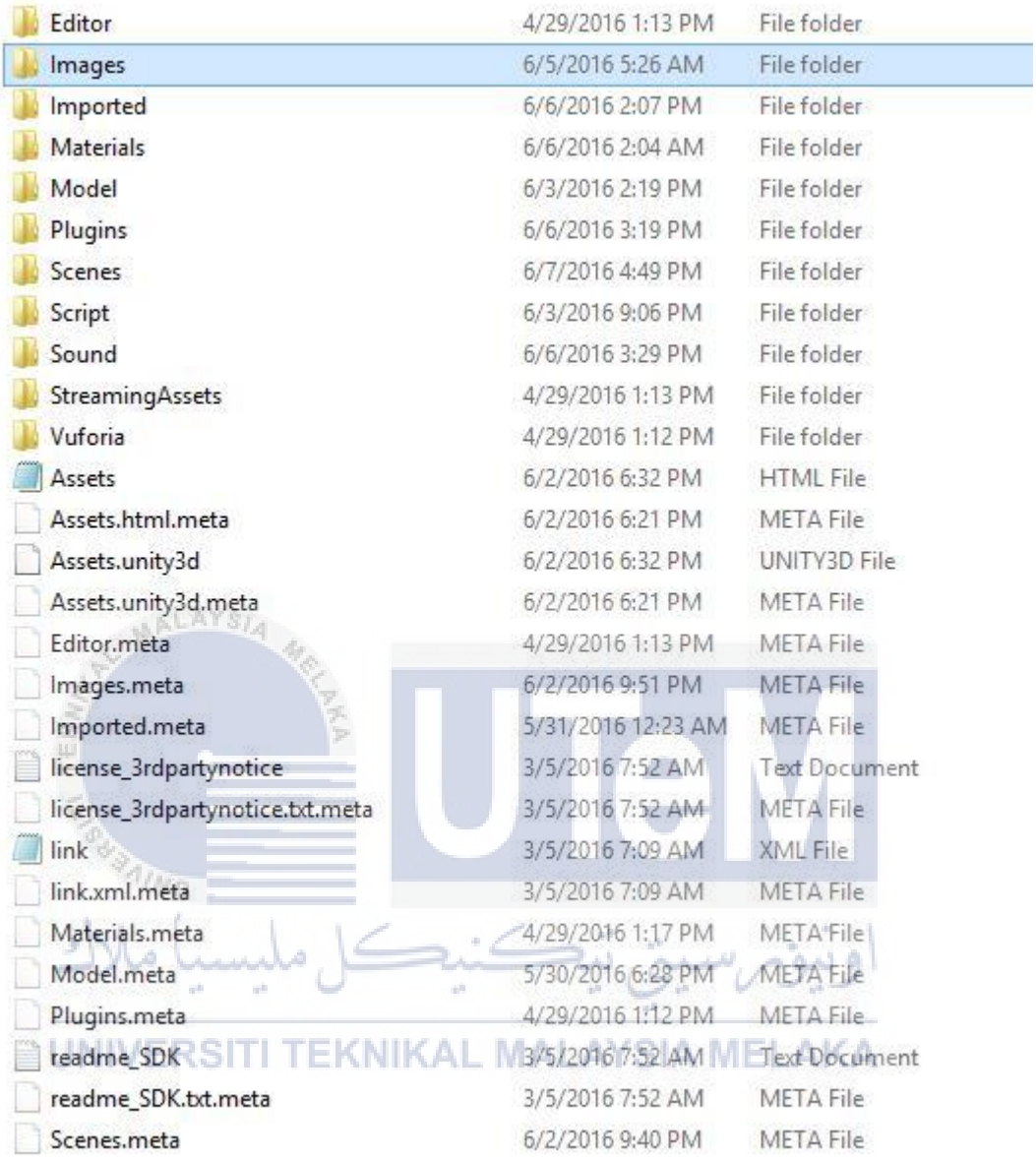


Figure 5.5 Path saving all the components.

Next, after all components have saved in the folder of Assets, developer need to store all the image target at Vuforia database.

5.4 Product Configuration Management

This section will explain about the configuration environment setup and version control procedure. Configuration environment setup is explained about how the developer design and configures or installs the required software for this mobile application. While for the version control procedure is explained about the steps of procedure and control in managing the version of the mobile application.

5.4.1 Configuration Environment Setup

Many development tools are used and need to configure. There are two important development tools which are Unity3D and Vuforia SDK will be determined in this section.

5.4.1.1 Configuration for Vuforia SDK

The first step to develop an augmented reality environment in mobile application is to create an account for free at the https://developer.vuforia.com/, Vuforia developer official website.

1. Go to Vuforia official website, register as a member for free.

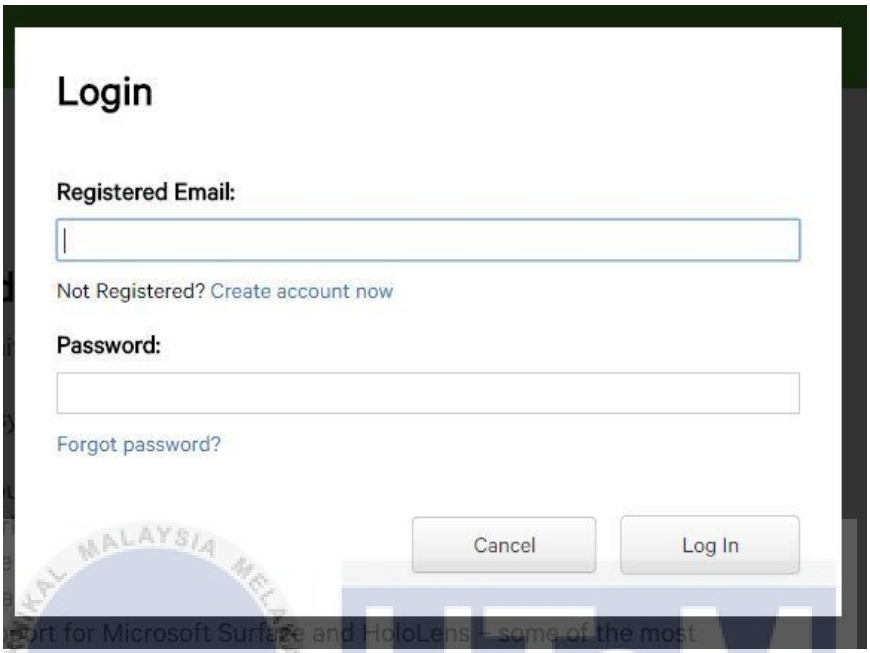


Figure 5.6: Register an account.

2. Go to Develop menu to add and click "Add License Key".

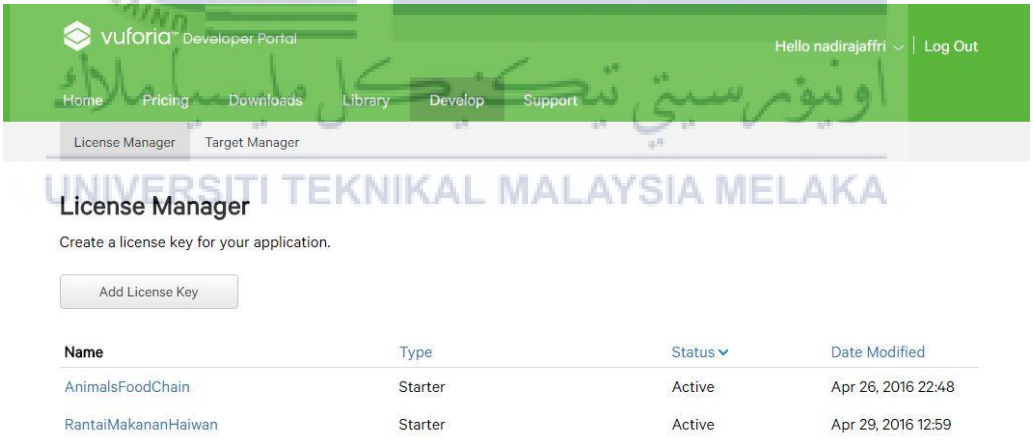


Figure 5.7: Develop Menu

3. Copy the License key to put it into Unity3D to get start create AR environment.

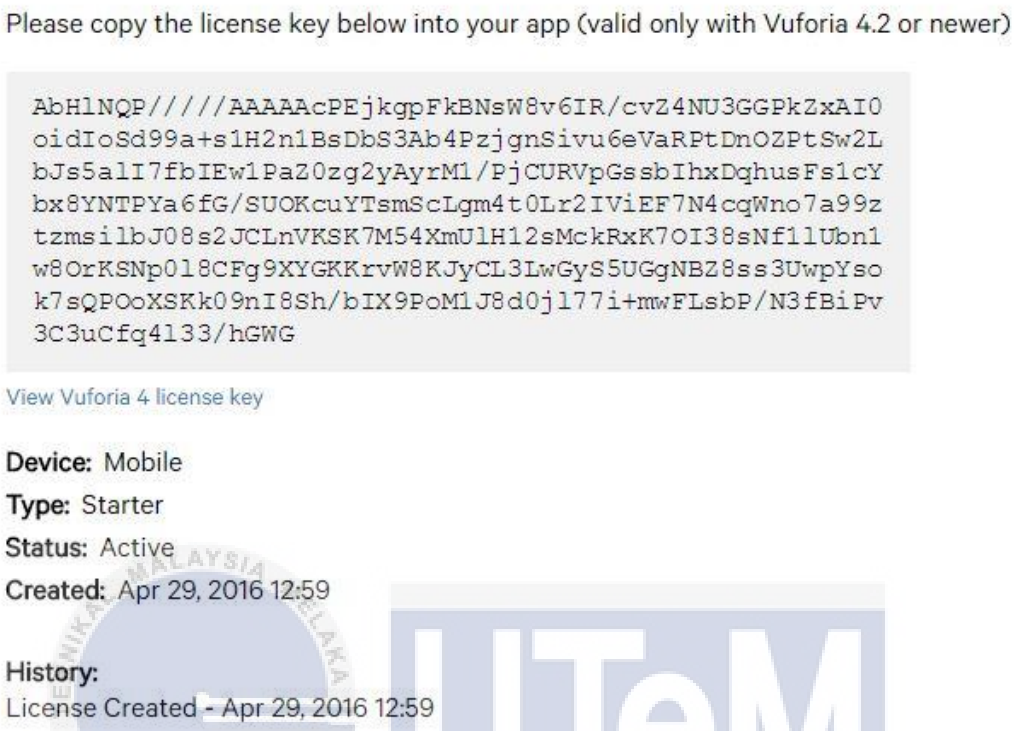


Figure 5.8 License Key

4. Click “add target” for getting start or click “Download Database(all)” to download the image target

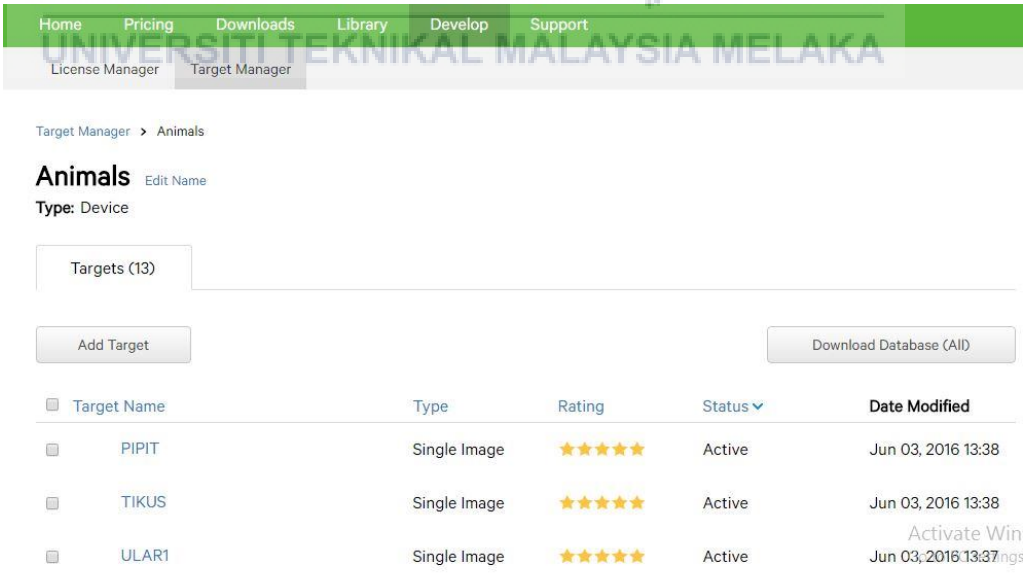


Figure 5.9 Target manager

5. Download the database in type of Unity Editor

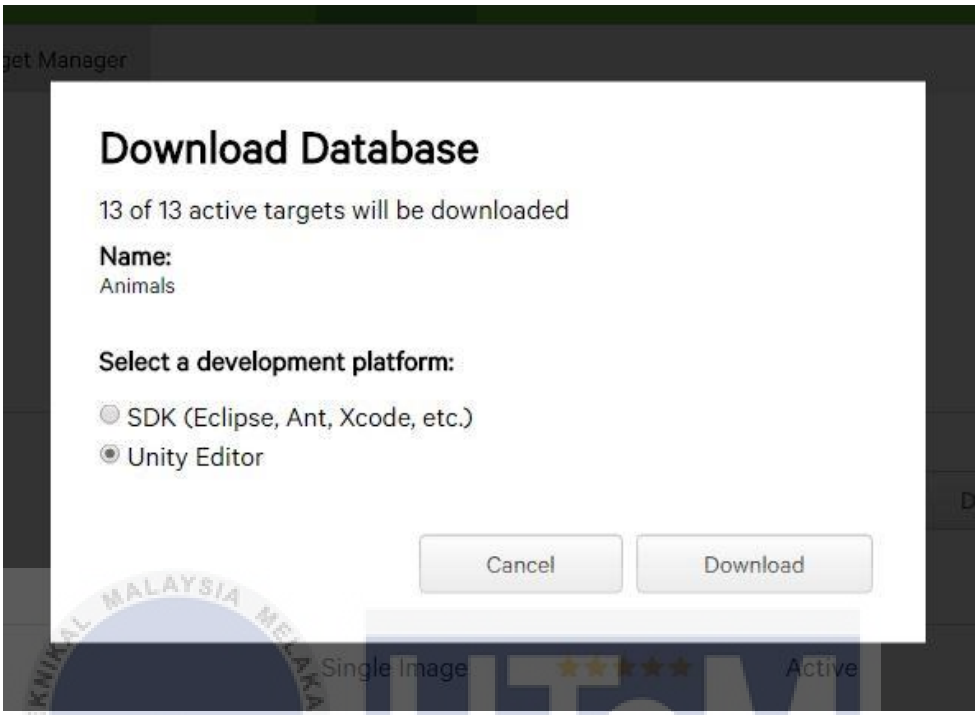


Figure 5.10: Download the database

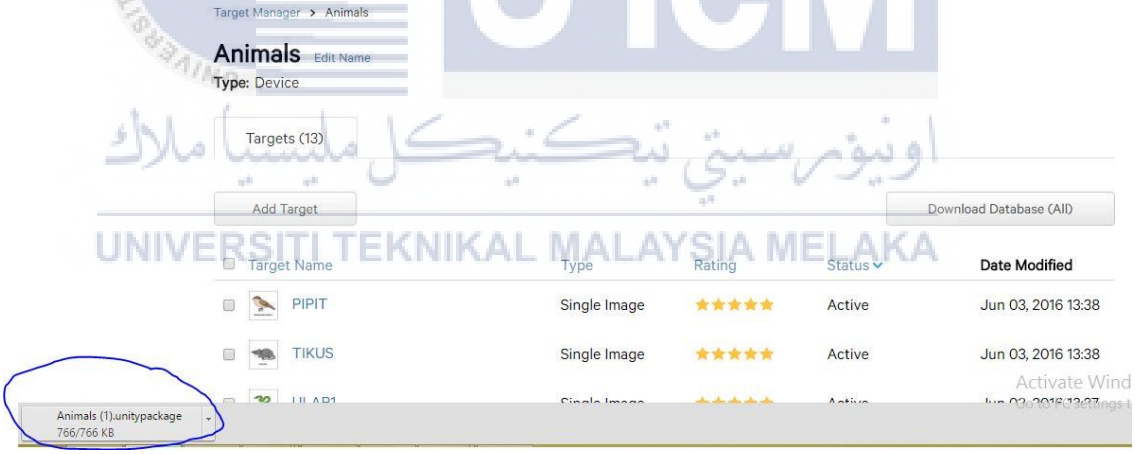


Figure 5.11 Download the Database

6. Import Database in Unity3d

Figure 5.12 Import the database into Unity

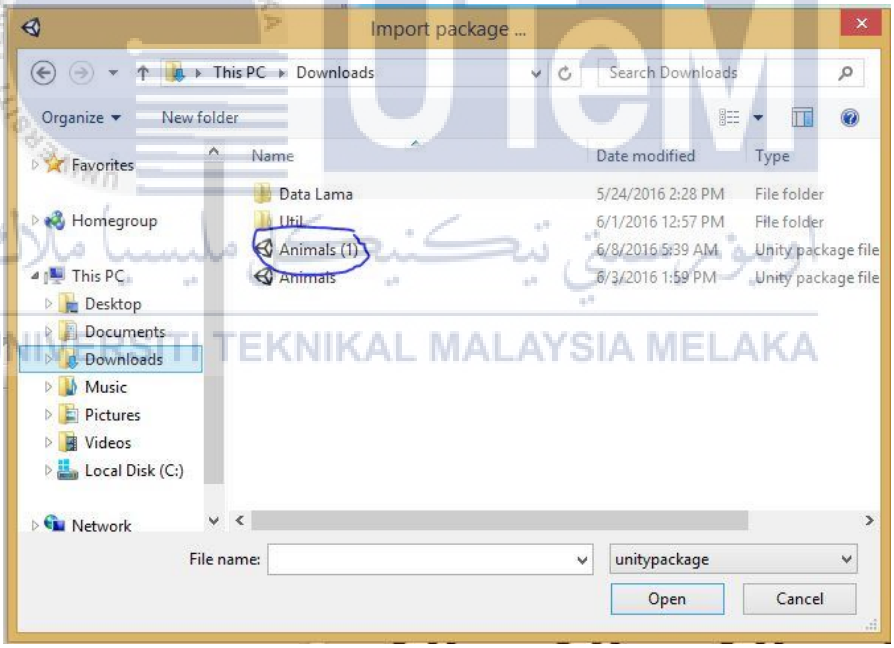


Figure 5.13 Database of image target

7. Paste the License Key at Unity3D

Figure 5.14 License Key

8. Now Unity3D has been converted to Augmented Reality environment.

5.4.1.2 Installation for android or mobile devices

1. Open your Unity3D
2. Go to File -> Build Settings. Figure 5.15 show the image when click build settings.

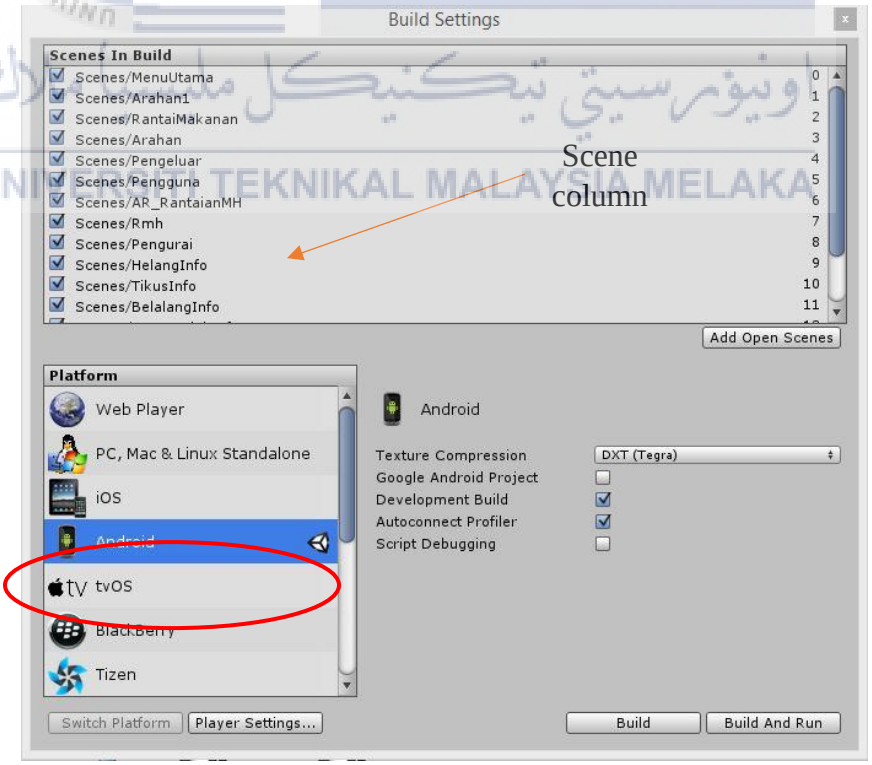


Figure 5.15: Build settings

3. Make sure drag all the scene in scene in build column.
4. Click on Android column -> Build
5. Specified folder to save .apk file. Figure 5.16 show the example folder to save .apk file.
6. Click SAVE.

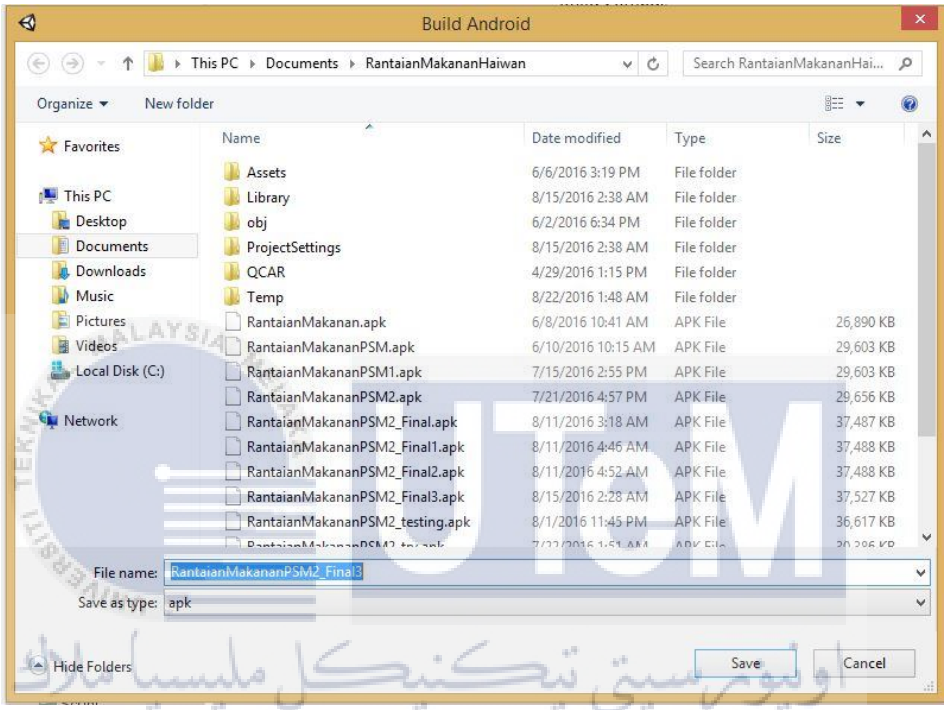


Figure 5.16: Example folder to save .apk file

7. Now .apk file already save to the specified folder.
8. Plug the device's USB cable into your computer.
9. Open the folder that save .apk file.
10. Copy and paste the file to the storage on the devices. Make sure have enough space to copy file into the devices.
11. Open the File Manager - > SD Card or another storage name. Figure 5.17 show the .apk file on the devices.

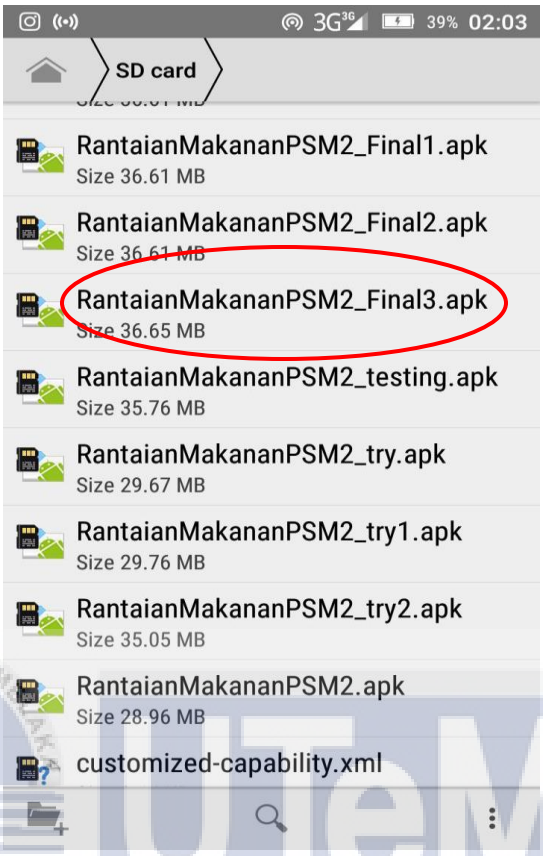


Figure 5.17: .apk file on devices.

12. Click on the .apk file and click install.
13. After finish install, click open or done.
14. Now can application of animal's food chain are available on the mobile devices.

5.4.2 Version Control Procedure

There are two types of version control procedures for this AR mobile application which is alpha and beta testing.

5.4.2.1 Alpha Version

Alpha version is a part where the output is tested by developer for find out the error that may occur before the product is delivered to the users as Beta version. During

the development of the mobile application, there have six versions for alpha testing. Table 5.3 shows the version control procedure and the description for each version.

Table 5.2: Version control procedure and description

Version	Description
Version 1.0	Completion of 3D text name for animals and food and also the 3D modelling for animals and food
Version 2.0	Create interfaces for the mobile application and allocate two buttons inside the interface of AR environment.
Version 3.0	Import the 3D animals with animation into AR environment and set it as object target.
Version 4.0	Import other 3D modelling object into the scene and set their properties
Version 6.0	Add two visual button on the image target.

5.4.2.2 Beta Version

Beta testing is conducted on the end user sites. A prototype was created and will test with the target user during Final Year Project II.

Table 5.3: Beta Version control and description

Version	Description
Version 1.0	Test the product to supervisor.
Version 2.0	Test the product to expertise.
Version 3.0	Test the product to the target user which is standard 5 students.
Version 4.0	Test the product to the teachers that teach science subject for standard 5.

5.5 Implementation Status

Implementation status is about the development progress of this AR mobile application which is managed in order to finish the task according to the project milestone. The implementation status for each task is stated in the Table 5.4.

Table 5.4: Implementation status

Animals Food Chain via AR	*Start*	*Finish*	*Status*
Proposal Submission	2/22/2016	2/26/2016	On Time
Proposal Correction and Improvement	2/29/2016	2/29/2016	On Time
Requirement Planning	3/1/2016	3/2/2016	On Time
Analyze the target user	3/2/2016	3/4/2016	On Time
Report Chapter 1 and Chapter 2	3/2/2016	3/4/2016	On Time
User Design	3/7/2016	3/8/2016	Delay
Analyst and develop models and prototypes	3/9/2016	3/19/2016	Delay
Determine learning process based on audience need	3/20/2016	3/21/2016	On Time
Report Chapter 3 and Chapter 4	3/22/2016	3/24/2016	Delay
Construction	3/25/2016	3/26/2016	Delay
Programming and application development	3/27/2016	4/3/2016	On Time
User testing	4/4/2016	4/4/2016	On Time
Finishing the project	4/5/2016	4/28/2016	Delay
Report Chapter 4	4/29/2016	5/2/2016	On Time
Cutover	5/3/2016	5/15/2016	On Time
Data Conversation, testing and changeover	5/16/2016	6/2/2016	Delay
Project Demo and PSM Report	6/3/2016	6/7/2016	On Time
Presentation	6/8/2016	6/8/2016	On Time
Report Correction	6/9/2016	6/9/2016	On Time
Continue do the report Chapter 5 for PSM 2	6/27/2016	7/1/2016	Delay
Do the correction on the product for PSM 2	7/2/2016	7/29/2016	Delay
Do testing product at the target user and expertise	8/2/2016	8/5/2016	On Time

Do the report for Chapter 6 and Chapter 7	8/6/2016	8/10/2016	On Time
Presentation PSM 2	8/11/2016	8/11/2016	On Time
Report Correction	8/20/2016	8/20/2016	On Time

5.6 Conclusion

Implementation phase is the major phase for developing this mobile application because it includes a detailed of the product development process. It describes the production of text, graphic and animation clearly. After the media creation was done, the integration process of the product also explained in detail. Other than that, the configuration management are explained about the software tools that required by the developer for managing the development of the mobile application. Lastly, the implementation status for each task will be defined to indicate the progress of the project.

For the next chapter, the Animal food chain mobile application is ready to be tested by the user to validate and verify the user requirements. Besides that, the activity in the testing phase is to detect any error or deficient of the mobile application. Therefore, test plan will be discussed in the next chapter which includes test organization, test environment, test schedule and test strategy. Besides that, test design will also develop in the next chapter. For the test design, it is included the test description which the test of each module will be designed and the test data will collect from the user. Lastly, the entire test that collected will be analysis.

CHAPTER VI

TESTING AND EVALUATION

6.1 Introduction

This chapter discuss the most important part of the project which is testing phase. The purpose of this testing to estimate the project had successfully achieved the objective and able to transfer the information to the target audience.

This project testing will be conducted in two ways, which is black box testing and user acceptance testing. Black box testing will test the functionality of the website and mobile phone at the expert group, while user acceptance testing is about how target users feel about the application. The activities involved in this testing phase are test plan and test implementation. For the test plan, it can be divided into test organization, test environment, test schedule and test strategy. Whereas the test implementation includes the test description, test data, test result and analysis as well as analysis testing.

6.2 Test Plan

In developing this application, proper planning need to be done to make sure the operations runs smoothly without any interruption and meets its objectives besides, to eliminate any deficiency from data collection. The test plan is the first stage of testing

phase which is about document detailing a systematic approach to test a website and mobile application that has been develop. The documents strategy will be used to ensure the website and mobile application meet its objectives, design specifications and other requirements needed. There are four type of testing included which is test organization, test environment, test schedule and test strategy.

6.2.1 Test Organization

Test organization is to determine who are involved in the testing phase of animal's food chain website and mobile application. The person who are commonly involve are developer, supervisor, evaluator and students. Table 6.1 shows the responsibility of the personnel during testing phase.

Table 6.1: Details of the test organization

Criteria	Alpha Version	Beta Version
Profession	BITM third year students	Standard 5 students
Responsibility	Respondents will tests the functionality of the website and mobile application that has been develop based on the navigation, interactivity, interface design, content and functionality of AR.	Responsible for testing the website and mobile application according to the questionnaire prepared by developer.
Age (years old)	20 and above	10
Gender	Female – 5 persons	Male – 9 persons Female – 12 persons
Ethnic	Malay – 5 persons	Malay – 19 persons India – 2 persons
Total of respondents	5	21

6.2.2 Test Environment

This section describes the location and environment of the testing that will be conducted. The location be the must be a suitable place so that the testing can be carried out smoothly and completely.

Besides that, the platform and the minimum requirement to run the products need to be specified. The testing conducted using personal laptop and display it using projector. There are two smartphones that compatible with Android operating system are also needed to carry out the testing. Table 6.2 demonstrated the test environment for the testing.

Table 6.2: Test Environment

Testing	Alpha Version	Beta Version
Profession	BITM third year students	Standard 5 students
Location	UTeM, Melaka	Sekolah Kebangsaan Pulau Sebang
Environment	A room with sufficient light.	Computer laboratory has been used as a place to do the testing. A sufficient lighting and quite from any sound / music is prepared for this testing due to insufficient of lighting will influence the testing of augmented reality mobile application.

Hardware	• 2 smartphones with Android platform
	  ○ Version 2.3 (Gingerbread) or higher
	  ○ With a phone camera
	• A phone camera used to take picture while do the testing.	

Others	• Flash card in softcopy or hardcopy form	

Phone camera use to take the picture while testing has been conducted and also take picture while student using animal's food chain website and mobile application. Figure 6.1 show the layout of computer laboratory when the testing conducted.

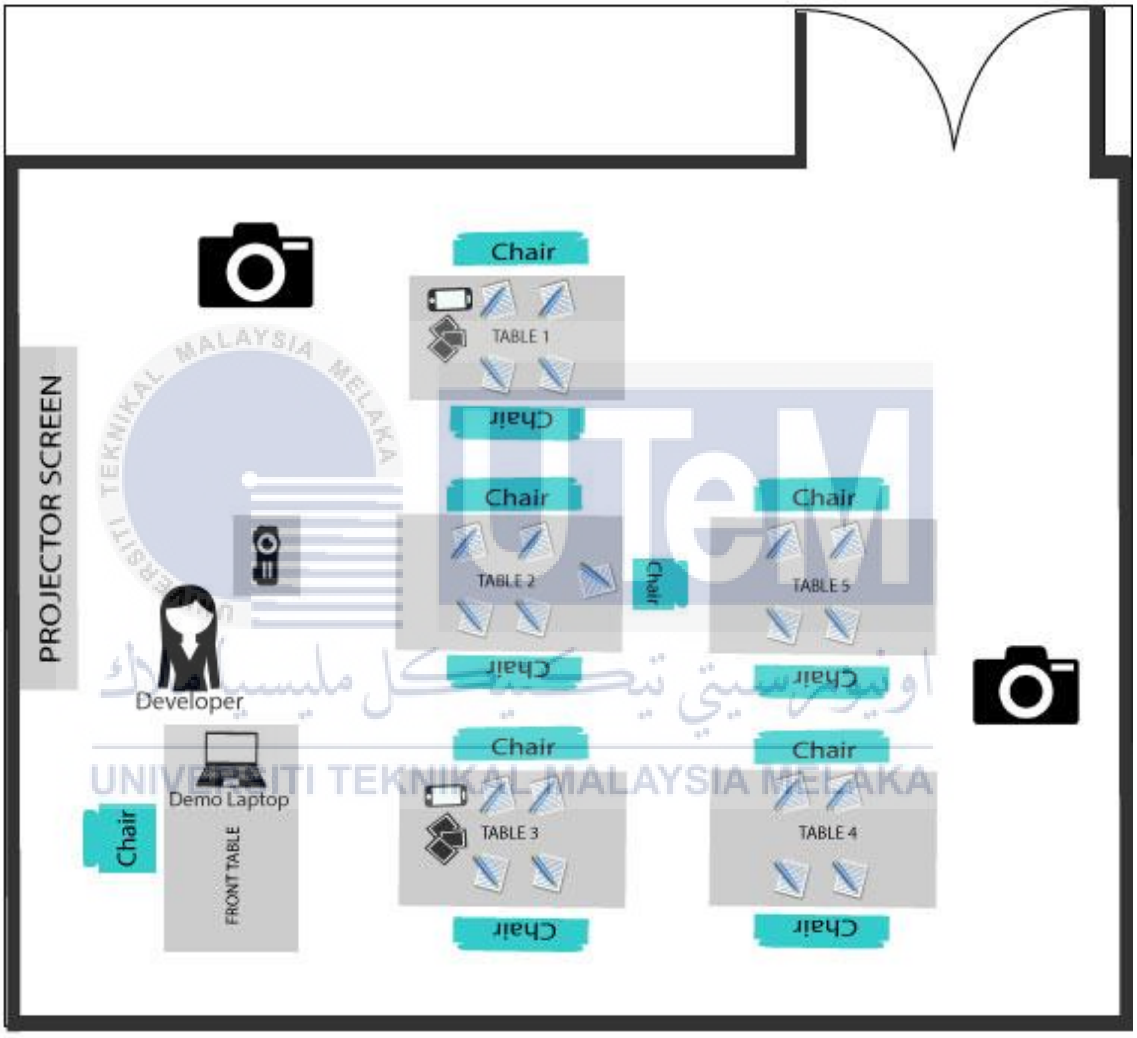


Figure 6.1: Computer Lab

6.2.3 Test Schedule

The test schedule is used for managing the time and duration for developer to complete the test to ensure testing process run smoothly. This testing is carried out based on the test scripts that prepared.

Table 6.3: Test Schedule

Testing	Alpha Version	Beta Version
Profession	Multimedia developer	Standard 5 students
Total of participants	5	21
Date	4 August 2014	5 August 2014
Duration per session (minutes)	10	15
Number of participants per session	1	5 to 6 students per section
Total time spent (minutes)	20 minutes	60 minutes

6.2.4 Test Strategy

There are strategy and guidelines need to be follow while conducts the testing to ensure the testing can be analyst and accepted. The tester is given by set of question and they needed to complete it after test the application. There are many test strategies that can be used such as Bottom-Up Testing, Top-Down Testing, Black Box Testing and White-Box Testing. In this project the strategy chosen for alpha version testing is Black Box Testing which is functional and integration testing and for beta version testing is using User Acceptance Testing (UAT).

Black box testing is a method that examines the functionality of the website and mobile application without looking its internal structures. This method is used to fine the errors such as incorrect or missing features, interface errors, performance or navigation errors as well as initialization and termination errors. This testing will be conducted by following the testing form that prepared to test the specific functions of the website and mobile application. A set of questionnaire will prepared for each testing. UAT testing based on five aspect/module. There are also set of question for Pre-Test and Post-Test that consist of multiple choice of question for UAT. Tester need to answer the question by giving the rating and as a guideline, five levels of evaluation is used in the alpha and beta version testing which are:

a. Strongly Dissatisfied– 1
b. Dissatisfied – 2
c. Not sure – 3
d. Satisfied – 4
e. Strongly Satisfied - 5

i. Alpha Version Testing

Functionality testing is a testing process that used within the website and mobile application to ensure it conforms to all requirement. Functionality testing is a way to checking software to ensure it has all the required the functional requirement. Besides, integration testing is the combination of animal's food chain mobile application and the flash card provided in website and hardcopy to know whether it can be function together correctly or not.

The questionnaire that has been prepared for both of the testing is based on four aspect which is visual clarity, navigation and interactivity, content and functionality of AR.

ii. Beta Version Testing

User acceptance testing is consist is to ensure that the solution will word for the target user. This testing conducted to test whether target user will accepts the solution that provided. UAT carried out based on the test script and there a set of questionnaire before and after the testing process to allow them to use the animal's food chain website and mobile application and answer the questions that has been prepared.

The question are design based on five aspect/module which is visual clarity, functionality and content, multimedia element, additional features and effectiveness. There are also Pre-Test and Post-Test multiple choice questions and they need to answer it before and after the testing has been done. The Pre-test question is the question based on their effectiveness of learning using textbooks and the Post-Test question is the

question they need to answers after used the animal's food chain website and mobile application that has been develop.

6.3 Test Implementation

This section will be discuss the implementation of testing. Test implementation describes on how the testing will be implemented to the tester. The test implementation consist of test description, test data, test result and test analysis and lastly the analysis testing.

6.3.1 Test Descriptions

The description is a part where the case status description for alpha version was measured and expected result for the beta version. Table 6.4 and Table 6.5 show list of question for Functionality and User Acceptance Testing.

i. Alpha version testing

Table 6.4: List of question for Functionality testing

No.	Aspect / Module	1	2	3	4	5
PART A: VISUAL CLARITY						
1.	Well organize the layout of interface for website and application					
2.	Easy to read all the text in mobile application and website.					
3.	Suitable choose of colors for the design and all image.					
4.	Screen color schemes did not interfere with readability.					
5.	All the buttons labels are clear and easy to understand.					

6.	Example of animal's food chain shown easy to understand.					
7.	The design of the interface used suitable for animal's food chain.					
PART B: NAVIGATION AND INTERACTIVITY						
1.	Clear navigation between pages in the website and mobile application.					
2.	Menu is easy to control and understand.					
3.	All button return correct response.					
4.	Response time with the buttons is fast and smooth.					
PART C: CONTENT						
1.	Easy to understand the information provided in mobile application and website.					
2.	2D animation provided is very interesting.					
3.	All the information provided is about animal's food chain.					
4	The instruction provided in the mobile application is simple and clear.					
5.	All the animals and food shown in included in animal's food chain.					
6.	The information provided give you more understand about animal's food chain.					
PART D: FUNCTIONALITY AR						
1.	Use of AR attracts the attention to focus on 3D animals and foods.					
2.	AR applied in the mobile application is impressive.					
3.	Content presented through AR is clearly.					

PART E : INTEGRATION PRODUCTS						
1.	Every ID marker returns correct output when it scanned.					
2.	The information about the animals and food will be shown after clicked the info button.					
	Each button will not take more than 1 minutes to give response.					
3.	Each button response consistently in mobile application and website.					
4.	No confusion between content with the real environment.					
5.	Each menu button in mobile application and website linked to correct pages and content.					

ii. Beta Version Testing

There are two categories has been test for beta version testing among target user which is standard 5 student. Two categories based on their learning using textbooks and after they using animal's food chain website and mobile applications. The question are design based on five aspect/module which is visual clarity, content, multimedia element, additional features and effectiveness. List of questions for User Acceptance Testing show in Table 6.5.

Table 6.5: List of Question for User Acceptance Testing

1	2	3	4	5	Aspect/Module	1	2	3	4	5
THROUGH TEXTBOOKS					**KEJELASAN VISUAL**	**TROUGH WEBSITE AND MOBILE APPLICATION AR**				
					The layout for the image and font clearly and neat.					
					The layout is easy to read, clear and concise.					
					The font used easy to read.					
					The image shown using suitable color.					
					Image shown is very clear and interesting.					
					Image and design are used is related with the topic of animal's food chain.					
					Example of animals and plants can be seen clearly.					
					Example of food chain shown is parallel in the real world.					
					Example of food chain shown easy to understand					

					CONTENS					
					The information given easy to understand.					
					The animation shown very interesting.					
					All the information given related to animal's food chain.					
					Instruction given easy to understand.					
					All the animals and plants shown are included in the food chain.					
					Habitat for the food chain is clearly stated.					
					The information provided makes you understand what the animal food chain clearly.					
					MULTIMEDI ELEMENT					
					There are multimedia element used.					
					The example of animals shown are in 3D images.					
					The learning techniques with the example of animals that can produce sound is very interesting.					

					The use of multimedia element help you easy to understand what you have learn.					
					ADDITIONAL FEATURES					
					There are additional features provided in this method of learning.					
					The learning method is use Augmented Reality (AR).					
					The image of animal and food were shown seem more real.					
					EFFECTIVENESS					
					Learning through this method is very interesting and not boring.					
					Easy to understand what has been learn.					
					The images that can be scanned and produce a 3D image is very interesting.					
					Do you satisfied with this learning technique.					

					This method of learning easy to control.					
					Method of learning that have interesting animation.					
					Do you like if this learning techniques is being used in the classroom.					

6.3.2 Test Data

Test data is the collected results from all the testing. The result of Functionality testing and UAT that collected are attached in Appendix B and C.

6.4 Test Results and Analysis

In this section, all the data of each type of testing are collected from the testers and calculated into mean, median and mode. This process can help to determine whether the end product are accepted or not by the user. The result are gathered and analyze in the table below.

i. Alpha version testing

The result of functional testing and integration testing from BITM third year students is shown in Table 6.6.

Table 6.6: Result for Functional Testing

No.	Aspect / Module	Median	Mode
PART A: VISUAL CLARITY			
1.	Well organize the layout of interface for website and application	4	4
2.	Easy to read all the text in mobile application and website.	5	5
3.	Suitable choose of colors for the design and all image.	4	4
4.	Screen color schemes did not interfere with readability.	5	5
5.	All the buttons labels are clear and easy to understand.	5	5
6.	Example of animal's food chain shown easy to understand.	5	5
7.	The design of the interface used suitable for animal's food chain.	4	4

PART B: NAVIGATION AND INTERACTIVITY			
1.	Clear navigation between pages in the website and mobile application.	4	4
2.	Menu is easy to control and understand.	5	5
3.	All button return correct response.	4	4
4.	Response time with the buttons is fast and smooth.	4	5
PART C: CONTENT			
1.	Easy to understand the information provided in mobile application and website.	4	4
2.	2D animation provided is very interesting.	4	4
3.	All the information provided is about animal's food chain.	4	4
4	The instruction provided in the mobile application is simple and clear.	4	4
5.	All the animals and food shown in included in animal's food chain.	4	4
6.	The information provided give you more understand about animal's food chain.	5	5
PART D: FUNCTIONALITY AR			
1.	Use of AR attracts the attention to focus on 3D animals and foods.	5	5
2.	AR applied in the mobile application is impressive.	5	5
3.	Content presented through AR is clearly.	5	5
PART E: INTEGRATION PRODUCT			
1.	Every ID marker returns correct output when it scanned.	5	5
2.	The information about the animals and food will be shown after clicked the info button.	4	4
3.	Each button will not take more than 1 minutes to give response.	4	4

4.	Each button response consistently in mobile application and website.	4	4
5.	No confusion between content with the real environment.	5	5
6.	Each menu button in mobile application and website linked to correct pages and content.	4	4

ii. Beta Version

There are four types of test results in beta testing. Table below shows the result of UAT from 21 testers.

Table 6.7 Result for User Acceptance Testing

Median	Mode	Aspect/Modules	Median	Mode
THROUGH TEXTBOOKS		**VISUAL CLARITY**	**TROUGH WEBSITE AND MOBILE APPLICATION AR**	
4	5	The layout for the image and font clearly and neat.	5	5
4	5	The layout is easy to read, clear and concise.	5	5
5	5	The font used easy to read.	5	5
5	5	The image shown using suitable color.	5	5
5	5	Image shown is very clear and interesting.	5	5
4	5	Image and design are used is related with the topic of animal's food chain.	5	5
4	5	Example of animals and plants can be seen clearly.	5	5

4	4	Example of food chain shown is parallel in the real world.	5	5
4	4	Example of food chain shown easy to understand.	5	5
		CONTENT		
4	4	The information given easy to understand.	5	5
4	4	The animation shown very interesting.	5	5
4	5	All the information given related to animal's food chain.	5	5
5	5	Instruction given easy to understand.	5	5
5	5	All the animals and plants shown are included in the food chain.	5	5
5	5	Habitat for the food chain is clearly stated.	5	5
5	5	The information provided makes you understand what the animal food chain clearly.	5	5
		MULTIMEDIA ELEMENT		
4	4	There are multimedia element used.	5	5
3	3	The example of animals shown are in 3D images.	5	5

4	5	The learning techniques with the example of animals that can produce sound is very interesting.	5	5
4	5	The use of multimedia element help you easy to understand what you have learn.	4	5
		ADDITIONAL FEATURES		
2	3	There are additional features provided in this method of learning.	4	5
3	2	The learning method is use Augmented Reality (AR).	5	5
2	2	The image of animal and food were shown seem more real.	5	5
		EFFECTIVENESS		
4	4	Learning through this method is very interesting and not boring.	5	5
5	5	Easy to understand what has been learn.	5	5
4	3	The images that can be scanned and produce a 3D image is very interesting.	5	5

4	5	Do you satisfied with this learning technique.	5	5
4	5	This method of learning easy to control.	5	5
4	4	Method of learning that have interesting animation.	5	5
5	5	Do you like if this learning techniques is being used in the classroom.	5	5

Table 6.8 Result for Pre-Test and Post-Test

Student	Marks (%)		Increment (%)
	Pre-Test Quiz	Post-Test Quiz	
Student 1	70%	70%	0%
Student 2	50%	60%	10%
Student 3	80%	80%	0%
Student 4	70%	100%	30%
Student 5	90%	80%	-10%
Student 6	90%	90%	0%
Student 7	90%	100%	10%
Student 8	80%	90%	10%
Student 9	80%	100%	20%
Student 10	100%	100%	0%
Student 11	100%	100%	0%
Student 12	70%	90%	20%
Student 13	100%	100%	0%
Student 14	100%	100%	0%
Student 15	60%	100%	40%
Student 16	60%	70%	10%
Student 17	90%	100%	10%
Student 18	100%	100%	0%
Student 19	70%	100%	30%
Student 20	100%	90%	-10%
Student 21	100%	100%	0%

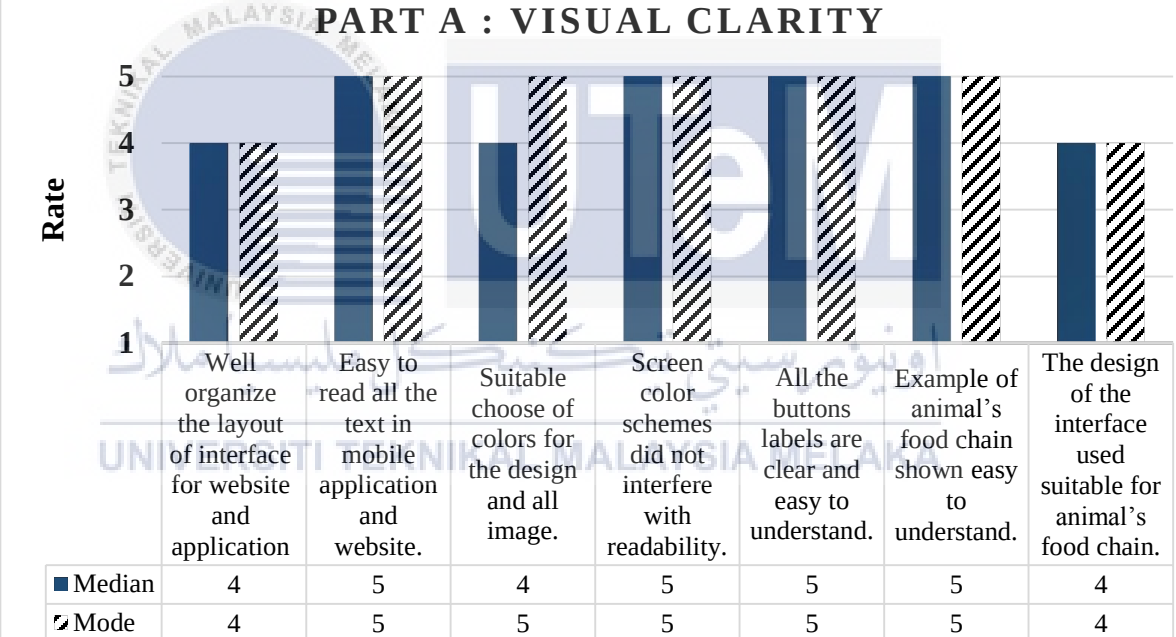
6.5 Analysis Testing

This part is to analyze the results that collected and summarized in the testing. The data will be collected into bar chart form and evaluated according to the results.

i. Result for Alpha version testing

There are one parts of testing for alpha version testing which is functionality testing to demonstrate the data collected from the testers. After analyze all the result collected, summary for alpha version testing is concluded.

A. Result for Functionality Testing



	Well organize the layout of interface for website and application	Easy to read all the text in mobile application and website.	Suitable choose of colors for the design and all image.	Screen color schemes did not interfere with readability.	All the buttons labels are clear and easy to understand.	Example of animal's food chain shown easy to understand.	The design of the interface used suitable for animal's food chain.
Median	4	5	4	5	5	5	4
Mode	4	5	5	5	5	5	4

Figure 6.2: Statistic of visual clarity for functionality testing

Figure 6.2 show the criteria that has been tested related to the visual clarity for animal's food chain website and mobile application. The criteria is based on the layout, text, color and the design used. As shown in the bar chart above, level of rate for all the criteria achieve 4 and above which means expertise is are agreed that the visual clarity used is suitable for standard 5 student. Hence, it approved that the layout of animal's food chain website and mobile application is acceptable.

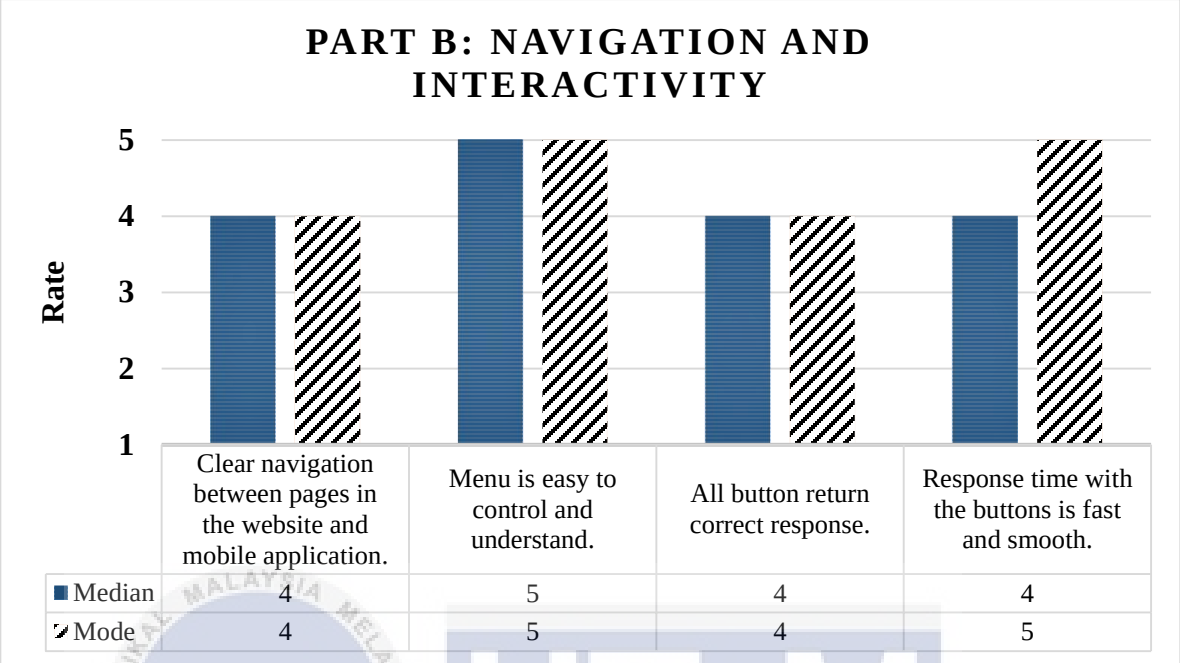


Figure 6.3: Statistic of Navigation and Interactivity for functionality testing

Figure 6.3 explain the question related to the navigation and interactivity for animal's food chain website and mobile application. These criteria is related to the respond time when navigate and controlling all the button and menu. From the bar chart above, all the categories achieved 4.5 and above which is near to agree and it is proves that animal's food chain website and mobile application is user friendly easy to control.

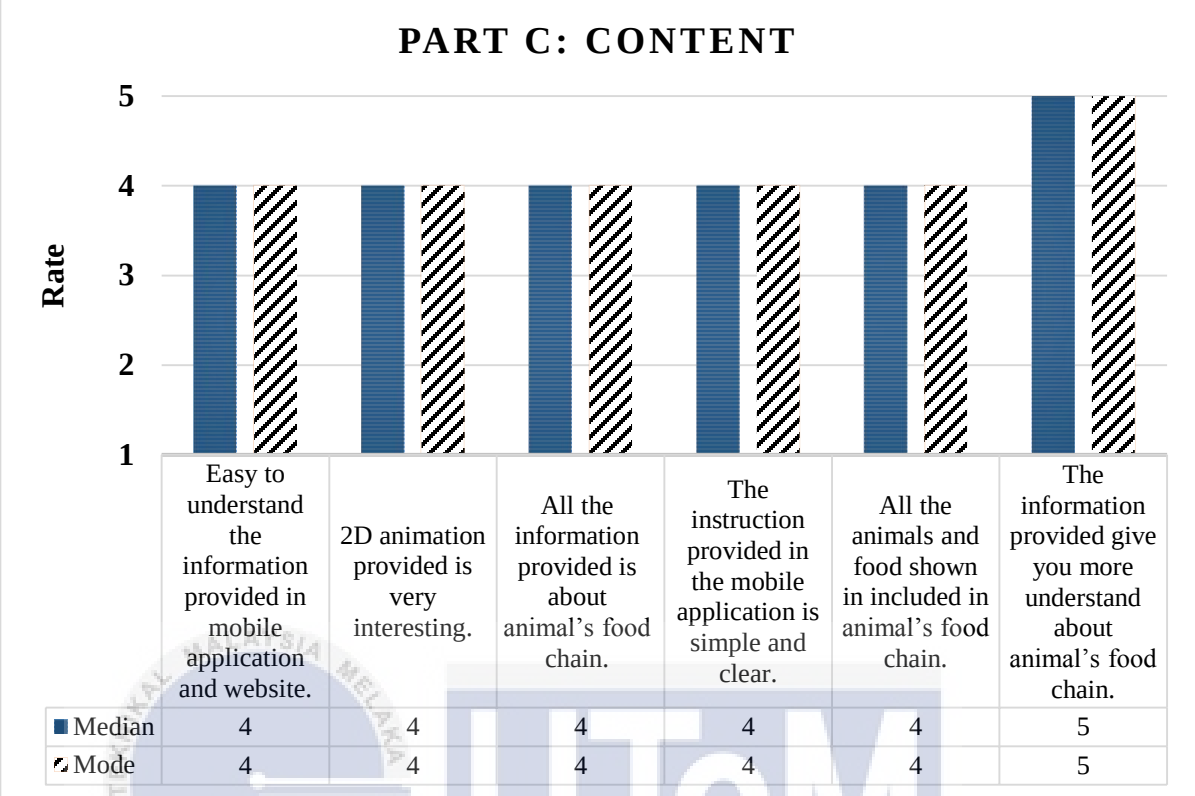


Figure 6.4: Statistic of Content for functionality testing

Figure 6.4 show the statistic to the question that related to content of animal's food chain websites and mobile application which consist of the information and instruction provided, 2D animation and whether the information provided give more understanding about animal's food chain or not. Almost all of the categories achieved 4 and it shown that the information provided in the website and mobile application is useful for student to learn animal's food chain. Besides, the 2D animation provided is quite interesting. Almost all of the statement achieving 4 which mean the expertise agreed with this.

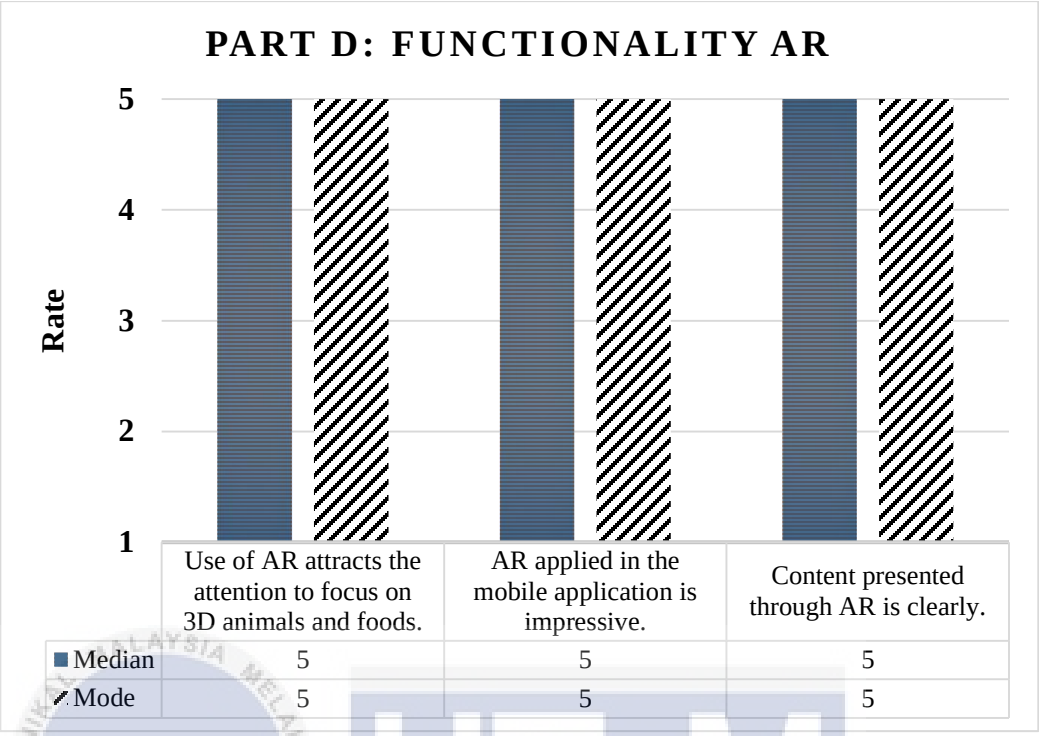


Figure 6.5: Statistic of Functionality AR for Functionality Testing

Figure 6.5 show the collected result form question that related to functionality of AR in animals food chain mobile application. From the bar chart above, all the categories achieved 4 and above which means the tester strongly satisfied the AR animal's food chain mobile application is good one of the best ways to attract students focus learn about animal's food chain. Based on the level achieved for AR category is 5, this means that AR applies in animal's food chain mobile application are impressive as a new methods of learning in schools.

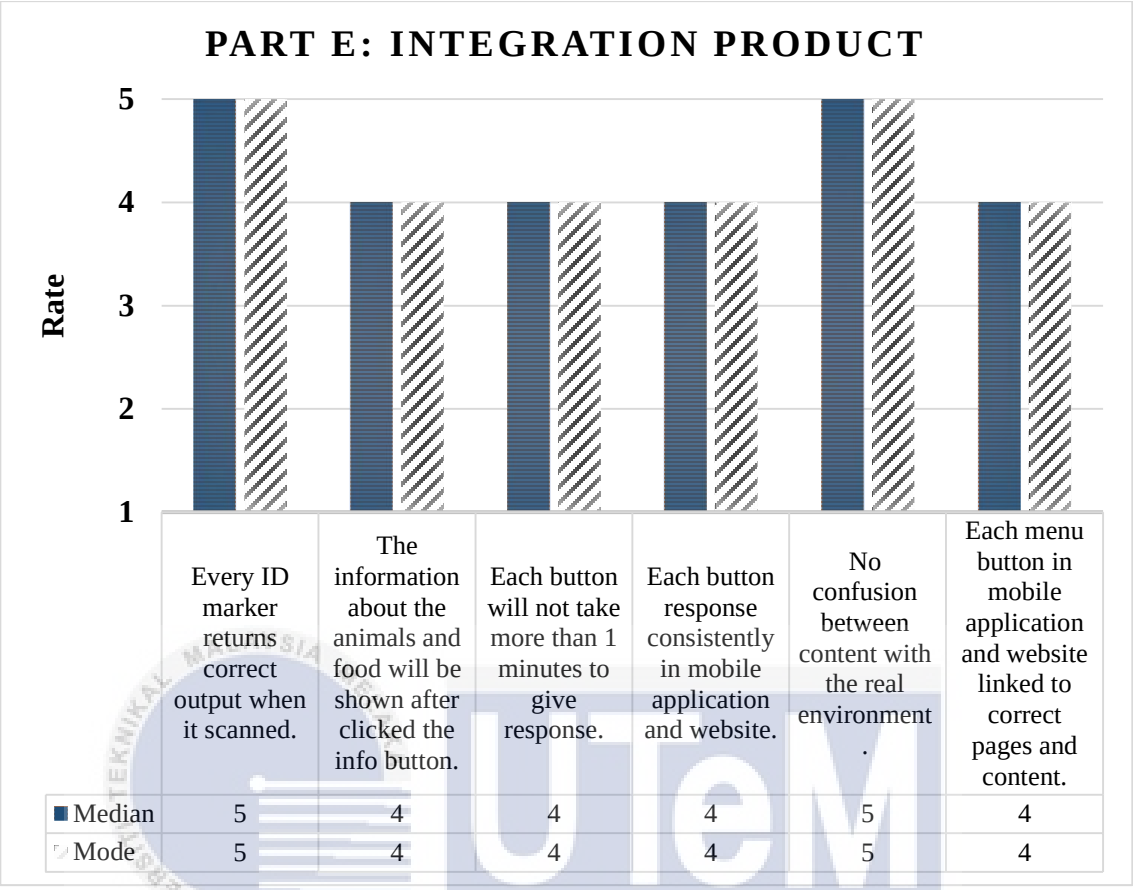


Figure 6.6: Statistic of Integration Product for Functionality Testing

Figure 6.6 above shows the result for integration testing. The level achieve is 4 and above and it proves that every ID marker at the flash card returns correct output when it scanned. The website and mobile application works fine with their own functionality. There are also no confusion between content with the real environment of animal's food chain. All the content in the website and mobile application is also related to animal's food chain and the performance response of the application and website are as user expected.

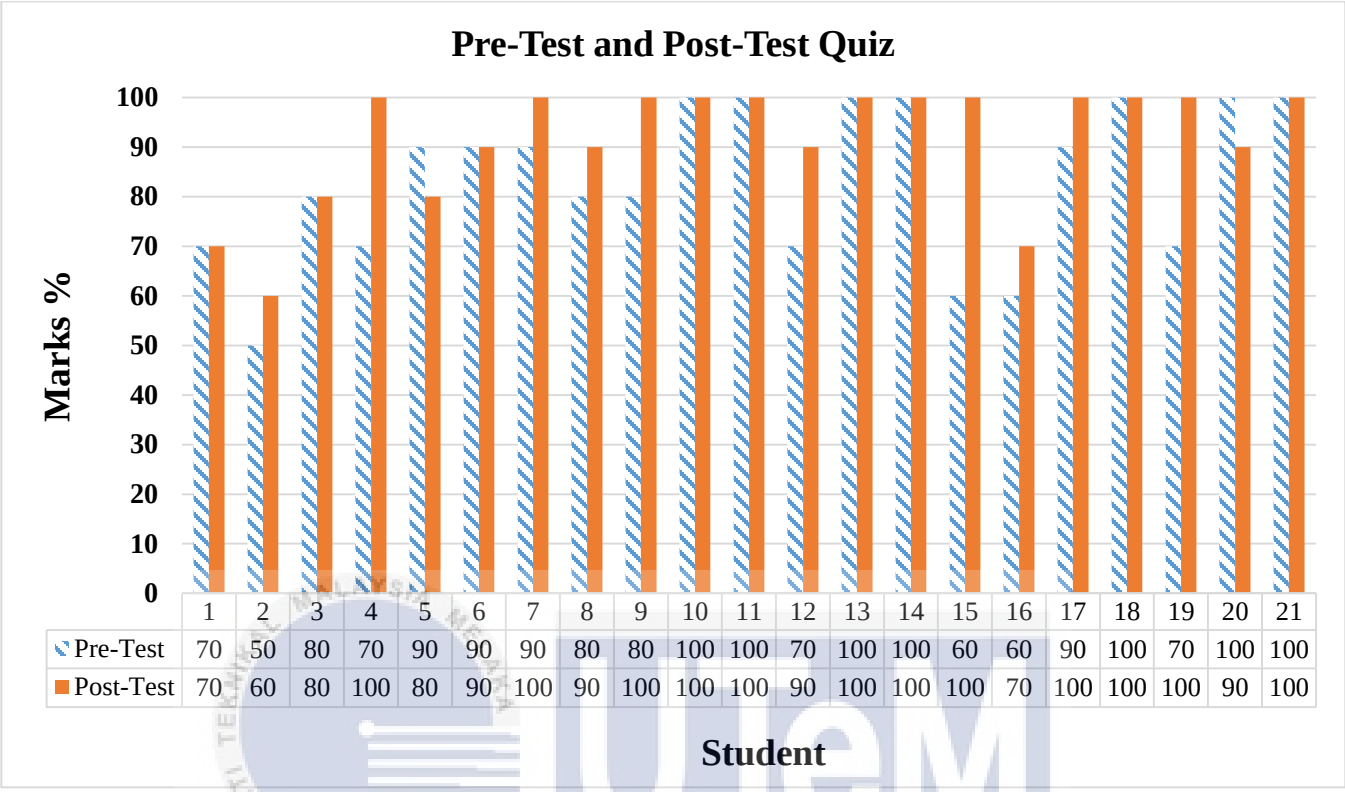
B. Summary for Alpha Version Testing

From the both result of functionality and integration testing, a summary is made. Four criteria that has been tested based on visual clarity, navigation and interactivity, content and functionality of AR and also the integration testing. The result from all of this criteria are achieved 4 and above which is equals to BITM third year students are agreed all of the function in animal's food chain website work well. They also strongly satisfied that animal's food chain mobile application can integrated with the flash card provided.

ii. Result for Beta Version Testing

For beta version testing, there are question that has been stated based on the criteria for textbooks and application. There are also two type of quizzes that has been tested based on textbooks and application which is pre-test quiz and post-test quiz. This two type of question need to be answer by students. Student need to answer pre-test question before they used the application while they need to answer post-test question after they used the application. All the result has been collected and analyzed as below.

A. Result for Pre-Test and Post-Test Quiz



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Pre-Test	70	50	80	70	90	90	90	80	80	100	100	70	100	100	60	60	90	100	70	100	100
Post-Test	70	60	80	100	80	90	100	90	100	100	100	90	100	100	100	70	100	100	100	90	100

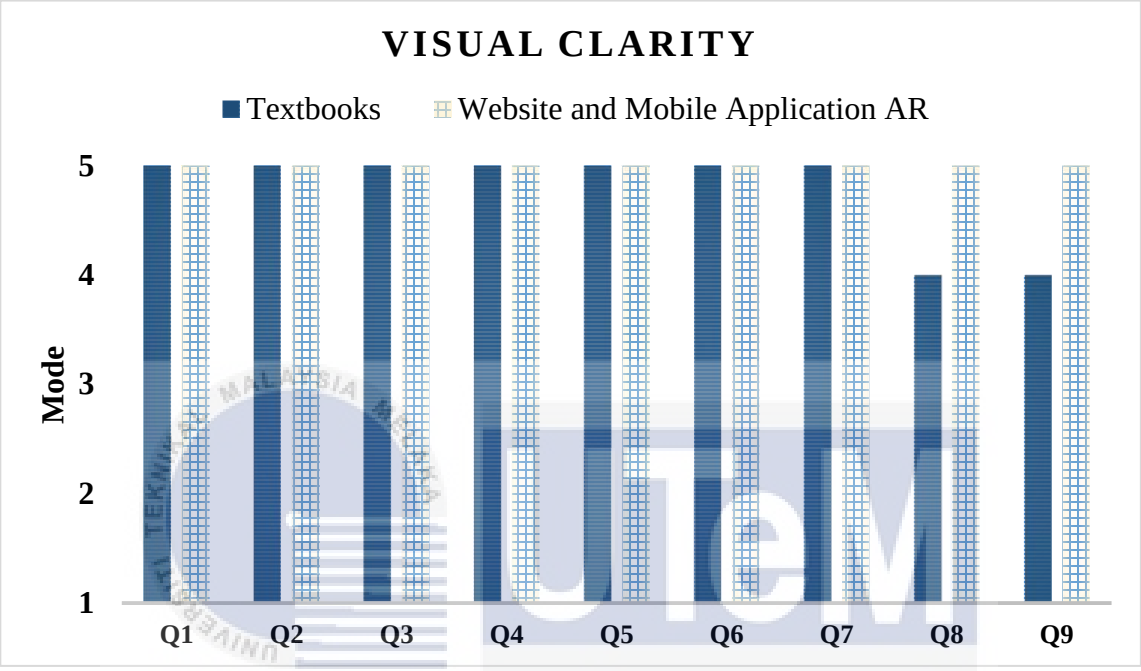
Figure 6.7 Statistic of Pre-Test and Post-Test Quiz

Bar chart above show the result to test the effectiveness of user learn animal's food chain using textbook and mobile application. All the question in this pre-test and post-test is based on the topic of food chain. The bar chart above show the percentage of marks each student answer pre-test and post-test quiz. The testers can answer the question but not all of them can answer with correct.

The percentage of each student's answer the pre-test quizzes is below than 60% and above compared in post-test quizzes. This is prove that, each student have their own understanding about animal's food chain using textbooks or using mobile application AR and websites. However, more than 10 student get 100% marks for post-test quizzes which is prove that the animal's food chain website and mobile application can help them to give real visual representation about animal's food chain same in real environment eventhough this methods is a new learning method. For the overall result, can be conclude that the

third objective before develop this project is achieve, which is using animal's food chain website and mobile application more effective compared using textbooks.

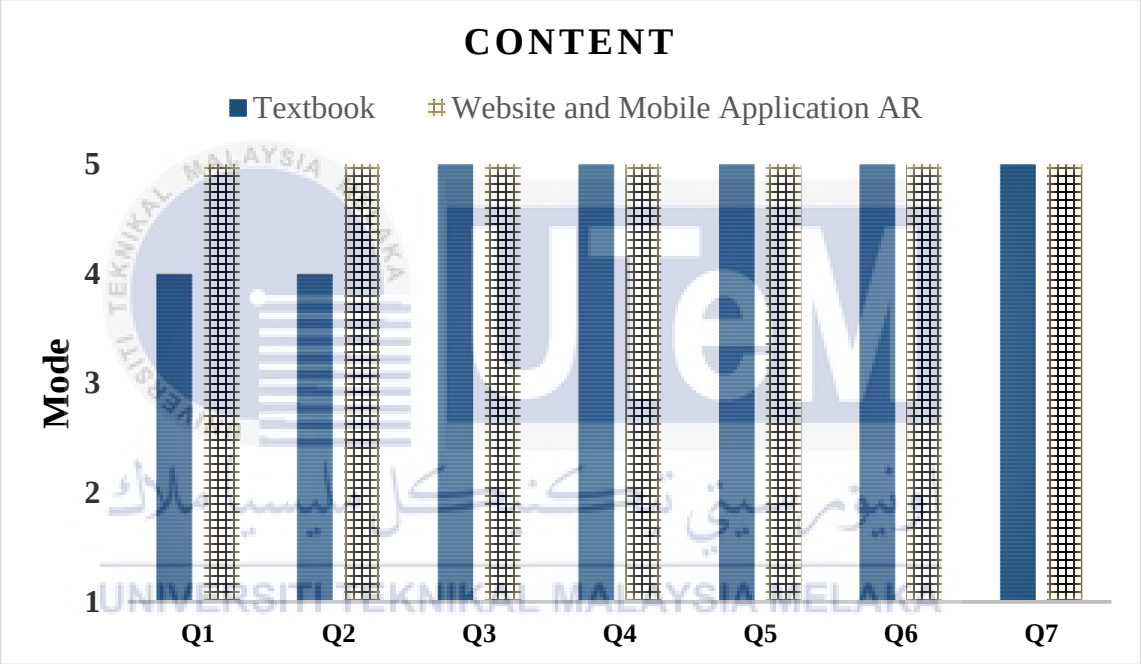
B. Result for User Acceptance Testing



Q1	The layout for the image and font clearly and neat.
Q2	The layout is easy to read, clear and concise.
Q3	The font used easy to read.
Q4	The image shown using suitable color.
Q5	Image shown is very clear and interesting.
Q6	Image and design are used is related with the topic of animal's food chain.
Q7	Example of animals and plants can be seen clearly.
Q8	Example of food chain shown is parallel in the real world.
Q9	Example of food chain shown easy to understand.

Figure 6.8: Statistic of Visual Clarity for UAT (Textbooks and Application)

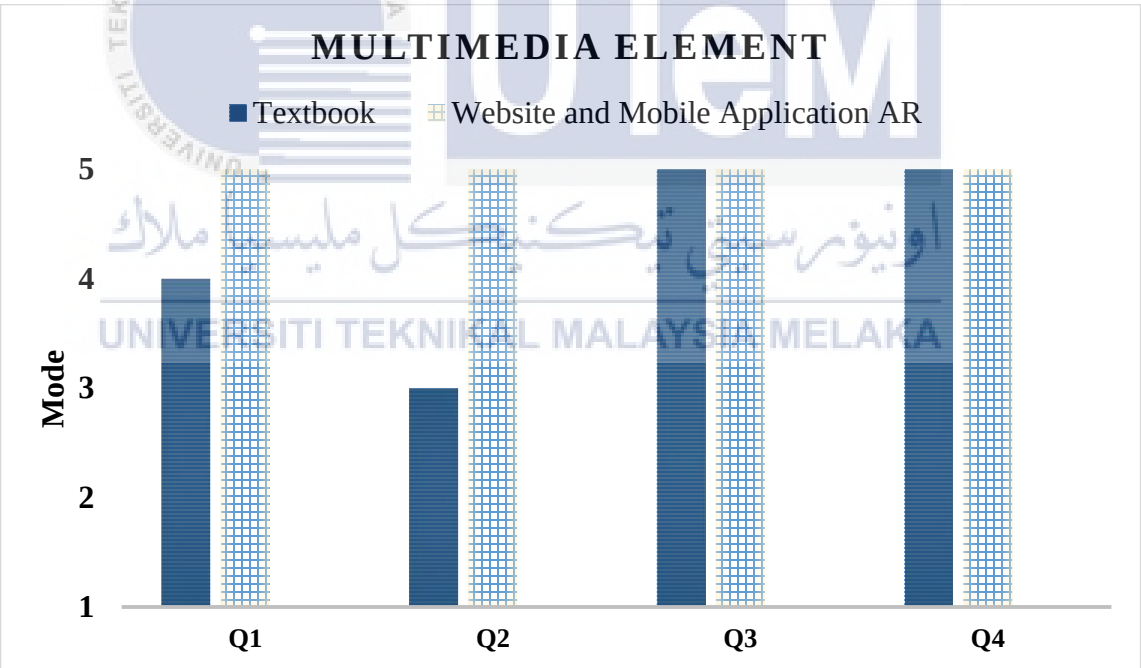
Figure 6.8 demonstrated the questions related to visual clarity of textbooks and animal's food chain website and mobiles application. From the bar chart above, it is clearly shows that almost all of the students strongly satisfied with all aspect of visual clarity in animal's food chain websites and mobile application rather than textbook. Users give the highest range in visual clarity for website and mobile application which is prove that they satisfied with the all aspect of visual element in website and mobile application compared using textbook.



Q1	The information given easy to understand.
Q2	The animation shown very interesting.
Q3	All the information given related to animal's food chain.
Q4	Instruction given easy to understand.
Q5	All the animals and plants shown are included in the food chain.
Q6	Habitat for the food chain is clearly stated.
Q7	The information provided makes you understand what the animal food chain clearly.

Figure 6.9: Statistic of Content for UAT (Textbook and Application)

Figure 6.9 show the collected result for content criteria on textbook and animal's food chain website and mobile application. All of the result for content criteria achieved 5 for website and mobile application which means users strongly satisfied with all the content provided in the animal's food chain website and mobile application. The bar chart also show there are two category on textbooks achieve below 5 which means, the information given in the textbooks about animal's food chain quite hard to understand. There are no animation provided in the textbooks and this affect the criteria get below 5. With the use of website and mobile application to learn about animal's food chain, users satisfied that the information provided makes them better understanding about animal's food chain.

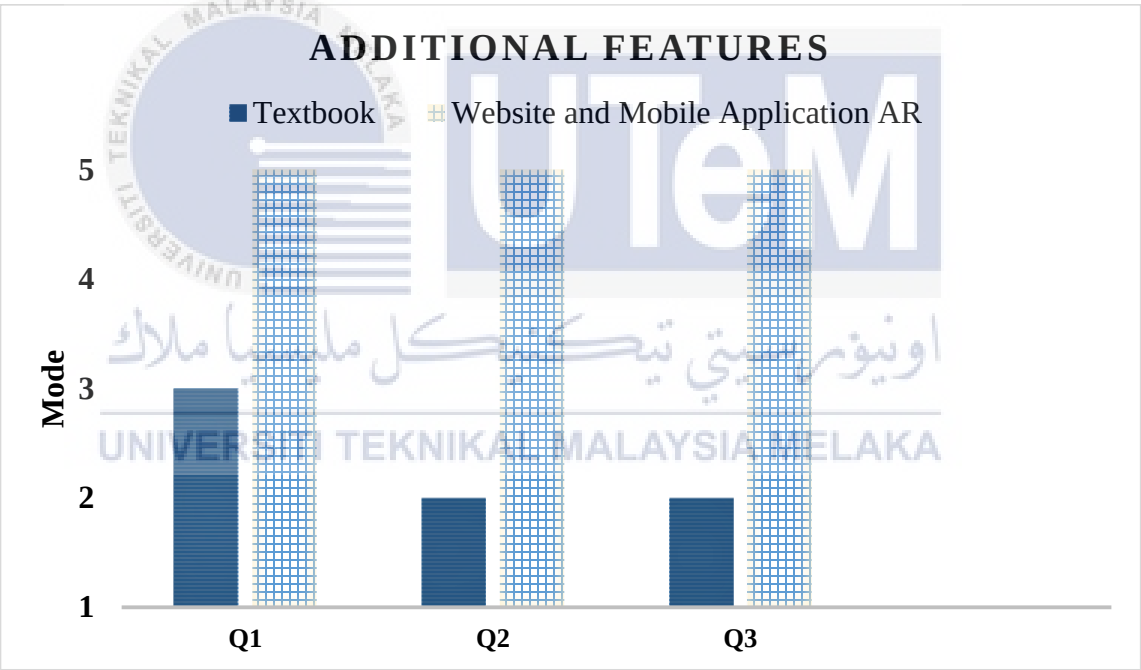


Q1	There are multimedia element used.
Q2	The example of animals shown are in 3D images.
Q3	The learning techniques with the example of animals that can produce sound is very interesting.

Q4	The use of multimedia element help you easy to understand what you have learn.

Figure 6.10: Statistic of Multimedia Element for UAT (Textbook and Application)

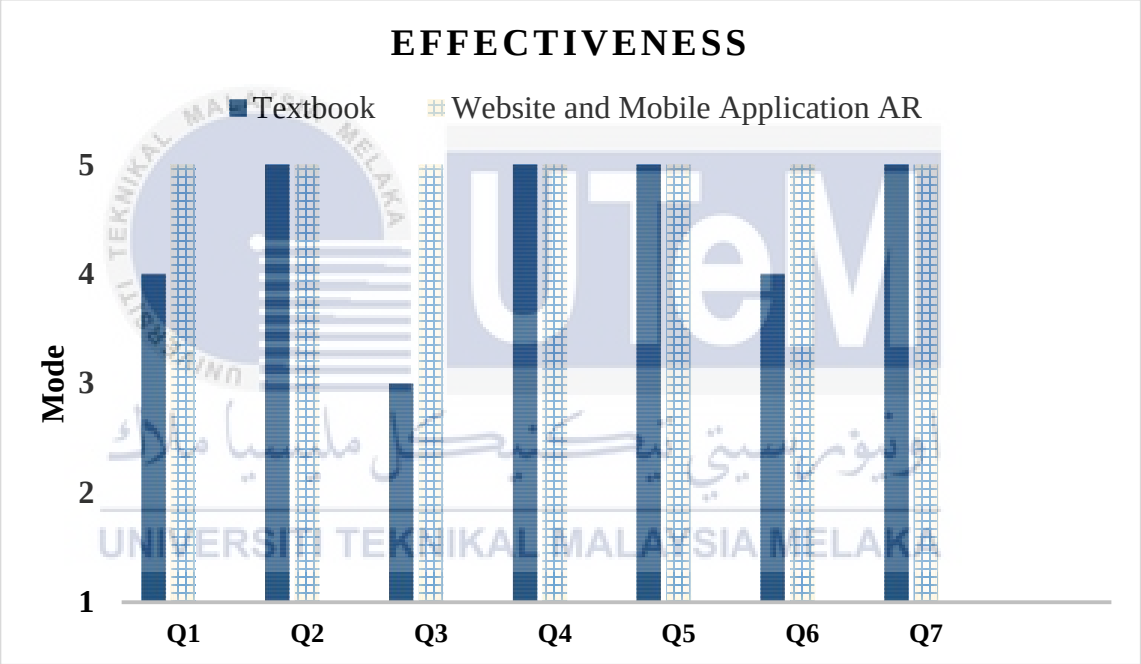
Figure 6.10 demonstrated the question related to multimedia element on textbook and animal's food chain website and mobile application. The bar chart level achieved 4 and above for multimedia element criteria for website and mobile application which means that the user satisfied with use of multimedia element in the websites and mobile application animal's food chain. This is because there are example of 3D images shown in websites and mobile application that has been develop. The user also agreed that the used of multimedia element can help them easy to understand what they have learn.



Q1	There are additional features provided in this method of learning.
Q2	The learning method is use Augmented Reality (AR).
Q3	The image of animal and food were shown seem more real.

Figure 6.11: Statistic of Additional Features for UAT (Textbook and Application)

The Figure 6.11 above show additional features criteria on textbook and website and mobile application. The bar chart prove that animal's food chain website and mobile application have all the criteria stated for the additional features because all the criteria level is achieve 5. The bar chart above reach up to 4 and above for question 2 about learning methods is use Augmented Reality (AR) for mobile application which means that they know the mobile application animal's food chain use Augmented Reality as new techniques of learning for children and make the animals and food were shown seem more real.



Q1	Learning through this method is very interesting and not boring.
Q2	Easy to understand what has been learn.
Q3	The images that can be scanned and produce a 3D image is very interesting.
Q4	Do you satisfied with this learning technique.
Q5	This method of learning easy to control.
Q6	Method of learning that have interesting animation.
Q7	Do you like if this learning techniques is being used in the classroom.

Figure 6.12: Statistic of Effectiveness for UAT (Textbook and Application)

Figure 6.12 show the result that has been analyzed based on the effectiveness on textbook and animal's food chain website and mobile application. All the level of criteria achieve 5 on website and mobiles application which means learning process using website and mobile application is very interesting and not boring rather than using textbook. They also strongly satisfied that the flash card that has been scan using mobile application produce 3D images and it is quite interesting. From the result for this category, the testers agree if this learning techniques is being using in their classroom to make the learning process become more interactive and fun.

Figure 6.13: Statistic of Post-Test Quiz (Website and Mobile Application

To test the effectiveness of using the website and mobile application learned animal's food chain, bar chart above shows the result from the post -test quiz. For question 1, 3, 4 and 7 all 21 student can answer it correctly. For the question 2,5,6,8,9,10 few students cannot answer the question correctly.

C. Summary for Beta Version Testing

From the five of the criteria that has been tested, which is visual clarity functionality and content, multimedia element, additional features and effectiveness, it is obviously show that website and mobile application animal's food chain is able to be a new method or learning to deliver the knowledge of food chain among standard 5 student. Almost all the aspects are satisfy and acceptable by students. So for the conclusion, it is shown that this animal's food chain website and mobile application is accepted by standard 5 students and is achieve the third objective which mentioned in Chapter I which is to enhance new method of learning compared using traditional method of learning which is using textbook.

6.6 Conclusion

In a conclusion, testing process is carried out very smoothly and successfully at SK Pulau Sebang, Alor Gajah, Melaka. From the result that has been collected, the product is able to work with AR for the target users and it is helpful for them to used it to learn more about animal's food chain. Both website and mobile application are easy to controlled, easy to use and the information provided successfully delivered to them.

For the overall analyses that has been done, this proves that animal food chain's website and mobile application can give students better understanding about food chain. Learn animal's food chain in website and mobile application AR can visualize the animals same in the real environment. This approach can be used as a new method of learning that can attract student to learn about animal's food chain in deeper.

This kind of technology can be a new methods of learning among children to make the learning process will be more interactive and fun. However, the improvement for this product need to be carried out based on the observation of product weakness and strengths. Next chapter will discuss further about the weakness and strengths.

CHAPTER VII

PROJECT CONCLUSION

7.1 Observation on Strengths and Weaknesses

Animal's Food Chain mobile application that developed is using Vuforia SDK. Vuforia SDK is a good software that suitable for developer to develop and interactive augmented reality application to deliver information among user. For this animal's food chain website and mobile application, there still have its own strengths and weakness.

7.1.1 Strengths

The strengths of this website and mobile application below:

i. Use AR to attract children

AR concepts is applied on the mobile applications used to make students more exciting to learn about animal's food chain. This is because, they can see the animals and plants in 3D images. AR also allow student to get experience same like real environment. AR application is the main medium that used to deliver the

information about animals food chain in this mobile application to make the learning process will be more interactive.

ii. Use 2D animation on responsive website do deliver information about animal's food chain.

The responsive website was developed to give the information about animal's food chain. There are 2D animation included on this website to deliver information about animal's food chain in interactive ways. Students can see more example of food chain compared in textbook. The use of clear image and suitable use color also the strengths for this website and mobile application that was developed. It is because, students will not easy to get boring because every children like to see colorful image.

iii. Interactive with the animals and foods

For this website and mobile application, it provided simple interaction between the 3D animals and foods with the user. This mobile application need user to interact with the 3D animals and foods to get the output such as the information about themselves and to see the example food chain that they includes. After using this website and mobile application, students will be easy to categorizing the animals and food in their own classification such as producers, consumers or decomposer.

iv. Better understanding about animal's food chain

This website and mobile application give better understanding about animal's food chain compared to using textbook. It is because, in the textbooks, there are only text and images to describe about animal's food chain. While, this website and mobile application used the element of multimedia such as using audio, using animals with suitable color and also 2D animation. Use of multimedia element in their learning methods can make student easy to understand what they learn because have a visual representation. Besides that, the combination of use 3D and

AR technology attract the student attention to be focus what they learn. Therefore, it is suitable to delivering knowledge about animal's food chain among children and students and it is also compatible tool to deliver knowledge to everyone.

v. Application easy to control

Animal's food chain website and mobile application easy to control. This is because all the button use are easy for students or target user to understand it. The instruction given how to used animal's food chain mobile application are also easy to understand and helpful for students to use this mobile application.

8.1.2 Weakness

This animal's food chain website and mobile application also have some weakness even this project is known to be successfully develop. This website and mobile application based on the real time system, which mean that this website need to be run on the developer laptop while the mobile application need to be run with capturing device and recognize by the mobile application itself.

i. Need sufficient of light

The animal's food chain mobile application need to be run at the place that have a sufficient of light. This is because, it needs to detect the marker at the flash card to displaying 3D animals and foods. If do not have enough of light, the 3D animals or foods cannot be displayed or it will not display in stable position.

ii. Problems of overlapping the button.

Animal's food chain mobile application can detect all markers at the same time but sometimes the button overlap each other. This will make confusion to user because they do not know which button represent the right markers. So this will make user hard to view the right info about the animals and foods.

iii. Need to view on android smartphone

This mobile application only applicable for the user of android devices. So the devices that use window or iOS, they cannot use this mobile application.

iv. Do not own a smartphone

Animal's food chain mobile application need to be install on the Android device to be function. However, not all of student have their own smartphone. Hence, they have to use their family's smartphone or their friend's smartphone to access this mobile application.

7.2 Proposition for Improvement

7.2.1 Future works

Based on the strengths and weakness that have been stated in the previous section, there are some improvements need to be done to improve the animal's website and mobile application.

Firstly, the texturing of the 3D animals and foods need to be improve to be more realistic and same in the real environment. Besides that, the developer needs to add the animation to illustrate the interaction between animals and food it should eat. By adding the interaction between animals and foods it should eat, the learning process will be more realistic same like in real environment.

Moreover, the developer can improve the design of the 2D animation on the animal's food chain website. Developer also can create a simple 2D video and adding into the mobile application for introducing the animal's food chain. This make the website and mobile application more interesting and attractive.

The developer also can improve to make interaction between animal's and food it should eat. For example, when eagle and snake flash card are scan, it will fly or go the foods it should eat such as snake eat rat and eagle eat snake. With development this improvement on this mobile application, learning animal's food chain via Augmented Reality will be more exciting and fun.

Lastly, developers needs to overcome the problem of overlapping the button when the markers is detected. This will make sure user easy to recognize which button in the right markers.

7.3 Contribution

This animal's food chain website and mobile application will helpful for standard 5 students to learn more about animal's food chain topic in their school. All the information provided and explained in the website and mobile application is related to animal's food chain. In the mobile application that has been developed, they can view clearly the animals and foods through AR technique which is display is 3D images. There are several example of food chain also includes in this animals food chain website and mobile application.

Teacher can use this mobile application to teach students about animal's food chain in classroom. The methods of learning will be more interactive and fun. Student also will not be easy to get bored compared only using textbooks. This animal's food chain website and mobile application also can be used anywhere and anytime so students can learn it anytime not only learn it in the classroom.

7.4 Conclusion

After takes few months of development this project, Animal's food chain website and mobile application evolves from an idea to reality. During the testing process, students will be able to view all the animals and food clearly in 3D images. They can get the information about animal's food chain through this website and also this mobile application. The learning process about animal's food chain will be more interactive and fun.

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APPENDICES

APPENDIX A: TEST SCRIPT

Details:

- 21 testers for the testing.
- 5-6 testers per section.
- Around 15 minutes per cycle.

Instructions

1. Let 5-6 students be one group at each table.
2. Answer Pre-test quiz before starting the testing.
3. Do the demonstration about animal's food chain website in 5 minutes.
4. Continue the testing by let students use the animal's food chain mobile application with the flash card provided.
5. Pause them to answer the User Acceptance question that has been prepared.
6. Let them answer the post-test quiz question.
7. Testing finish.

APPENDIX B: FUNCTIONALTY TESTING FORM (QUESTIONNAIRE AND TEST DATA)

PROJECT TITLE: USING AR FOR TEACHING SUBJECT RANTAIAN MAKANAN HAIWAN FOR STANDARD 5.

FUNCTIONALITY TESTING

Instruction: Please (√) on the space given with your own choice aspects level score based on your observation for this website and mobile application's function.

Strongly Dissatisfied	Dissatisfied	Not Sure	Satisfied	Strongly Satisfied
 =1	 =2	 =3	 =4	 =5

No.	Aspect / Module					
PART A: VISUAL CLARITY		**1**	**2**	**3**	**4**	**5**
1.	Well organize the layout of interface for website and application	0	0	0	3	2
2.	Easy to read all the text in mobile application and website.	0	0	0	2	3
3.	Suitable choose of colors for the design and all image.	0	0	0	3	2
4.	Screen color schemes did not interfere with readability.	0	0	0	2	3

5.	All the buttons labels are clear and easy to understand.	0	0	0	2	3
6.	Example of animal's food chain shown easy to understand.	0	0	0	2	3
7.	The design of the interface used suitable for animal's food chain.	0	0	0	4	1
PART B: NAVIGATION AND INTERACTIVITY						
1.	Clear navigation between pages in the website and mobile application.	0	0	1	3	1
2.	Menu is easy to control and understand.	0	0	0	2	3
3.	All button return correct response.	0	0	0	3	2
4.	Response time with the buttons is fast and smooth.	0	1	0	2	2
PART C: CONTENT						
1.	Easy to understand the information provided in mobile application and website.	0	0	0	3	2
2.	2D animation provided is very interesting.	0	0	0	3	2
3.	All the information provided is about animal's food chain.	0	0	0	4	1
4	The instruction provided in the mobile application is simple and clear.	0	0	0	3	2
5.	All the animals and food shown in included in animal's food chain.	0	0	1	3	1
6.	The information provided give you more understand about animal's food chain.	0	0	0	2	3

PART D: FUNCTIONALITY AR						
1.	Use of AR attracts the attention to focus on 3D animals and foods.	0	0	0	2	3
2.	AR applied in the mobile application is impressive.	0	0	0	0	5
3.	Content presented through AR is clearly.	0	0	0	1	4
PART E: INTEGRATION PRODUCTS						
1.	Every ID marker returns correct output when it scanned.	0	0	0	2	3
2.	The information about the animals and food will be shown after clicked the info button.	0	0	0	3	2
3.	Each button will not take more than 1 minutes to give response.	0	0	0	4	1
4.	Each button response consistently in mobile application and website.	0	0	0	3	2
5.	No confusion between content with the real environment.	0	0	0	2	3
6.	Each menu button in mobile application and website linked to correct pages and content.	0	0	0	3	2

APPENDIX C: USER ACCEPTANCE TESTING FORM (QUESTIONNAIRE AND TEST DATA)

BORANG UJIAN PENERIMAAN PENGGUNA

Tajuk kajian: Using AR for teaching subject Rantaian Makanan Haiwan for standard 5.

Borang ini bertujuan mendapatkan maklum balas anda mengenai keberkesanan teknik pembelajaran Subjek Sains topik Rantaian Makanan Haiwan bagi pelajar tahun 5 melalui telefon pintar menggunakan aplikasi Realiti Tambahan (*Augmented Reality*) AR.

Segala maklumat yang diperolehi adalah **SULIT** dan hanya digunakan untuk tinjauan kajian semata-mata.

BAHAGIAN A: LATAR BELAKANG RESPONDEN

Arahan: *Bahagian ini merupakan soal selidik mengenai latar belakang anda. Sila tandakan (√) pada ruang yang disediakan.*

1. Jantina :

☐ Lelaki ☐ Perempuan

2. Bangsa :

☐ Melayu ☐ Cina ☐ India ☐ Lain-lain

3. Adakah anda bermain aplikasi di telefon pintar yang berkaitan dengan rantaian makanan haiwan sebelum ini?

☐ Ya ☐ Tidak

BAHAGIAN B: UJIAN PENERIMAAN PENGGUNA

Arahan: *Sila tandakan (√) pada salah satu skala berdasarkan ekspresi muka iaitu:*

SANGAT TIDAK BERPUAS HATI	TIDAK BERPUAS HATI	TIDAK PASTI	BERPUAS HATI	SANGAT BERPUAS HATI
 =1	 =2	 =3	 =4	 =5

					**Aspek/Modul**					
1	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**
MELALUI BUKU TEKS					**KEJELASAN VISUAL**	**MELALUI LAMAN WEB DAN APLIKASI AR**				
0	1	2	8	10	Susun atur gambar dan tulisan jelas dan rapi.	0	0	2	6	13
0	1	4	7	9	Susun atur mudah dibaca, ringkas dan jelas.	0	1	1	6	13
1	1	1	5	13	Tulisan yang digunakan mudah untuk dibaca.	0	1	4	2	14

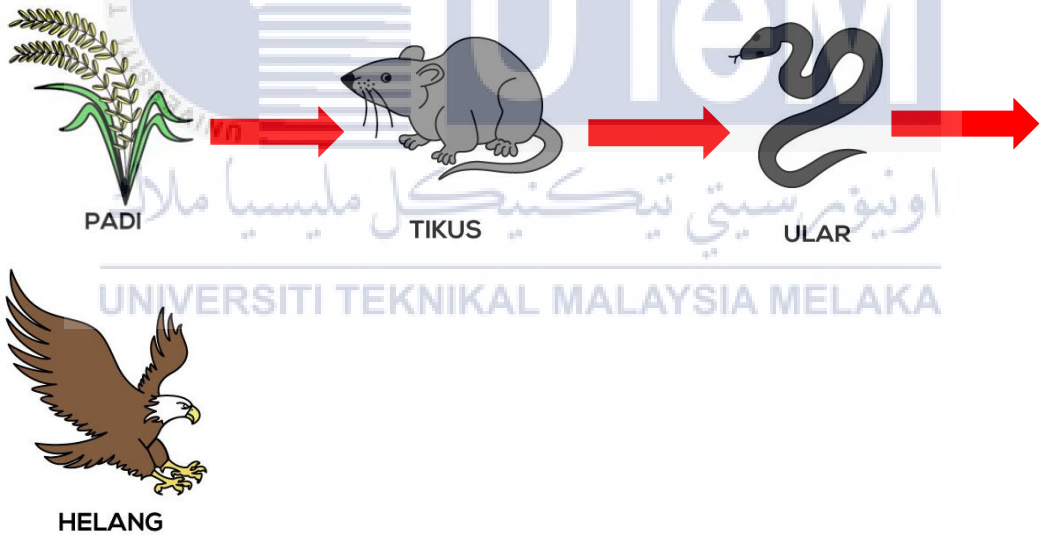
0	1	1	6	13	Gambar yang ditunjukkan menggunakan warna yang bersesuaian.	0	1	1	5	14
1	1	2	6	11	Gambar yang digunakan jelas dan menarik.	0	0	4	3	14
0	0	3	8	10	Gambar dan rekebentuk yang digunakan bersesuaian dengan topik rantai makanan haiwan.	0	0	3	3	15
1	0	3	7	10	Contoh haiwan dan tumbuhan dapat dilihat dengan jelas.	1	0	5	4	11
0	0	7	11	3	Contoh rantai makanan yang ditunjukkan selari dalam dunia sebenar.	1	0	2	6	12
0	0	1	12	8	Contoh rantai makanan yang ditunjukkan mudah difahami.	0	0	2	5	14
FUNGSI DAN KANDUNGAN										
0	0	1	11	9	Maklumat yang diberikan mudah difahami.	0	0	0	6	15
1	1	5	8	6	Animasi yang ditunjukkan sangat menarik.	0	0	3	6	12
0	1	3	7	10	Setiap maklumat yang diberikan berkaitan dengan rantaian makanan haiwan.	0	1	2	3	15
0	0	4	5	12	Arahan yang diberikan mudah difahami.	0	0	0	6	15
0	1	1	3	16	Setiap haiwan atau tumbuhan yang dilihat termasuk di dalam rantai makanan.	0	0	3	3	15

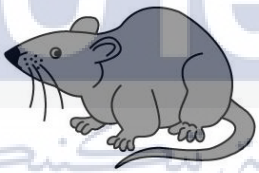
0	1	2	7	11	Habitat bagi rantai makanan dinyatakan dengan jelas.	0	0	2	5	14
0	0	3	7	11	Maklumat yang diberikan membuatkan anda memahami apa itu rantai makanan haiwan dengan jelas.	0	0	4	6	11
					ELEMEN MULTIMEDIA					
2	0	5	10	4	Terdapat elemen multimedia yang digunakan.	0	0	1	4	16
3	1	7	5	5	Contoh haiwan yang ditunjukkan adalah di dalam bentuk 3D imej.	0	1	4	5	11
5	0	5	5	6	Teknik pembelajaran dengan contoh haiwan yang boleh mengeluarkan bunyi adalah sangat menarik.	0	0	2	9	10
1	0	4	7	9	Penggunaan elemen multimedia membantu anda untuk lebih mudah memahami apa yang dipelajari.	0	0	1	4	16
					FUNGSI/CIRI TAMBAHAN					
3	2	4	9	3	Terdapat elemen tambahan yang disediakan di dalam teknik pembelajaran ini.	0	0	4	4	13
3	1	6	5	6	Pembelajaran menggunakan aplikasi realiti tambahan (AR).	0	0	2	2	17
2	0	4	4	11	Gambar haiwan dan makanan yang ditunjukkan kelihatan lebih nyata.	1	0	0	2	18

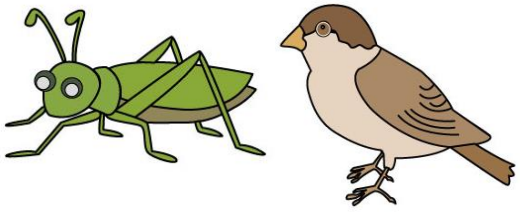
					KEBERKESANAN					
1	1	1	12	6	Pembelajaran melalui kaedah ini sangat menarik dan tidak membosankan.	0	0	1	8	12
0	0	2	7	12	Cepat untuk difahami apa yang dipelajari.	0	0	2	3	16
2	1	7	5	6	Gambar yang boleh diimbas dan mengeluarkan 3D imej adalah sangat menarik.	0	1	3	2	15
1	1	3	7	9	Adakah anda berpuas hati dengan teknik pembelajaran ini.	0	0	2	3	16
0	2	5	7	7	Teknik pembelajaran in mudah dikendalikan.	0	0	4	4	13
0	2	6	7	6	Teknik pembelajaran yang mengandungi animasi menarik.	0	0	3	3	15
0	0	1	9	11	Adakah anda suka sekiranya teknik pembelajaran ini digunakan di dalam kelas.	0	0	2	3	16

TERIMA KASIH KERANA SUDI MELUANGKAN MASA ANDA MENGISI BORANG UJIAN PENERIMAAN PENGGUNA.

APPENDIX D: PRE-TEST QUIZ

BAHAGIAN B: KEBERKESANAN (KUIZ)	
1.	Rantaian makanan ialah hubungan makanan antara hidupan. A. Ya B. Tidak
2.	Anak panah (➡) memberi maksud _____ A. dimakan oleh B. makan
	Soalan 3 hingga 5 berdasarkan Rajah 1.  **Rajah 1**

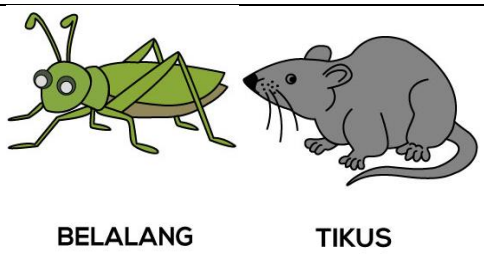
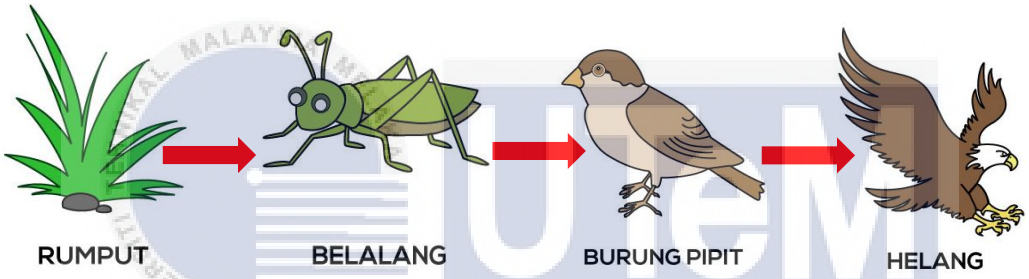
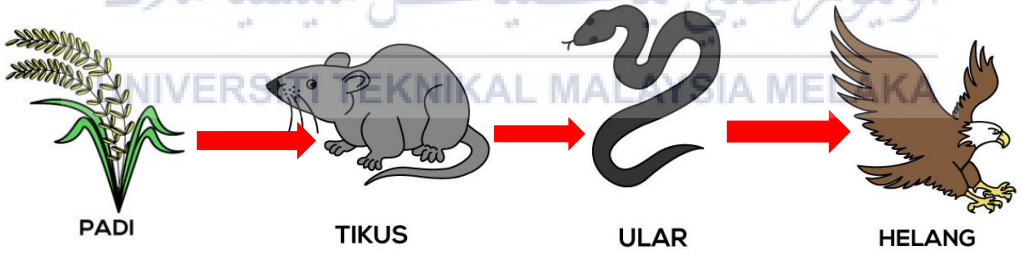
3.	 PADI Padi dimakan oleh _____ A. Ular B. Tikus C. Helang
4.	 TIKUS Tikus dimakan oleh _____ A. Ular B. Helang C. Padi
5.	 ULAR

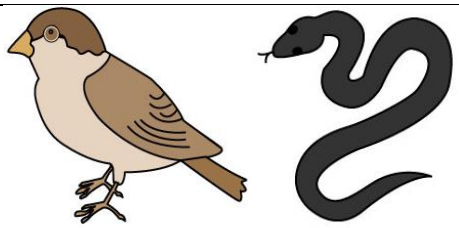
	Ular dimakan oleh _____ A. Padi B. Tikus C. Helang
6.	Apakah rantai makanan bagi hidupan yang terdapat di ladang kepala sawit? A. Padi ⟶ tikus ⟶ ular ⟶ helang B. Buah kelapa sawit ⟶ tikus ⟶ burung hantu
7.	Apakah rantai makanan bagi habitat sawah pagi? A. Padi ⟶ tikus ⟶ ular ⟶ helang B. Buah kelapa sawit ⟶ tikus ⟶ burung hantu
8.	Tumbuhan merupakan _____ A. Pengeluar B. Pengguna
9.	 BELALANG BURUNG PIPIT

	Belalang dan burung pipit adalah _____ A. Pengeluar B. Pengguna
10.	Haiwan yang memakan tumbuhan atau haiwan lain dikenali sebagai pengguna. A. Ya B. Tidak

APPENDIX E: POST-TEST QUIZ

BAHAGIAN B: KEBERKESANAN (KUIZ)	
1.	Rantaian makanan haiwan adalah hubungan diantara pengeluar, pengguna dan pengurai. A. Ya B. Tidak
2.	Anak panah (➡) memberi maksud A. dimakan oleh B. makan
3.	 Padi dan rumput dikategorikan sebagai _____ A. Pengeluar B. Pengguna C. Pengurai
4.	Pengguna terbahagi kepada _____ A. 1 B. 2 C. 3

5.	 Belalang dan tikus dikategorikan sebagai pengguna _____ A. Primer B. Sekunder C. Tertier
	Soalan 5 dan 6 berdasarkan Rajah 1 dan Rajah 2  Rajah 1  Rajah 2
6.	

	 BURUNG PIPIT ULAR Haiwan diatas dikategorikan sebagai pengguna _____ A. Primer B. Sekunder C. Tertier
7.	 HELANG Helang dikategorikan sebagai pengguna _____ A. Primer B. Sekunder C. Tertier
8.	Pengguna sekuder ialah pengguna yang memakan _____ A. Tumbuhan hijau B. Primer
9.	Pengguna tertier ialah pengguna yang memakan pengguna _____ A. Primer B. Sekunder

10.	 CACING Cacing dikategorikan sebagai _____ A. Pengeluar B. Pengguna C. Pengurai

APPENDIX F: ANALYSIS QUESTION FORM

Soal selidik ini bertujuan mendapatkan maklum balas anda mengenai keberkesanan teknik pembelajaran di sekolah untuk Subjek Sains topik Rantaian Makanan Haiwan bagi pelajar tahun 5.

Objektif soal selidik ini adalah:

1. Untuk mendapatkan maklum balas keberkesanan teknik pembelajaran di sekolah.
2. Untuk mendapatkan pandangan anda mengenai pembelajaran melalui telefon pintar menggunakan aplikasi Realiti Tambahan *(Augmented Reality)* AR.

Segala maklumat yang diberikan dalam soal selidik ini adalah **SULIT** dan hanya digunakan untuk tinjauan kajian semata-mata.

BAHAGIAN A: LATAR BELAKANG RESPONDEN

Arahan: *Bahagian ini merupakan soal selidik mengenai latar belakang anda. Sila tandakan (√) pada ruang yang disediakan.*

1. Jantina :

   ☐ Lelaki ☐ Perempuan

2. Bangsa :

   ☐ Melayu ☐ Cina ☐ India ☐ Lain-lain

BAHAGIAN B

Arahan: *Sila tandakan (√) pada ruang yang disediakan.*

Bil.	Soalan	Ruangan Jawapan
1.	Adakah anda mempunyai telefon pintar?	☐ Ya ☐ Tidak
2.	Adakah anda menghabiskan masa lebih 1 jam untuk bermain aplikasi di telefon pintar?	☐ Ya ☐ Tidak
3.	Adakah anda pernah mempelajari mengenai rantaian makanan haiwan?	☐ Ya ☐ Tidak
4.	Rantaian makanan haiwan adalah salah satu topik di dalam Subjek Sains?	☐ Ya ☐ Tidak
5.	Anda mempelajari rantaian makanan haiwan di sekolah?	☐ Ya ☐ Tidak
6.	Anda mempelajari rantaian makanan haiwan melalui buku teks?	☐ Ya ☐ Tidak
7.	Adakah anda pernah mempelajari topik ini melalui internet?	☐ Ya ☐ Tidak
8.	Adakah anda mengetahui apa itu aplikasi Realiti Tambahan *(Augmented Reality)* AR?	☐ Ya ☐ Tidak
9.	Jika ya, adakah anda pernah menggunakan aplikasi Realiti Tambahan *(Augmented Reality)* AR mengenai haiwan?	☐ Ya ☐ Tidak

10.	Bagaimanakah cara yang lebih anda fahami untuk mempelajari topik rantaian makanan haiwan?	☐ Melalui internet ☐ Membaca buku teks ☐ Menonton video ☐ Melalui AR

BAHAGIAN C

Arahan: *Sila tandakan (√) pada salah satu skala iaitu :*

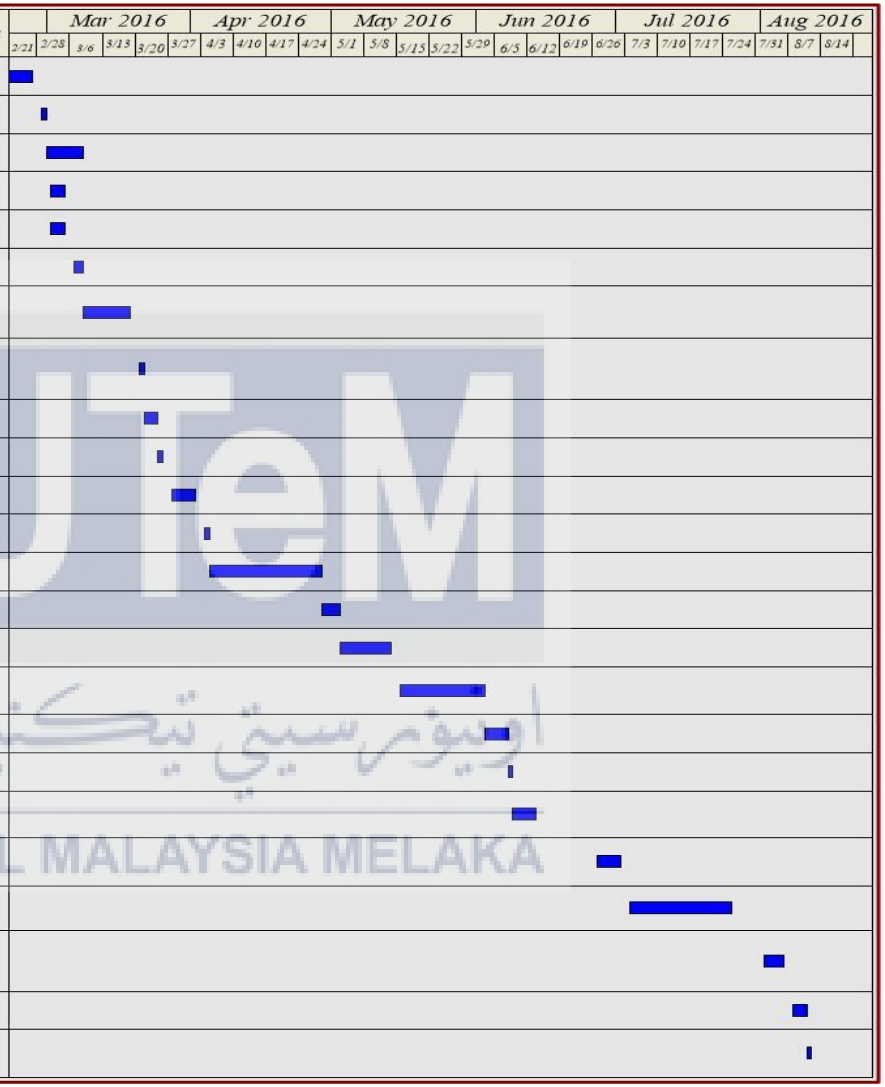
1. **SANGAT TIDAK SETUJU**
2. **TIDAK SETUJU**
3. **TIDAK PASTI**
4. **SETUJU**
5. **SANGAT SETUJU**

	Soalan	**1**	**2**	**3**	**4**	**5**
1. 2.	Rantai makanan adalah hubungan antara pengeluar, pengguna dan juga pengurai.					
3.	Rumput dan padi dikategorikan sebagai pengeluar.					
4.	Burung pipit dan tikus dikategorikan sebagai pengguna.					
5. 6.	Pengguna di dalam rantai makanan ialah terdiri daripada pengguna primer, pengguna sekunder dan pengguna tertier.					
7.	Pengguna primer ialah pengguna yang memakan tumbuhan sahaja.					

8.	Tikus dan belalang dikategorikan sebagai pengguna primer.					
9.	Pengguna sekunder ialah pengguna yang memakan pengguna primer.					
10. 11.	Burung pipit boleh dikategorikan sebagai pengguna primer dan pengguna sekunder.					
12.	Pengguna tertier ialah pengguna yang memakan pengguna sekunder.					
13.	Siratan makanan adalah topik yang sukar difahami.					
14.	Anda lebih gemar mempelajari rantaian makanan haiwan menggunakan buku teks?					
15.	Anda lebih faham topik ini sekiranya guru memberikan aktiviti dan contoh yang nyata tentang rantaian makanan haiwan di dalam kelas.					

APPENDIX G: GANTT CHART

ID	Task Name	Start	Finish	Duration
1	Proposal Submission	2/22/2016	2/26/2016	1w
2	Proposal Correction and Improvement	2/29/2016	2/29/2016	.2w
3	Requirement Planning	3/1/2016	3/8/2016	1.2w
4	Analyze the target user	3/2/2016	3/4/2016	.6w
5	Report Chapter 1 and Chapter 2	3/2/2016	3/4/2016	.6w
6	User Design	3/7/2016	3/8/2016	.4w
7	Analyst and develop models and prototypes	3/9/2016	3/18/2016	1.6w
8	Determine learning process based on audience need	3/21/2016	3/21/2016	.2w
9	Report Chapter 3 and Chapter 4	3/22/2016	3/24/2016	.6w
10	Construction	3/25/2016	3/25/2016	.2w
11	Programming and application development	3/28/2016	4/1/2016	1w
12	User testing	4/4/2016	4/4/2016	.2w
13	Finish project	4/5/2016	4/28/2016	3.6w
14	Report Chapter 4	4/29/2016	5/2/2016	.4w
15	Cutover	5/3/2016	5/13/2016	1.8w
16	Data Conversation, testing and changeover	5/16/2016	6/2/2016	2.8w
17	Project Demo and PSM Report	6/3/2016	6/7/2016	.6w
18	Presentation	6/8/2016	6/8/2016	.2w
19	Report Correction	6/9/2016	6/13/2016	.6w
20	Continue do the report Chapter 5 for PSM 2	6/27/2016	7/1/2016	1w
21	Do the correction on the product for PSM2	7/4/2016	7/25/2016	3.2w
22	Do the testing product at the target user and expertise	8/2/2016	8/5/2016	.8w
23	Do the report for Chapter 6 and 7	8/8/2016	8/10/2016	.6w
24	Presentation PSM2	8/11/2016	8/11/2016	.2w



APPENDIX H: IMAGE TESTING