AR GEOGRAPHY TEXTBOOKS

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UNIVERSITI TEKNOLOGI PETRONAS
MAY 2015

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Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
(Business Information System)

MAY 2015

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A project dissertation submitted to the
Business Information System Programme
Universiti Teknologi PETRONAS
In partial fulfilment of the requirements for the
BACHELOR OF TECHNOLOGY (Hons)
(BUSINESS INFORMATION SYSTEM)

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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ABSTRACT

This paper describes the process of developing an Augmented Reality (AR) textbook mobile application. This mobile application allowed the students to view the superimposed virtual 3 dimensional animation objects in a fun and interactive manner using the marker-less physical traditional textbooks as the interaction tool. The idea of the whole project is to create a whole new and better learning experience that would be able to captivate student's interest in study. Besides, the reason behind choosing the Geography subject as the topic is because it is one of the subjects that has been teaches to every students who are pursuing their studies in every secondary school located in Malaysia. The author also believed that Geography subject is very important as it provide us with the knowledge of the world around us. It is also related to etiquette as it discussed the impact of both natural and manmade factors. Though each student will get a free textbook under Textbook Loan Scheme (SPBT) sponsored by Ministry of Education, the problem is that students might find the traditional textbooks dull and boring considered the factor of these current generations are pretty tech-savvy these days. Students in these generations are easily distracted and bored when they need to learn from a traditional textbook. This is due to maybe they are always surrounded by new technology and gadgets that can offered them a lot of entertainment which is very interactive and fun. However, the use of augmented reality should solve this problem. Augmented Reality (AR) is considered the best of both worlds, where, real and virtual objects are combined in the real environment, that will allow the use of both technology based application and a traditional physical textbooks, combining the benefits of both and meeting the students and teachers midway. Although AR technology is not new, its application on education sector is still not enough. The main aim of this research is to develop an interactive AR textbook where it can create a whole new and better learning experience that would be able to captivate student's interest in study. One of the objectives of the study is to enhance the traditional textbooks by implementing an AR technology. Meanwhile the scope of this project involves 3D modeling, texturing, rigging and animation.

ACKNOWLEDGEMENT

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Geography subject is considered as one of the most main subject that all students in lower secondary school (Form 1 to Form 3) located in Malaysia need to learn. It is because at the end of Form 3, students need to take Lower Secondary Evaluation or also known as *Pentaksiran Tingkatan 3* (PT3) that will evaluate their understanding of these subjects. Based on the PT3 result, students will be given 3 different type of streamed to choose which is Academic Stream (Science/ Art), Technical and Vocational Stream, or Religious Stream. Thus it is important for the students to understand and harness their knowledge and skills in these subjects. In addition, it also had been taught in Bahasa Malaysia since the early age.

According to Ministry of Education Malaysia, Geography subject aims to equip students with the understanding and the basics of geographic skills (particularly in Malaysia context) and human values. Besides, these subjects also prepare the students for the challenges of life towards creating the better society and community. It is also considered as a relevant subject for students in secondary school as it is basically the continuation of *Kajian Tempatan* subject in primary school. In addition, Ministry of Education Malaysia also believed that Geography subject content is relevant to practice in human life.

On the other hand, there are several methods that can be used for teachers to teach students in secondary school regarding this Geography subject. Method such as giving a lecture (based on the text book) to the whole class was a common method used by the teachers besides story-telling and singing. However, by using only these methods to teach, it will be difficult for teachers to keep their students focus on the subject through the whole hour of classes. This is because most of the students usually will get boring easily with the traditional plain textbooks that consist mainly of text.

Besides, it is usually hard for teachers to get 100 percent attention and focus from their students during the class hour regarding the teaching subject as they easily get distracted by little things happened around them out of curiosity. In addition, there are many cases where students tend to sleep during the class hour as long as it involving sitting down at a table for a certain period accompanying with the old plain boring textbook. These situations surely will affect the ability of the students to learn the value in the book as their attention and focus are being disturbed by external as well as internal factor.

Interactive reading can be described as reading accompanied by the action from the reader. It involves interaction or participation from the user to click, touch, think or maybe questioning during the reading session. It is a good way to avoid boredom while reading where the reader does not need just look at the plain book and read. In addition, Fountas & Pinnel (2007) stated that interactive reading is actually a teaching method where the students can actively participate to an oral reading of a text by listening and responding. This method has been approved effectively in helping students remember of what they had read.

Furthermore, students nowadays has been familiarized themselves with a gadget as most of them owned at least one mobile phone provided by their parents to use as a medium of communication or others. Based on the 2012 study conducted by the Pew Research Center, these generations which are born between early 1980s to the early 2000s are too obsessed with their mobile phones to the extent that they treat it like as an extension of themselves. This obsession make students attracted more to these new technological gadget compared to book. It is also maybe because of these technologies, it is possible to create a better learning environment in which the learning process are more attractive through smartphones.

The project is aimed to develop an application to assist students learning Geography subject through AR Textbook that are based on contextual environment by implementing augmented reality concept in order to make the learning process more interactive and effective. Through this project, students can learn and harness their knowledge since "they learn doing, using their senses, and exploring their environment of people, things, places and events" (UNICEF, 1994).

1.2 PROBLEM STATEMENT

The current method of teaching and using traditional text book especially in school learning process can be boring and non-interactive and this obviously can affect the student performance and ability to learn since they cannot focus 100 percent on what has been taught. Furthermore, it is also believed that the ability to focus and concentrate would be the key of success to understand of what has been taught. Barton (2012) stated that attention span is directly proportional to someone age by 3 to 5 minutes per year. However according to Sullivan (2013), children nowadays can only concentrate their mind and give full 100 percent attention to things that are interested to them only such as using gadget for 2 hours meanwhile it is hard for them to spend even 2 minutes in doing their homework without distraction. Thus, we can see that kid nowadays is more interested to play smart phones instead of studying.

Another factor that may cause students less interested to read from the textbook itself is may be because of the way traditional education textbook seems less interactive to them. There is just a book that contains a text and several pictures that required no user interaction at all. Since kids nowadays are already been exposed to technology such as smartphones, laptop or tablet, they tends to focus and spend times on things that make them interested instead of facing a book which contain a lot of words and sentence.

Obviously every problem has a solution including this problem where students find it harder and difficult to learn effectively by using traditional method. Since new generation nowadays tends to spend most of their time in front of the screen, that would be a good way to fully utilize this habit in order to attract the student for learning activities. It is also better for these students to involve themselves in interactive reading as it can stimulate and improve mental capabilities that contribute to retain of new learning and integrate it with what they already know (UNICEFT, 1994).

Thus, it would be excellence to develop AR Geography Textbook application to ace this problem as the students would be able to get more understanding and harness their knowledge while learning Geography subject by using a smart phone technology.

1.3 OBJECTIVE OF STUDY

The research study is aimed to develop Interactive AR Textbook Apps for students specifically focus on Geography subject. There are several objectives of the research such as the following:

- To investigate the use of AR concept in captivating student's interest towards the Geography subject.
- To enhance the interaction of traditional textbooks by creating an interactive Augmented Reality user interface application on an android platform.
- To develop an AR textbooks in order to provide a whole new and better learning environment for the students.
- To evaluate the perception of students regarding the AR textbook specifically on Geography subject.

1.4 THE RELEVANCY OF THE PROJECT

Based on the current way of teaching especially in secondary school, this project is totally relevance because augmented reality enables the students to participate in an interactive and interesting learning process whether at home or school. This project is designed to make use of AR technology as a method to teach in education sector. For the time being, the project will only focus in developing AR concept to explain on several applications available in Geography Textbook Form 1 only such as the process of greenhouse effect, how acid rain is formed and others.

Furthermore, we believed that students will also find it interesting to discover a new way to read their traditional textbook using smartphones as a tool. In addition, the AR technology applied in this project will make the learning process seems more enjoyable as it need active participation from students such as clicking or responding while they listen to an oral text reading.

On the other hands, it is very relevance to apply this technology on the mobile phone instead of using computer with a camera as mobile phones is more convenient and easy to carry anywhere. Besides, there are a large number of android users which consist of

65 percent from total population of smartphone user in Malaysia. Thus, it is relevance to develop this AR Geography Textbook on smartphones that running an android platform.

1.5 SCOPE OF STUDY

The objective of this project is aimed to develop Interactive Augmented Reality Textbook Apps for students specifically focus on Geography subject. The apps will be designed specifically to ease the students in learning some theory through animation. There is several areas involve in the scope of this project that will be used in the development phase such as the following:

- **Augmented Reality** technology and concept has been used in various field including educational field. The developers as well as publisher are more likely want to involve in this AR technology as it promise a bright future in term of providing an innovative way for creating and ease the learning process among students.
- **An Android (Mobile) Applications & Interaction**: The project is aimed to use mobile phone (smartphones) with the android platform as it is much cheaper and easy to carry to anywhere compared to using a computer with a camera installed. Furthermore, since android operating system is an open source and practically free to be use, it become common for the developer to use it in their mobile phones as an operating system rather than IOs (apple operating system). Thus, with the completion of the project, we hope that kids will be able to use this application freely on their smartphones in order to assist them understanding and harness their knowledge while enjoying the AR Textbook.
- **Cloud Computing** may be used in this project where the camera will be use to capture the designated image and the processed feature will be send to the cloud for computing. On the other hands, there are possibilities for the project to use the cloud as the database.
- A **physical Textbook** (Geography Form 1) that has been issued by Ministry of Education Malaysia that is currently being practically used in most of the secondary school.

1.6 FEASIBILITY OF THE PROJECT WITHIN THE SCOPE & TIMEFRAME

In summary, the target user for the application is a lower secondary school student at the age of 13 years old (Form 1). The application allows the students to interact with their textbooks while they are reading it. The students also may be able to manipulate and interact with the animation in order to learn and get better understanding from the concept and theory explained in the book.

It will take about 8 consecutive months or 2 semesters in UTP Academic Calendar to develop this project. The first 4 months required the students to do some research regarding the chosen topics. This phase involve the methodology process, which are planning, analysis & designing phase. In the end of it, students need to submit an interim report containing Chapter 1 until Chapter 5 in order to pass the FYP1 subject. During the second phase (next 4 month), students should need to develop, implement and testing their application/ project. Therefore, it is important for student to properly manage their time so the project can be completed within the allocated timeframe.

CHAPTER 2

LITERATURE REVIEW

2.1 TEXTBOOK

Shannon (2010) describe textbook as a commodities, cultural representation, and political subject. Meanwhile, Hutchinson and Torres (1994) stated that textbook plays a very important role especially on a teaching and learning environment. For example, textbooks can be used as a guideline to ensure that the entire syllabus is well covered during classes (Allwright, 1981). A lot of effort and money had been spends by countries to produce them as it is considered one of the universal element to educate new young generation. Besides, textbook also can acts as guidelines to a new teacher regarding the course and class activities besides assuring consistency and logical progression in a class.

However, there is an argument in which it is not enough by just using only the textbook without any supplemental material as it is not the most satisfactory method for meeting students' needs. According to Garinger (2002), instructor as well as the teachers has to realize that there is a difference between providing organized, objectives-based instruction and being a slave to the textbook.

Furthermore, it can't be denied that the fact in which its still maintain an enormous popularity in education sector due to the several benefits it's offered in teaching process such as the following (Richards & Renandya, 2002):

- It provide structure and a syllabus for a subject
- Assisting in helping standardize instruction
- Provide variety of learning resource
- Visually interactive/ appealing

However, textbook also can have its own flaws such as the following:

- May consist of inauthentic language
- Content may be distort
- Probably does not meet the students' needs
- Usually too expensive

2.2 CURRENT LEARNING APPROACHES

The current learning approaches can be divided into two groups, which is by using non-technology based or technology based. In non-technology based, students usually use a physical textbooks provided by school in a class learning process. Teachers usually will explain about the subject by giving lectures or using the blackboard located in front of the class. On the other hand, the teaching approached by technology based usually in a form of e-books and web services. The following sections discussed several examples of current teaching/ learning approached used by the students.

2.2.1 Non Information Technology Based Approaches

Buku Teks Geografi is a textbook that has been distributed by the government of Malaysia to be use in all the secondary school located in Malaysia. The textbook has been standardized across Malaysia so the student is not confused by the outside teaching material. Besides, one of the reasons why it is all the same across Malaysia is because the previous examination called PMR is a standardized test especially for Form 3 students. The author for this textbook (Form 1) is Chong Mai San, and Dr. Azizan bin Hj. Abu Samah.
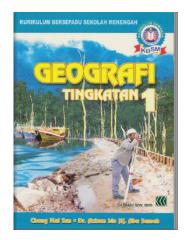
FIGURE 2.1   Form 1 Geography Textbooks

However, by simply reading the textbook can be boring and students tend to be sleepy while doing this plain activity. It may be because of the students cannot interact actively with teaching material thus their focus on the subject can be lose easily. Even the textbook now consist full of color and attractive picture to attract the students to read it, students nowadays would happily to spend their time at home on technological devices such as smartphones, tablet and laptop compared to the old plain textbook.

2.2.2   Information Technology Based

In replacing the physical books, FrogAsia with the initiative by the Ministry of Education has launched a 1BestariNet project aims to transform the learning process in Malaysia by leveraging both the internet and technology. Under 1BestariNet, Malaysia is the first country in the world to connect all schools across Malaysia through a single, cloud based learning platform (the Frog VLE). In addition, 1BestariNet IDs have been distributed to all students, and teachers in all ten thousands primary and secondary government schools nationwide, with a total of 10 million IDs.

Since the IDs have been distributed, students nowadays can view the textbooks on their laptop, smartphones or tablet via The BookShelf App. Students have the access to all types of textbook starting from form 1 until

form 5 textbooks through the Frog platform. From the Bookshelf, students can choose neither to purchase nor download the new eBooks or not. However, students still can view the full content of the textbook if they decide not to purchase it.

FIGURE 2.2   Form 1 Geography eBook

However, the available textbook is still the same as the physical textbooks. The only differences are it has been converted to the eBook. It may ease the students in a way that they can access it from anywhere but it is still the same textbook that requires minimum interaction from the reader.

2.3 Augmented Reality (AR)

Augmented Reality is the ability to insert and overlay digital and visual information to the real world. While Paul Milgram and his colleagues (Milgram & Kishino, 1994) characterize AR as being a fusion of real and virtual data within a real world environment, Azuma and his colleagues base their definition of AR on the attributes of the AR application (Azuma et al., 2001). It can be a live view of a real-world environment whose elements are supplemented by computer-generated sensory input such as graphics, video, sound or Global Positioning System (GPS) data. It may not be something new as augmented reality application has been used in weather visualizations in television.

2.3.1 Type of AR

We can basically categorized augmented reality into two types in which it is either marker-based or marker-less. Cameras and other visual prompts is usually used for real image recognition in marker-based AR meanwhile marker-less AR utilized the function of positional data that are already available in our smartphone such as GPS feature in order to determine user location.

(i) Marker Based

Since augmented reality presents information in a correct real-world environment through the screens in real time, the system needs to know where the user is and what the user is looking at. This Marker Based uses real-world symbols or image as a reference point for computer graphics to be overlaid. It usually uses the camera feature of a smartphone or computer to recognize the image or object. In practice, developer usually will create a 3D model or animation and assigned it to AR-marker (a printed 2D symbol). When this AR-marker is being move under the webcam, the system will analyze and recognize it and as a result, the 3D model or animation that has been assigned earlier may pop up on the user screen. Furthermore, the displayed model or animation may transform according to the flow as the user move their screen around the AR-marker. In addition, the most common form of marker-based AR that is well known is QR (Quick Response) codes. However, other forms also exists such 2D tags, Popcode and Google's Goggles.

FIGURE 2.3   An Example of AR Using Visual Marker

Types of Marker Based AR

As we discussed earlier, Marker Based AR uses a camera as a tool for image or object recognition. However, there are several form of marker based AR that is already available in the market for a past few years such as the following:

- **2D Tags (Microsoft Tag)**

    Microsoft Tags are basically a barcode (2D barcodes) that has been developed by Microsoft specifically designed for marketing purposes to businesses. It is a platform for businesses to connect with their customer through their marketing campaign (promotion, coupon and others). In addition, the user can scan the 2D barcodes with any smartphones as long as they download the apps named *Tag app* in the Google Play Store or App Store. However, Microsoft has terminated this service since 19 August 2013 and it is expected to be available back on 19 August 2015.

FIGURE 2.4   Example of 2D Tags

- **Popcode**

  Popcode is basically using the same concept as the augmented reality but it does not need the user to print a large black and white marker in order to use it. While the companies *Popcode* claimed their apps as marker less, their program is basically using image recognition (Popcode logo) to add AR content into the real world. Plus, it is completely free use either for user as well as to the developer.

FIGURE 2.5   Example of Popcode AR Robot

- **Google Goggles**

  There is some argument between the developer might as well as the user whether this application is using an AR tool or not. Google Goggles is actually a visual search application through a mobile phone. It allows the user to take a picture of an object and the application will bring up the information related to the picture

taken. For example, user can use a picture of a book on Google Goggles and they may see the exact match book result without typing or saying a word. The fact that these application can brings up information about an image that actually at somewhere else can lend itself to AR application.

FIGURE 2.6   Example of Google Goggle

(ii) Marker-less

As described earlier, marker-less AR generally uses the GPS feature of a smartphone in order to locate and interact with augmented reality resources. It accurately detects the real-world environment in real-time and allow users to place virtual objects in that environment. However, marker-less AR also can be use on an image and object. Differences from marker-based AR where the image is simply provided beforehand in the app, marker-less AR dealing with an image/ object that were not provided to the application beforehand. It is very difficult to implement as it involve identifying colors, shape or some others features that may exist in camera frames. For example, if a user designed the apps to automatically trigger the AR components when it detect a cat on a camera, it should work as long as any type of cat is presence without providing images of all types of cat in the world beforehand.
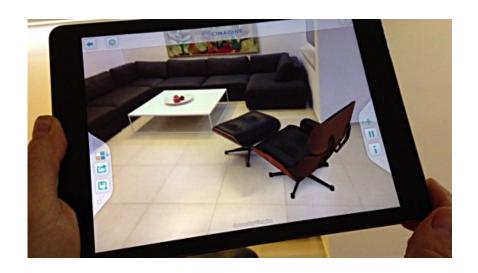
FIGURE 2.7   An example of Marker-less AR System from
Cimagine Media

Figure above illustrated the marker-less AR application developed by Cimagine Media. This application does not need a physical markers to add the AR components while it use only smartphones/ tablet camera and sensors in order to position selected virtual object such as dining table according to a room size. Besides, user also does not need to have a physical catalog in order to use this application as it can be accessed via a free companion app which means that the apps as well as the catalogue came in one package when the user download it on the App Store.

2.3.2   Augmented Reality (AR) Hardware

AR is a form of technology that we are probably already using it in daily life whether we realized it or not. In order to see AR, we need some kind of interface (hardware) to act as the intermediaries between the software and the real world. In addition, AR hardware needs four of these elements in order for it to works which is an **input** (AR Marker for example), a **sensor** (used by the user to performed action like clicking button on the touchscreen), **processor** (recognize the AR Marker) and a **display** (display the information). However, the

augmented reality hardware can be anything simple or sophisticated such as the following:

- **Computer (desktop monitor with camera)**

FIGURE 2.8   Computers with Camera

There are many technologies available to use in Augmented Reality rendering such as monitors and others. Meanwhile camera is used as a tool for image/ object recognition.

- **Modern mobile devices like smartphones or tablet**

    Most of the modern mobile devices like tablet or smartphones usually contained these 4 elements that suitable for AR platform which is input, sensor, processor and display. These modern mobile devices also attached with a camera and Microelectromechanical systems (MEMS) sensors such as GPS and solid state compass featured which are also suitable to be used in AR.

- **Eyeglasses**

FIGURE 2.9   Google Glass

Besides desktop monitor and smartphones screen, AR display also can be rendered through a devices that resembling eyeglasses. The most popular and well known AR glasses are Google Glass. This project was developed by Google X which is the same facilities within Google that developed Google Driverless Cars.

- **Optical Head-mounted display (OHMD)**
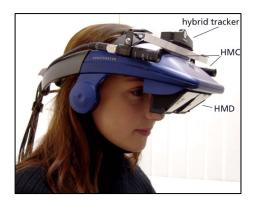
FIGURE 2.10 Optical Head-Mounted Displays (OHMD)

Head-mounted display (HMD) is a display device that people usually wear it on the head as part of the helmet. Meanwhile, OHMD allowed user to see through reflecting projected images. It combined both images

at the physical view as well as virtual objects and displays it over the field of view of the user.

- **Contact Lenses**
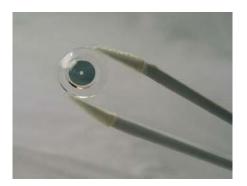
FIGURE 2.11 AR Contact Lenses

Although it believed that the contact lens that can display AR component in full HD is still under development and far from real, there is a project developed by Innovega named *iOptik* where it requires a pair of glasses and contact lens in order for it to function. It works in a way that the glasses will project a picture onto the contact lens, which works as a filter to separate digital environment with the real world and then interlaces into one image. On the other hands, the futuristic video entitled *Sight: Contact Lenses with Augmented Reality* have won the best futuristic augmented reality video award in 2013.

2.3.3 Augmented Reality (AR) Software

Besides meeting the hardware requirement, developers also need software to successfully develop their own AR application. On the other hands, Augmented Reality SDK (Software Development Kit) provide to developers the tools and libraries in order to build AR applications easily. The following is a list of augmented reality development tools and SDKs that are already available in the market:

- **ARToolKit**

FIGURE 2.12 ARToolKit Logo

ARToolKit is basically a software library for building AR application that was originally developed by Dr. Hirokazu Kato. It uses computer algorithm to solve the problem of tracking user's viewpoint. There are several features that ARToolkit offered such as the following:

- Available in SGI IRIX, Linux, MacOS, and Windows OS
- The ability to use any square marker patterns
- Fast enough for real time AR application
- It offered single camera position/ orientation tracking
- Easy camera calibration code
- Distributed with the complete source code (OpenSource for non-commercial usage)

- **Layar**

FIGURE 2.13 Layar Logo

Layar is a mobile augmented reality browser. They are a Dutch companies based in Amsterdam, The Netherlands and have been founded in the summer of 2009. It has attracted many developers around the world to create AR content as it is well known for the most popular platform for AR in the world. For the record, they had successfully made

collaboration with many of the world top brands such as Pepsi, Coca-Cola, Honda, BMW and others. Some of the features of Layar include:

- Basic Buttons (Open a website, Call a number, Vote in a poll)
- Media Buttons (Play video, audio, Show a carousel)
- Social Buttons (Share on Facebook, Like a Facebook page)
- Advanced Buttons (3D models, Custom animations, Instant testing)

- **Junaio**

FIGURE 2.14 JUNAIO Logo

Powered by Metaio (pioneer and leader in Augmented Reality technology), Junaio is a mobile AR platform that allows user to interact with AR component. Recently, Junaio has released a new Beta version named Junaio Mirage that is available to use on the smart glasses such as Epson, Vuzix and Google Glasses. Developers can create their own AR application by using Metaio Creator which it offered graphical user interface where developer can perform drag-and-drop action in creation of AR interfaces.

- **Vuforia**

Vuforia™ is a product of Qualcomm Connected Experiences, Inc. It currently launches new SDK Vuforia™ 4.0 where it provides some new features such as the following:

- Objects Recognition – Enables apps to recognize and track variety of object such as toys and consumer product.

- Vuforia Object Scanner – Enable apps to provide real-time visual feedback as the user scan the object.
- iOS 64-bit Support – Developer can now build 64-bit apps in iOS that are more responsive and has better graphic quality.

2.3.4 Application Area of Augmented Reality

It has been more a decade that people still believed AR is merely just a concept of science fiction. However, thanks to the advancement of technology, it is finally happened nowadays. There are several reasons why many researches has been pursued Augmented Reality (AR) in their research as they believed that it is the future that may change our way of thinking and how we do see things. According to Azuma, et al (2001), AR can improved users' perception, knowledge even interaction with the real world. This is supported by Schmalstieg (2001) which believed that AR has the potential to increase productivity when doing something in real world such as learning and others.

Whether we realized it or not, AR application has started penetrating the market of mobile application such as Android and iOS. We also discover in our research that AR has already been use in various sectors including entertainment, medication, military, education and others. However, Ludwig & Reimann (2005) argued that AR application should only fall into these three main categories which are:

1. Presentation and Visualization
2. Industry
3. Edutainment (Educational Entertainment)

Thus, it really shows that AR application actually has a promising future to give an impact and brings changes in all sector especially in a sector that rapid information transfer is very crucial and critical (Krevelen & Poelman, 2010).

Hence, the research relating in the application of AR in these sectors will be examining first before we discussed about the application of AR in education.

(i) Entertainment

It has been almost a decade that Augmented Reality has been in the entertainment industry. We can see the implementation of AR in several fields of entertainment such as cinematography and electronic games.

- **Cinematography**

FIGURE 2.15. View from Iron Man Heads Up Display

The use of augmented reality (AR) is becoming popular in the film production process. According to Cameron (2010), directors such as James Cameron have started using AR as a tool to assist in the creation of movies with complex special effects combined with numerous computer generated assets (CGA).

Iron Man movies are one of the examples of several other famous movies that implement AR concept in their storyline. This can be shown from the "H*eads Up Display*" wear by Iron Man that gives stacks of real time information to assist Tony Stark in any situation.

Besides Iron Man, there are also several movies that use AR concept in their storyline such as *Kingsman: The Secret Service*.

One of the gadgets that featured an AR concept in the movies is the Bulletproof AR Umbrella. As it name speaks, it is the bulletproof umbrella where the user can see through the umbrella. In the movies, it enabled the Kingsman to locate their enemies by seeing through the umbrella only without being harm.

FIGURE 2.16 Scene from *Kingsman: The Secret Service* Displaying an AR Umbrella

Besides of these two well-known movies, Korean producer also has begins to start implementing an AR concept in their TV series or also known as Korean Drama entiled *Hyde, Jekyll and I*. This drama is based on the web comic "Jekyllbaksaneun Haideussi" by Lee Choong Ho that was first published at 15 Feb 2011. In the drama, Seo Jin the main character always wears an AR spectacle to monitor his heart rate. This spectacle collects the data from heart rate device and projecting it through the spectacles screen in real time.

FIGURE 2.17 Scene from *Hyde, Jekyll and I* Displaying an AR
Spectacles

- **Electronic Games**

Nowadays, industry likes electronic games industry and social
media industry is quickly hopping aboard the augmented reality
locomotive. Smartphone apps now enable user to fire a gun to a
targeted object by circling around in their environment via phone
screen. For example, "**Mana Naga**" mobile apps by Astro
required the user to circling around their environment in order to
search and shoot the dragon.

FIGURE 2.18 AR Cards Developed by Nintendo

Besides, Nintendo also has launched their own AR cards where
the user can experiences their games in the real world. Every

user will get a packed of six AR Cards with every purchase of Nintendo 3DS system. By placing these cards on a flat surface and looking through their Nintendo 3DS camera, the character as well as the game content will be appeared in front of their eyes. However, user still needs to use a designed physical button to interact with the pop up character. Another interesting feature offered by Nintendo is the user can pose and take 3D photos with their favorite Mii™ character by using Nintendo 3DS camera only.

(ii) Military

Helmet-Mounted Sights (HMS) or Display (HMD) allows users to view relevant information such as instructions, maps, and enemy locations. (Yuen, Yaoyuneyong, & Johnson, 2011). This helmet involving AR applications has been used by fighter and helicopter pilots for many years.

However, AR military-grade helmets such as ARC4 system are still in development. The gadget attaches to a military helmet, and it also can be integrated to weapon control system. This ARC4 allows commanders to send maps and other key information such as the location of enemies, satellite footage and mission objectives directly to the soldier's field of vision.

FIGURE 2.19 ARC4 Systems Designed to Fit onto a Helmet and
Give Live Updates

(iii) Medical Application

Dr. Michael Aratow Chief Information Officer for San Mateo Health
Services stated that AR application has been playing an important role
since it has been applied in the medical field for nearly ten years.
According to Fuchs (2002), minimally invasive surgery (MIS) has
influenced the techniques used in every specialty of surgical medicine. It
basically includes procedure where a thin tube attached with a camera is
inserted into the patient's body which the surgeon can view organs and
tissue inside of the body. Small, specialized surgical instruments are also
inserted through small incision (often less than an inch) so that the
surgeon can perform the operation without an external incision.

One of the main strengths of AR in medical applications is its ability to
overcome difficulties related to hand-eye coordination (Johansson et al.,
2001)

(a)   (b)
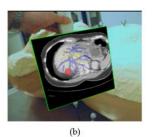
FIGURE 2.20 Overcoming the problem of hand-eye
coordination using Augmented Reality

FIGURE 2.20 (a) display typical examination using sonography
while FIGURE 2.20 (b) enables the user to see the data at the

same location where his/her hands operate using an AR application.

2.3.5 Augmented Reality (AR) in Education

The usage of AR technology may be benefits education sector in many subjects such as math on the lessons about fraction or in chemistry on the lessons in term of displaying and understanding periodic table.

For example, AR may be benefited in term of (Yuen, Yaoyuneyong, & Johnson, 2011):

1. It help the learning process on the subject where the students could not gain real-world first-hand experience such as Astronomy and Geography subject (Shelton&Hedley,2002)
2. Encourage students to explore class materials from different angles (Kerawalla, Luckin, Selijefot,& Woolard, 2006)
3. Enhance collaboration between students and instructors (Billinghurst, Augmented Reality in Education. New Horizons for learning, 2002)
4. Foster student creativity and imagination. (Klopfer & Yoon, 2004)
5. Help students to learn something new at their own pace. (Hamilton & Olenewa, 2010)
6. A suitable environment can be created according to various learning styles (Classroom Learning with AR, 2010).

(i) AR Books

A study by Marshall et al. has revealed that people still prefer printed books since they favor physically, transportability, flexibility and robustness. However, the AR technology has a great potential to offer students as well as teachers an interactive experiences in learning environment. Digitally augmenting and enhancing real books basically will give the advantage of both.

With AR technology, books will become more interactive since it will be supplemented by additional visual information based on pictorial content in the real book. There are certain pop-up books that are already available in the market that allow user to experience the sight of 3D models such as the following:

- **New Horizon**

FIGURE 2.21 New Horizon Text Book

In addition, AR book also can be used at the secondary level in learning new language. Japanese publishing company Tokyo Shoseki is producing textbooks that support AR apps on smartphones, bringing characters to life for students to listen to. New Horizon is actually the name of the textbook in Japan. It has been used by junior high school students since 1966. However, only 40% of schools are using it as their textbook as of 2003. This textbook has undergoes several changes through time although it is just only a minor change. For example, previous edition shows the kids visit the Australia instead of Canada in the new edition. Besides, there are shoes on sale instead of T-shirts. In addition, New Horizon also is intended for adults who are interested to pursue their English studies at a high school level.

- **Wonderbook: Book of Spells**

FIGURE 2.22 'Wonderbook™: Book of Spells from J.K. Rowling'

For instance, an AR book entitled "*Wonderbook*" was introduced by Sony press conference at the 2012 Electronic Entertainment Expo. It is basically the augmented reality book for PlayStation 3 which is specially designed to be used together with the PlayStation Move and PlayStation Eye. It was released together with the Book of Spells during the past June 2012 holiday season.

In addition, Book of Spells was developed by SCE London Studio in conjunction with J.K. Rowling as a companion to the Harry Potter Series. Although the games duration is significantly short and only one person can play it at a time (single-player), it has received tremendous positive review and praising for using the concept of Augmented Reality together with PlayStation Move in order to maximize user participation as well as experience on the game.

J.K.Rowling also stated that this book is an extraordinary device that offers a reading experience like no other. In order for the book to appear on the screen, the user needs to have PlayStation

Eye to detect the book as it use AR technology application. It also uses the motion sensitive controller as a magic wand so the reader can experience on how they can casting spells as they read through pages.

- **Wonderbook: Diggs Nightcrawler**

FIGURE 2.23 "Wonderbook: Diggs Nightcrawler"

Diggs Nightcrawler was the second game that using an AR book after the release of Book of Spells. It was developed by Moonbot Studios and released on 31 May 2013 at Europe. It is also use PlayStation 3 as the platform as it is the second game to make use of the Wonderbook peripheral. Diggs Nightcrawler consists of only 3 chapters in their storyline where the main character is an inchworm as a private detective. However, his best friends Humpty Dumpty or also known as The Don of Library City has been murder. The stories continue when Diggs (inchworm) wants to uncover the mystery of the murder, assisted by the player. This wonderbook is difference from the Book of Spells where user need to frequently rotate, tilt, turning its page and shake the book in order to interact with the game. In addition, the user also can take their own picture using PlayStation Move as a camera on a photographic mission during the completion of the game.

- **Wonderbook: Walking with Dinosaurs**

FIGURE 2.24 "Wonderbook: Walking with Dinosaurs"

Walking with Dinosaurs was the third game to make use of the Wonderbook peripheral. It was developed by Supermassive Games with collaboration with the BBC. It has been released on 13 November 2013 at Europe and 12 November 2013 at North America. The book basically consists of five chapters with two sections with each chapter. In every chapter, it need user to read one section only out of two. Each chapter is difference from another in term of storyline, characters and dinosaur species. However, the first chapter features the characters from the *Walking with Dinosaurs* feature film. User will received rewards in term of gold, silver or bronze medals depending on their performances in the game. The game also will test the user knowledge and understanding by providing a number of questions with each section.

- **The Future is Wild: The Living Book**

FIGURE 2.25 An Illustration of The Future is Wild - Living Book

Another type of AR book which is for education is "*The Future is Wild: The Living Book*". It was developed by Metaio located in Germany and has been launched at the Frankfurt Book Fair during the past 2011. The book, with 42 integrated AR special features such as zoom in or out function and others, demonstrates the potential of AR to encourage readers to build a connection to a book (Yuen, Yaoyuneyong, & Johnson, 2011).

One of the feature in the book is user can discover several types of animal such as the incredible giant rainbow squid in entire 3D animation. User also can discover which type of animal is the prey of the rainbow squid just by adding difference type of animal card. Every card will activated the new exciting action sequence in real time environment. Besides, the 3D globe model enables the user to view the movement of planet earth in the space. On the other hands, the user also can activate additional sequences just by using additional key on their keyboard.

- **Zooburst**
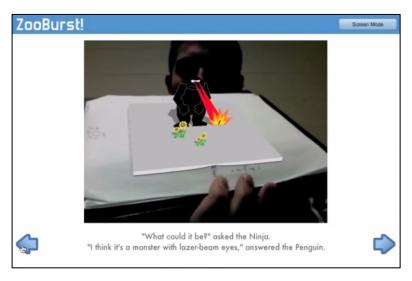
FIGURE 2.26 Zooburst Illustration

Zooburst is a digital storytelling tool that let's developer or storyteller create their own 3D pop-up books. However, there is several sample of 3D pop-up book that accessible by anyone in their website gallery. The user can view the storybook and rotate their mouse around the screen to take a better look. Besides, the item within the book is clickable allowing user to discover more about the character in the story. Anyone can easily move from page to page using the interface at the bottom of the screen. In addition, if user has the webcam installed on their computer, they also can experience the book appear in their palm of hands (AR way) just by clicking the AR button located at the top of the screen. However, users still need to navigate through the previous interface to cycle through pages.

- **Popar™ Book**

It use AR technology to attract the reader in immersive reading mode where it enables them to see their book come alive with a 3D pop up animation that will pop off the page. Actually, the camera detects and recognizes the visual marker on each page and translates it to a computer screen (3D object). One of the example of Propar Book is named *Planet 3D*. It informed the reader and provided information's regarding several different planets in our solar system. In addition, reader also can interact with these planets and move it around to view them from different perspective just by tilting the books. Furthermore, if the reader accidently closes the book, the animation will stay on the screen. Besides, one of the features of this book is it also include a flash card where user can see themselves wearing an astronaut costume just by holding the flashcard under their chin.

CHAPTER 3

METHODOLOGY

3.1 RESEARCH METHODOLOGY

Choosing the right research methodology is one of the crucial steps for developer/ researcher. It is vital because the project has the possibilities to be abandoned due to several reasons such as a system failure or there are too many bugs. As a result this may lead to the waste of time, energy and money. After considered all the requirements needed for this project, time constraints and the nature of this application, the author has chosen to use Rapid Application Development (RAD) as a methodologies for him project.
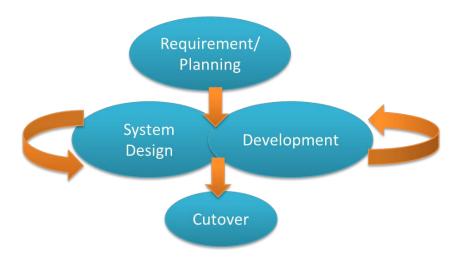
FIGURE 3.1   Rapid Application Development Model (RAD)

These methodologies usually use by developer/ researcher to develop and create a fully functional system within a very short period of time. Besides, it allows changes in system with a minimal causalities (cost, time, energy) thus creating a better quality system. However, developer/ researcher who intend to use this methodology had to fully and have clear understanding at all the requirement of their project first. Typically, the

involvements of the user are also very important in this methodology because it is necessary to clearly understand the requirement as well as the expectation from the user.

Furthermore, this methodology is exceptionally good for this particular project because this project has the possibilities to evolve throughout the process as we know that the time and money assigned for this project is very limited. Compared to RAD, traditional way of development that has been practiced earlier is completely difference. It has been said that each stage of development or phase in traditional way of development has to be completed first in order to proceed with the next step. Contrary with that, RAD need the developer to make a thorough analysis and planning regarding the project first before the next step can be taken. It offered the developer the flexibility to always develop and improve their project from time to time.

Thus, the author realized that it is best for him to use RAD methodology as a reference model because the author knowledge about the concept use on this project which is augmented reality is still not enough and it is believed that due to the reason, the project may need a few modification and improvement to be made from time to time.

This RAD methodology required the author to go through these 4 stages or step such as the following:

3.1.1 Requirement/ Planning

The objective of the Requirement Planning is to establish a general understanding about the project requirement and all the necessary information. At this stage, the author needs to define the problem statement of the project, objectives, relevancy as well as the scope of the project. It is very important for the author to clearly understand all the concept and practice regarding mobile application technology as well as the concept of augmented reality in the way that how it works and how it can be used and applied on the project. Besides, the author also needs to learn and research about how technology evolves in term of how it helps people doing things (Traditional Method vs Modern Method). Thus, it is also very crucial for the author to discover on how to deliver the targeted knowledge effective and efficiently using an AR on smartphone technology.

```
┌─────────────────────────────────┐
│     Define Problem Statement      │
└─────────────────────────────────┘
                  ▼
┌─────────────────────────────────┐
│   Research Current Situation/     │
│        Previous Findings          │
└─────────────────────────────────┘
                  ▼
┌─────────────────────────────────┐
│         Data Gathering            │
└─────────────────────────────────┘
```
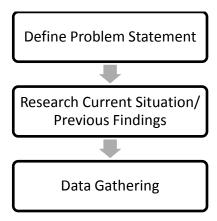
FIGURE 3.2   Task of The Requirement Planning

- **Define Problem Statement**

This task initiates the Requirement Planning stage where the author needs to identify what the problem he wants to solve by developing this mobile application. It is important to considered current trend where students nowadays tend to attach themselves with mobile gadget such as smartphones and tablet. This habit should be fully utilized by the students to seek more knowledge and harness their understanding in subject teaches in school. Therefore, the author decides to use AR as a platform in his mobile application where learning will never be as lame and boring as before.

- **Research Current Situation/ Previous Findings**

After the problem has been define clearly, it is important to proceed with conducting some research regarding the previous research finding and observing the current practice. This has to be done in order for the author to have a better understanding specifically on AR technology, Mobile Application concept, and others. Besides, the author also will be able to analyze the existing theories that are available from previous research findings.

- **Data Gathering**

  Data gathering is a stage where all the information on the user requirement is collected through several approaches such as observation on a method that are currently practice in school as well as conducting a survey related to the project. The author also can make an analysis and gathered all the required data by reviewing the existing mobile application that has already available in the market whether it has to be paid or no charge (FREE).

3.1.2 System/ User Design

The objectives of the System/ User Design phase is to select and identify who is the target user, where and how the end product will be use. It is necessary to described design function and operation in details including diagrams, storyboard and outline. The author also need to develop or sketching a proposed screen layout for his mobile application during this stage. Regarding the AR Geography Textbook, its' early designed was based on the layout below that has been developed specifically for this project.

- **System Architecture**

  In order to run the prototype, the users should use any Android tablet or smart phones (with version 3.5 and up). There are two elements that are necessary for the program to successfully run, which are the application on the phone with a camera as well as the markers from the textbooks.

  Below are the installation procedures:

  I.   Deploy the program from unity 3-D on to the android device and it will automatically install the program (apk file) on the device.

  II.   Open and run the program on the device.

  III.   Navigate through the main menu and click the logo to start

  IV.   Place the design markers and fill the camera with image target.

Figure 3.3 shows the brief flowchart of the system architecture.

FIGURE 3.3   System Architecture Design

- **Database Diagram**

  There are basically two types of database that can be used by the author which is device or cloud database. As it name speaks, device database can be accessible locally meanwhile cloud database are stored in the internet. It is a database that runs on cloud computing platform.
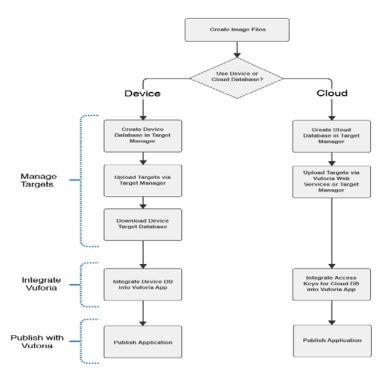
FIGURE 3.4   Device vs Cloud Database Workflow

The author has made some research regarding the differences between these two types of database such as the following:

Device Database	Cloud Database
Database can be accessed locally	Required internet connection
Response time is within 2 to 3 frames	Depends on the network condition
Multiple database can be active at the same time	Can recognize maximum 1 million target at the same time
Free	Free or Charged by usage

TABLE 3.1   The Comparison between Device and Cloud Database

The author has decided to use cloud database for his project. Although the images to be tracked is already known and device database offered higher response time, the author think it is suitable to use cloud database because the application itself will be consist of multiple video file which is probably too large to store and access it locally. In addition, target retrieved by cloud

recognition can carry up to 1 MB of metadata. Thus, it is important for the end user to have high speed internet connection to ease the learning process while using this app.

- **Use Case Diagram**
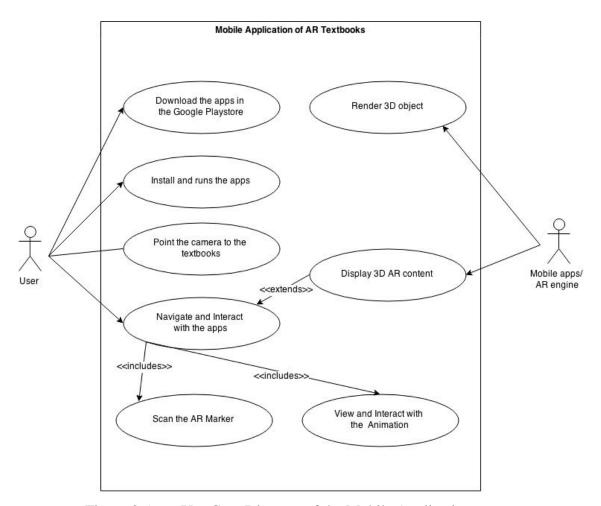
Figure 3.5   Use Case Diagram of the Mobile Application

3.1.3 Construction/ Implementation Phase

This is a stage where the author has to build and developed the working prototype of his mobile application. The prototype has to be based on the author system analysis and design that has been developed in the early stage of this project. Furthermore, the author has to make sure that each function on his mobile application has to successfully work and operational. It is advice that the

author to run a simulation several times to detect bug and make necessary modification to the apps if there is a problem occur.

3.1.4 Cutover

This stage is also known as deployment stage. During deployment stage, the author needs to plan and conduct user testing frequently until the end user satisfy with the product. At this stage, all the feedback from the user is very important and the author needs to take note on it so the necessary improvement can be applied on the application based on the feedbacks received. Besides, the author also needs to brief and explain to the user on how the mobile application works with providing simple guideline. On the other hand, the author can decide to deploy the project once the application itself is free from any error, bug and meet the user expectation.

3.2 TOOLS

For this project, tools can be defined as both hardware and software that will be used in the development of this mobile application.

3.2.1   Hardware & Equipment

The author decides to use his laptop for the development of this project. However, the minimal requirement that has to be met for the development is the laptop operating system (OS) should be Windows XP SP2+, 7 SP1+, or 8 (Windows Vista is not supported for Unity). Besides, the minimal Graphics Processor Unit (GPU) uses has to be at least graphic card with DX9 (shader model 2.0) capabilities. In other words, any graphic card that is made since 2004 should have no problem for using it.

Furthermore, another hardware that will be needed is a smartphone with a camera. It is recommended to use a large screen smartphone (phablet) as

animation, video look better on a bigger screen and it is easier to press anything appeared on a screen.

The following table shows a comparison between Dekstop PC, Smartphone (Phablet) and Tablet:

Device	Advantage	Disadvantage
Dekstop PC	1. Huge display screen 2. Higher performance	1. Heavy to carry to anywhere 2. Required external camera
Smartphone (Phablet)	1. Easy to carry around 2. Touchscreen display 3. Built-in camera 4. Large display screen 5. Higher number of user	1. Has smaller screen than Dekstop PC 2. Performances cannot beat Dekstop PC
Tablet	1. Lighter than Dekstop PC 2. Easy to use	1. Hardware is prone to damage 2. Higher cost

TABLE 3.2   The Difference between Dekstop PC, Smartphone and Tablet

In addition, equipment that is necessary for this project is a textbook itself. The textbook is needed to use along the application. At the early stage, the webcam was used to detect and recognize image/ AR mark on the textbook before it is deployed to a smartphones.
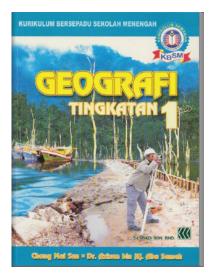
FIGURE 3.6   Form 1 Geography Textbook

The author has chosen Form 1 Geography Textbook as a reference to develop his mobile application because it contain several interesting topics that are worth to be discussed such as the effect of deforestation (flood), the process of greenhouse effect, urban heat island (UHI) and others.

3.2.2   Software, Platform & SDKs

During development phases, there are several different types of software/ platform/ SDKs that will be used in order to meet all the objectives and requirement for this project.

- **Android SDK**

  SDK or also known as Software Development Kit is a development kit used to assist in creating mobile application. So, Android SDK is used by developer to help them building Android application for the android platform. Usually, Android SDK consist of several source code from a sample project, tools for development, an emulator to test the code and required libraries in order to develop the Android application.

On the other hand, it is recommended to use recent android version which is Android 5.0 or 5.1 (Lolipop) for this project. However, a minimum of android 2.2 (Froyo) and above is required. The following names represent all version of android that are already available in the market:

Version	Codename
Android 1.5	Cupcake
Android 1.6	Donut
Android 2.0, 2.1	Eclair
Android 2.2	Froyo ("frozen yogurt")
Android 2.3	Gingerbread
Android 3.0, 3.1, 3.2	Honeycomb
Android 4.0	Ice Cream Sandwich
Android 4.1, 4.2, 4.3	Jelly Bean
Android 4.4	KitKat
Android 5.0, 5.1	Lolipop

TABLE 3.3   List of Android Version and Codename

- **Vuforia (SDK)**

  Vuforia is actually the Augmented Reality SDK for mobile devices that allowed it user/ developer to build an AR application. It basically uses computer vision-based image recognition to recognize and track the targeted image. In addition, it also offered a wide range of features such as object recognition, and object scanner. With support for iOS, Android, and Unity 3D, this platform is the best choice for any developer who want to build any AR mobile application.

- **Unity 3D**

Figure 3.7 Unity Logo

This software is basically used by developer to create multiplatform 3D and 2D games. However, it is also can be easily use to create application for mobile devices, desktop and others. Related to the author project, Unity 3D will help the author to compile all the SDK/ programs in order to produce final product which AR textbook mobile application.

- **Audacity**
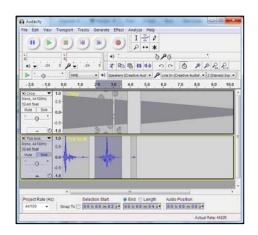
Figure 3.8 Illustration of Audacity software

Audacity software also will be used in the project. It is totally free, open source, cross-platform software that offered its' user to record and edit sounds. This program will be used to edit the interaction sound, for example the sound when user clicks something on the screen. Besides it is also used to edit sound from a video.

- **Adobe Photoshop CS5**

Figure 3.9   Using Adobe Photoshop to Design User Interface

For this project, Adobe Photoshop is basically use to design/ sketching the user interface of the mobile application. It is also use for designing the logo that will be used to represents the application.

3.3 PROJECT ACTIVITIES

3.3.1 Choosing the Textbook Application

During designing phases, there are many changes occurred in identifying which application in the geography textbooks (form 1) would be an appropriate topics to apply the AR concept. The decision is based on several factors such as the complexity of the topics and the relevant information it offered.

Diagram below represents all the topics that are available in the geography text book. However, the ones highlighted in a green mark were the considered topics to be use.

SECTION A: GEOGRAPHY SKILLS	
UNIT 1	POSITION (KEDUDUKAN)
UNIT 2	DIRECTION (ARAH)

UNIT 3	SCALE AND DISTANCE (SKALA DAN JARAK)
UNIT 4	GRAF
UNIT 5	MAPS (PETA)
SECTION B: PHYSICAL GEOGRAPHY AND HUMAN	
UNIT 6	EARTH (BENTUK MUKA BUMI)
UNIT 7	POTENTIAL AND THREATS AGAINST HUMAN ACTIVITY (POTENSI DAN HALANGAN BENTUK MUKA BUMI TERHADAP KEGIATAN MANUSIA)
UNIT 8	IMPACT OF HUMAN ACTIVITY TO ENVIRONMENT (KESAN KEGIATAN MANUSIA TERHADAP ALAM SEKITAR)
UNIT 9	THE MOVEMENT OF EARTH IN THE SOLAR SYSTEM AND EFFECT ON WEATHER AND CLIMATE (PERGERAKAN BUMI DALAM SISTEM SURIA SERTA PENGARUHNYA TERHADAP CUACA DAN IKLIM)
UNIT 10	EFFECT OF WEATHER AND CLIMATE TO HUMAN ACTIVITY (PENGARUH CUACA DAN IKLIM TERHADAP KEGIATAN MANUSIA)
UNIT 11	HUMAN INFLUENCES ON WEATHER AND CLIMATE (PENGARUH MANUSIA TERHADAP CUACA DAN IKLIM)
UNIT 12	NATURAL PLANT AND WILDLIFE (TUMBUHAN SEMULA JADI DAN HIDUPAN LIAR)
UNIT 13	FACTORS AFFECTING THE VARIOUS NATURAL PLANTS (FAKTOR-FAKTOR YANG MEMPENGARUHI PELBAGAI JENIS TUMBUHAN SEMULA JADI)
UNIT 14	KEPENTINGAN TUMBUHAN SEMULA JADI MALAYSIA
UNIT 15	THE EFFECTS OF HUMAN ACTIVITIES ON NATURAL PLANTS AND WILDLIFE (KESAN-KESAN KEGIATAN MANUSIA TERHADAP TUMBUHAN SEMULA JADI DAN HIDUPAN LIAR)
UNIT 16	MAINTENANCE AND CONSERVATION OF NATURAL PLANTS AND WILDLIFE (PEMELIHARAAN DAN PEMULIHARAAN TUMBUHAN SEMULAJADI DAN HIDUPAN LIAR)
SECTION C: LOCAL GEOGRAPHICAL STUDIES (KAJIAN GEOGRAFI TEMPATAN)	
UNIT 17	STUDY OF THE NIAH CAVE, SARAWAK (KAJIAN BENTUK MUKA BUMI GUA NIAH, SARAWAK)
UNIT 18	STUDY OF WEATHER AND CLIMATE AND ITS EFFECT ON FLAT GROUND (KAJIAN CUACA DAN IKLIM SERTA PENGARUHNYA DI TANAH RATA)
UNIT 19	STUDIES OF IMPACT OF HUMAN ACTIVITY ON FOREST SWAMP WATER IN COASTAL MASIN MORIB (KAJIAN KESAN TINDAKAN MANUSIA TERHADAP HUTAN PAYA AIR MASIN DI PERSISIRAN PANTAI MORIB)

TABLE 3.4   List of All Topics in the Geography Textbook

3.3.2 3D Modelling & Animation

As the 3D models will be pop-up from the book, the augmentation main idea, of bringing objects to life, therefore, it is very important, for the application core revolves around the 3D dimensional world and interacting with it. The application contains several 3D models. For 3D models creation, Blender software was used. As an example, the figure below is a Sun and Earth model, which was modeled in Blender to be used in the application.
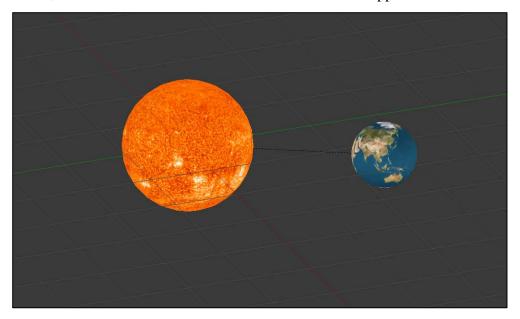
Figure 3.10: Earth and Sun view from Blender

After the modeling phases, comes the 3D animation phase, the 3D animation can be made in 3d part software (Blender), where the models were created, then exported as animation clips and used in unity3D, or it can be directly created in unity after importing the 3D model in unity environment. For this project, all applicable models were animated in Blender.

3.3.3 Development in Unity3D

Once all the augmented elements were prepared, the development of the application is commenced in Unity 3D and Vuforia extension. The development process using vuforia for augmentation comprises on replacing the unity 3D main camera, with the Vuforia AR prefab camera and making it

the main camera in the scene. As for the alphabet image target, one had to drag the 3D models on to the targets and parent them to the target; thus, when the app runs and the camera is pointed to the image target, the 3D models will pop up. In order to include the audio sound source, GUI, animation and interaction, one had to prepare, C# and JavaScript scripts so it will be integrated successfully in the model.
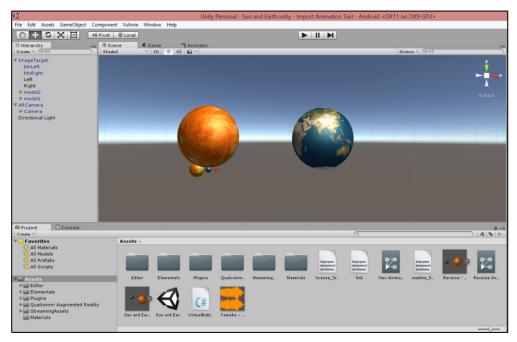
Figure 3.11: Developing the app in Unity3D

3.4 CHALLENGES AND ISSUES ENCOUNTERED

In general, during the development of this project, the author has encountered several challenges and difficulties that may hinder the progress of this project. However, all the issues and problem successfully overcome by the author thanks to the help and support from many parties. Several challenges and difficulties that have occurred are such as the following:

- **Program/ Software Installation**

  Downloading and Installing the software (Unity3D) was one of the earliest problem encounter by the author during the development of this project. There is several times the author failed to install the software due to the slow

internet connection at UTP. Besides, the software consist a lot of data so it is basically one huge file to install. The requirement for it is the computer has to connect with the internet so the installation of the software can be successful. However, thanks to the help from author colleagues that give the permission to use his broadband, the installation is successfully done.

- **Augmented Reality (AR)**

  It is difficult for anyone even the author itself to implement augmented reality concept in the mobile application without having the basic knowledge of it first. Fortunately, with the help of supervisor and other FYP colleagues as well as the video tutorial from YouTube and other sources, the author managed to understand the concept and applied it on the project.

- **Time Constraints**

  Time is always being the factor for any project. It required a lot of time with this magnitude of project. For the current progress, the author has successfully obtain few video related to the application in the textbook. However, sound editing, GUI and interaction scripting still is in progress. Due to proper time management and constant work, all the process and activities still follow with the schedule.

3.5 KEY MILESTONE

No.	Task/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	█	█												
2	Preliminary Research Work		█	█	█	█									
3	Submission of Extended Proposal						█	█	█						
4	Design Project Outcome						█	█	█	█	█	█			
5	Submission of Interim Report												█		
6	Proposal Defenses													█	
7	Project work continues													█	█

TABLE 3.5   Final Year Project 1 (FYP1) Key Milestone

No.	Task/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Work Continues	█	█	█	█	█									
2	Submission of Progress Report					█									
3	Project Work Continues						█	█	█						
4	Pre Sedex									█					
5	Submission of Technical Report										█				
6	Submission of Dissertation (SoftBound)											█			
7	Submission of Dissertation (HardBound)/ Viva												█	█	

TABLE 3.6   Final Year Project 2 (FYP2) Key Milestone

3.5 GANTT CHART

No.	Task/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Project Work Continues	■	■												
	Developing the Project		■	■	■	■	■								
	Testing						■								
	Preparing for Pre-SEDEX & Technical Report							■	■						
	Pre-SEDEX									■	■				
	Submission of Technical Paper										■				
	Submission of Dissertation (SoftBound)											■			
	Submission of Project Dissertation (HardBound)												■	■	
	VIVA Presentation														■

TABLE 3.7   Final Year Project 2 (FYP2) Gantt Charts

CHAPTER 4

RESULTS & DISCUSSION
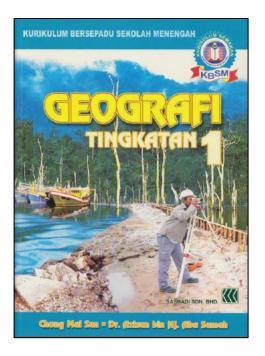
4.1 PROTOTYPE

The author has developed a prototype where the application has been installed on an Android device. The application will automatically controls the device's camera and when the camera is pointed on the target images from the textbooks, it will displays the animated 3-D model tailored based on specific target images.

Figure 4.1: Application on an Android device main menu

Figure above represents the location of the application named AR Geography Textbooks on an Android device main menu. The icon of the application is similar to the Form 1 Geography Textbooks front cover since the content of the application is basically based on the textbooks itself.
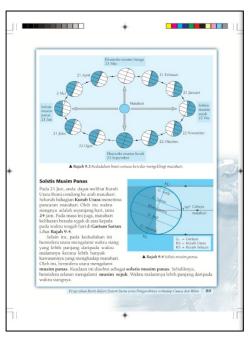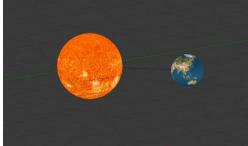
Figure 4.2: Form 1 Geography Textbooks Cover and Pages

Figure above shows the front cover as well as the pages inside the textbooks at which each designated pages contains information regarding geography learning knowledge. The figure inside the book will act as an image target for displaying Augmented Reality content.

When the user points the camera to the images target, 3D model with animation will pop up accordingly. Each images target have different 3D model that will represent different area of knowledge in Geography subject. Below are some pictures of the developed prototype:
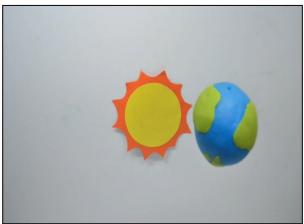
Figure 4.3: Earth rotation around the Sun

In the figure above, the Earth and Sun was modeled, textured and animate by using Blender software and then imported to Unity3D. The author has used a virtual button function as a method to get the user interaction based on the question displayed. If the user responded and click the 'YA' button, 3D animation will pop up portraying the earth rotation. Meanwhile, a full screen video of 21 seconds will be displayed if the user has clicked the 'TIDAK' button. The video basically explained on how the earth rotates in solar system.

4.2 USER TESTING

The author has done a user testing. User testing study are divided into two which user perception study as well as observation study which both involve high school students aged 13 years old. The current prototype was presented among 10 numbers of 13 years old high school students. The result helps to support the developed application for further improvement and alteration to the application.

Figure 4.4: High school students testing the application and trying to test the camera to see if it is in real time.

The user testing process started with the author explaining and demonstrated on how to use the application in front of the students. Based on the observation, as well as the videos recorded and taken during the testing of user's reactions and comments, all students seemed fascinated by augmented reality. Where a virtual object seems existent in real life and they tend to put their hand, towards the camera to check whether it is a trick or not, because many did not believe that it runs in real time. Generally, the students who tested the application liked it and would love to use such an application.

In addition, those who have tested the prototype application were surprised at first to see the 3-D models pop-up on the tab's screen over the book. Some of them praises it was a beautiful application as they were able to see 360 degrees of the 3-D objects, and some even mentioned that it's "magic".

(i) Others tried to hit the book where they thought the 3-D Model are there.

(ii) Sometimes user also tries to tap the screen waiting for interaction, but I explained that it would be one's focus on the next stage of development. However, by this incident it confirms the next step of making the application interactive.

(iii) Users were excited when the 3-D Models are pop up on the screen and begin to move (animate).

(iv) One of the users even argues with his peer so he could play with the app longer.

4.2.1 User Perception Survey

In the user perception survey, five questions asked to users. The survey involved 10 respondents. Each question is scaled from 1 to 5 at which 1 is the least agree and 5 is for the most agree.
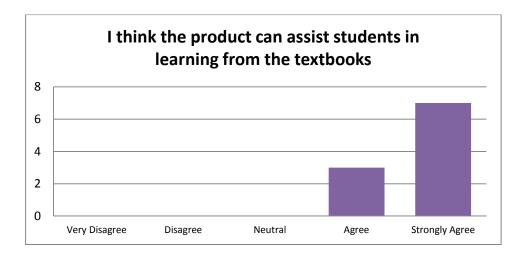
Figure above shows the graph conducted for the first question. The users were asked on their perception either the product can assist students in learning from the textbooks. Results have shown that majority 7 of the respondents rated with scale 5 and 3 parents/teachers rated scale 4. This shows that all of the respondents agree that the product can assist them.

I think the product are easy to be used.
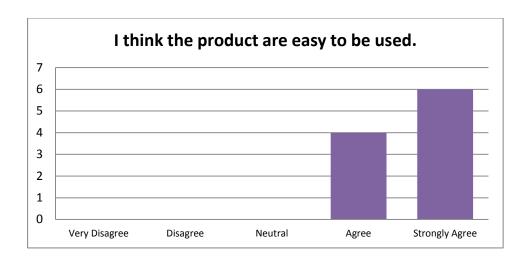
Figure above shows the graph on respondent's rate on the easiness to use the product. Results have shown that majority 6 of the respondents rated scale 5 while another 4 of them rated scale 4. This shows that most of the respondents agree that the product is easy to be used.

I think the product is fun and engaging.
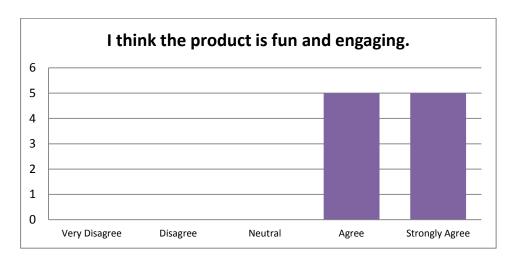
Figure above shows the graph on respondent's rate on either the product is fun and engaging. The graph shows that five of the respondents rate with scale five and the remaining rate with scale 4. The result shows that all of the respondents agree and most agree that the product is fun and engaging.

I think my friends would love this product.

	Very Disagree	Disagree	Neutral	Agree	Strongly Agree
Value				4	6
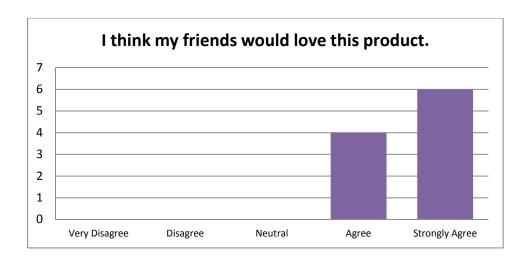
Figure above shows the graph on four questions asked which user's perception on either their friends would love to use this product too or not. The graph shows that majority 6 of the respondents rated with scale 5 which means they are most agree that their friends would love the product while the remaining 4 rated with scale 4.

I think I would purchase this product.

	Very Disagree	Disagree	Neutral	Agree	Strongly Agree
Value				4	6
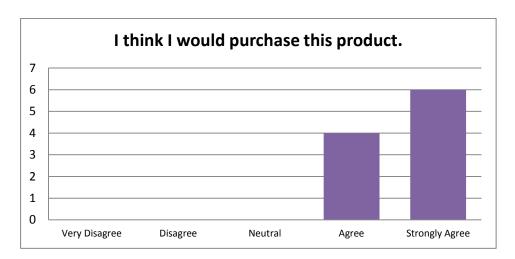
Figure above shows the graph on last question asked which are either the respondents would buy the product if the product available on market. The graph shows that majority 6 of the respondents rated scale 5, which is most likely that they would purchase the product, and the remaining 4-rated scale 4, which is likely to purchase.

Overall survey result, which based on the five questions, asked shown positive feedback from students as all of the questions were rated at scale 4 and 5. Some of the positive comments drops by them are:

I.   "Good Idea! I would love to use the product!"

II.   "Is it available in the market?"

III.   "It helps me learn from a textbook in a fun way."

IV.   "You should make it available at Google Play Store; I will download them."

CHAPTER 5

CONCLUSION

CONCLUSION

The scope of education especially in Malaysia has reached some new level where it has been broadened by the advancement in the field of Computer and Information Technology. Dede (2008) stated that educators will always found a way to develop new methods of teachings and learning as our information technologies transform from time to time. From traditional based learning environment, to electronic and mobile learning environment then upgrade to the new way of learning using the augmented reality technology. This statement has been supported by Dede (2008) that stated industry experts have predicted that the evolution of handheld devices which use AR technology to deliver content and experiences to the user will continue to escalate.

Furthermore, Augmented Reality also has already demonstrated the potential to bring improvement in several areas; and it specifically had a positive impact on education sector. According to Saenz (2010), the combination of AR simulation and training exercise, combined with tangible feedback interfaces such as the textbooks, has been shown to improve individuals' performance in learning something. In the other words, the author believed with augmented reality, learning session can be pretty interactive and immersive thus it may increase student's interest of learning both within class hour and at their home.

5.1 FUTURE EXPANSION

It is planned that in the near future the list below will hope to be accomplished:

    I.   Make a simple exercise games

    II.   Add more module and AR content

    III.   Publish in IOS

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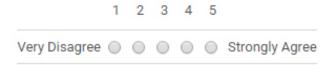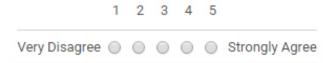| EXCLUDE QUOTES | OFF | EXCLUDE MATCHES | OFF |
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AR Geography Textbooks

Each question is scaled from 1 to 5 at which 1 is the least agree and 5 is for the most agree.

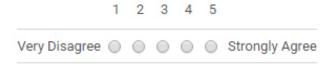### I think the product can assist me as a students in learning from the textbooks

1 2 3 4 5

Very Disagree ○ ○ ○ ○ ○ Strongly Agree

I think the product are easy to be used

1 2 3 4 5

Very Disagree ○ ○ ○ ○ ○ Strongly Agree

I think the product is fun and engaging

1 2 3 4 5

Very Disagree ○ ○ ○ ○ ○ Strongly Agree

I think my friends would love this product

1 2 3 4 5

Very Disagree ○ ○ ○ ○ ○ Strongly Agree

I think I would purchase this product

1 2 3 4 5

Very Disagree ○ ○ ○ ○ ○ Strongly Agree