"Augmented reality based application vs. Flash based application for ABC learning: A comparative study"

by

Nur Shafiqah Binti Zakariah

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information Communication Technology)

JANUARY 2011

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CERTIFICATION OF APPROVAL

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TRONOH, PERAK

January 2011

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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NUR SHAFIQAH BINTI ZAKARIAH

ABSTRACT

This project revolves around the studies of augmented reality (AR) and how it can be used to support children 6 years old and below to learn English alphabets more effectively. The aim for this project is to make a comparative study between Augmented Reality learning application and Flash learning application. The study is conducted throughout this project to know which methods provide more efficient ways of learning ABC for kindergarten children. Problems with studying in traditional way are identified in this project as well. Furthermore, a system that will use augmented reality technology is developed for this project (Learning ABC with AR). The methodology used in this system is prototyping. This report consists of five (5) major chapters including introduction, literature review, methodology, result and discussion and conclusion and recommendation.

ACKNOWLEDGEMENT

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CHAPTER 1

LEARNING ABC WITH AUGMENTED REALITY

1. INTRODUCTION

1.1. Background

Augmented Reality is a combination of a real scene viewed by the user and virtual scene generated by computer that augments the scene with additional information [1]. This technology has becoming popular as it does not require expensive tools; only a laptop webcam should suffice. Many companies like Wrigley's 5 and desktop magazine are already involving themselves in augmented reality advertisement to attract their customer into buying their products. Other industry such as education, medical, manufacturing, and military has already started putting on gears towards this technology.

For education, many parents choose to expose their children to an external medium; computer applications for their children to learn from. From web based to flash games application, more and more software is developed so that instead the children learning passively, now they can play in a more interactive environment and at the same time enriching the learning content in it. Currently, flash cards and Flash based multimedia application is one of the popular ways of teaching and learning alphabets. However, Augmented Reality is gaining wide attention from educators as an interactive engaging tool for learning.

For instance, isn't it great if a book is embedded with Augmented Reality Technology and the entire picture is viewed in third dimension form? Well, because of that, Learn ABC with Augmented Reality came into the picture. This project will be using augmented reality technology and 3D modeling concept which with using 3D modeling, it will stimulate the children interest to study English more effectively. Furthermore, between flash based learning application and augmented reality learning application, which one is more effective and efficient for kids to learn from? A comparative study is done to compare between both of them.

In addition for the comparison between these two subjects, the traditional way of teaching ABC to kids below 5 years old should be look into as well. Why people turn to online? Is there any defection in current way of teaching? Those are probably the questions need to be answered at the end of the project.

1.2. Problem Statement

For kids below 4 and 5, they are beginners in learning English alphabets. They like to learn things in an endless fun environment. But in the traditional way of teaching, the teachers interact with the students using their body language and talking in front of the classroom. This method is just a one way interaction thus making the English learning seems static and lack of fun. The learning will be focusing more on the input rather than the output. That is why parent's resorts to other medium, the existing ICT based applications which are Flash and multimedia based application.

Another problem is, when a group of student is assigned on a computer project and they are sharing one computer, their works on problem solving is more productive than one students working on the computer project alone. This is because, when doing things alone, there is less interaction and the learning is passive which lead to boredom and loss of interest.

The world now is changing. Instead of learning in class, there are now so-called "distance learning". Distance learning happens when students no longer need to be in an actual class but they can study online; in their own home. People turn online because they think it would be more convenient like mothers who works from

home can teach their kids at home instead of sending their kids to some institution or a day care which will cost them more than buying a courseware or access it online. [2]

1.3. Objectives

The aim for this project is to make a comparative study between Augmented Reality learning application and Flash learning application. The aim also includes creating a book and application that embedded augmented reality technology which can support children to learn English alphabets more interactive and fun by providing different kinds of learning stimulation through the application of new media to make children like to learn English more. The pictures in this application are designed in third dimension (3D) to increase the interest of students thus makes the learning becomes almost effortless when something fascinates students and reflects their interests and goals.

To achieve the aim stated above, the following objective is formulated for the project:-

1) To develop Augmented Reality based learning ABC application.
2) To conduct a usability studies towards Augmented Reality based application.
3) To conduct a comparative studies Augmented Reality based application with existing Flash based application for learning ABC.

1.4. Scope

This project will be focusing on education for the target group below 7 years old (basically kids in the kindergarten) by using Augmented Reality for interactivity. The human computer interaction (HCI) of the system also plays a prominent role to keep the kids to pay attention at the correct place as well as to make it attractive to the eye of the user. The graphics used in this system is 3D modeling where all the example of the alphabets (A for Apple; the Apple) is designed in 3D.

CHAPTER 2

2. LITERATURE REVIEW AND/OR THEORY

2.1. Theory of Augmented Reality

What is Augmented Reality in laymen term? Well, according to Ronald Azuma [3], augmented reality is an environment that includes both virtual reality and real world elements. For example, when an AR user used translucent goggles; the user could see the real world as well as computer generated images through it.

In short, an AR environment:
- Combines real and virtual environments,
- Is interactive in real-time,
- Is registered in four dimensions (three dimensional space and time),
- The virtual objects can be stationary or be manipulated,
- There is interactivity between the object and the real world,
- Abstract concepts can be made visible, understanding is enhanced.

Paul Milgram and Fumio Kishino defined **Milgram's Reality-Virtuality Continuum** in 1994 where it extends between the real environment and virtual environment with augmented reality and augmented virtuality in between. [4]

```
┌─────────────── Mixed Reality (MR) ───────────────┐
│                                                   │
├───────────────────────────────────────────────────┤

    Real ──▶ Augmented           Augmented  ◀── Virtual
 Environment  Reality (AR)        Virtuality (AV)  Environment
```
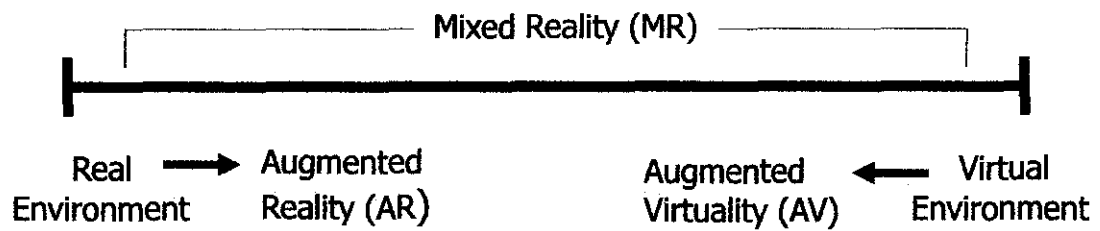
Miligram coined the term "Augmented Virtuality" to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects.

In Augmented Reality, the user is allowed to maintain a sense presence in real world, contrary with Virtual reality where it is completely replaced the real world into virtual. AR augments the real world with some 3D animations or graphics and combines it which makes the user feel that it actually exist in the same place. A mechanism is needed in order to combine the virtual and real worlds together.

2.2.Technology

2.2.1. Hardware

The main hardware components needed for augmented reality are input devices, display, tracking, and computer:

- Input devices :

Input devices can be in various techniques. For instance, a smart phone itself could be used as 3D pointing device, with 3D position of the phone restored from the camera images. Some employ pinch glove techniques. Another common technique is a wand with a button on it. [5]

Figure 2.1: One example of AR gloves

- Display:
  - **Head/Helmet-Mounted Display (HMD)** is a display device that is similar like binocular which we can see though two or one optic hole (monocular). This device is wear like a helmet or on top of the head.

Figure 2.2: A Binocular Head-Mounted Display (HMD)

This hardware works by placing images of both the physical world and registered virtual graphical objects over the user's view of the world. A typical HMD has either one or two small displays with lenses that are either optical see-through or video see-through in nature. Half-silver mirror technologies are used by optical see-through display to allow views of physical world to pass through the lens and graphical overlay information to be reflected into the user's eyes. The HMD must be tracked with a six degree of freedom sensor. This tracking allows for the computing system to register the virtual information to the physical

world. HMD are used in various applications. Ranging from military uses, governmental (fire, police, etc.) to civilian/commercial (medicine, video gaming, sports, etc.)[5]

- **Handheld Display** is any small computing device with a display that fits in a user's hand for example an IPhone. People are keen to use handheld display because of it is portable and ubiquitous nature of camera phones. All handheld AR solutions to date have employed video see-through techniques to overlay the graphical information to the physical world. Initially handheld AR employed sensors such as digital compasses and GPS units for its six degree of freedom tracking sensors. This moved onto the use of fiducial marker systems such as the ARToolKit for tracking. [5]

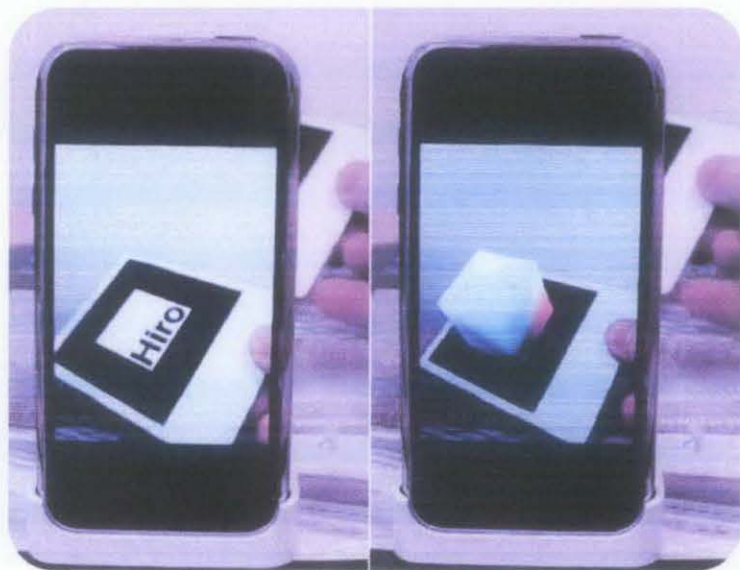

Figure 2.3: AR using IPhone.

- **Spatial Display** makes use of digital projectors to display graphical information onto physical objects. This make SAR has several advantages over traditional head mounted displays and handheld devices which the user now is not required carrying equipment or wearing the display over their eyes. SAR is a good for collaborative

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work, as the users can see each other's faces and can be used by multiple people at the same time without each having to wear a head mounted display.. The tangible nature of SAR makes this an ideal technology to support design, as SAR supports both a graphical visualization and passive haptic sensation for the end users. People are able to touch physical objects, and it is this process that provides the passive haptic sensation.[5]

Figure 2.4: Samsung 6 panel spatial display
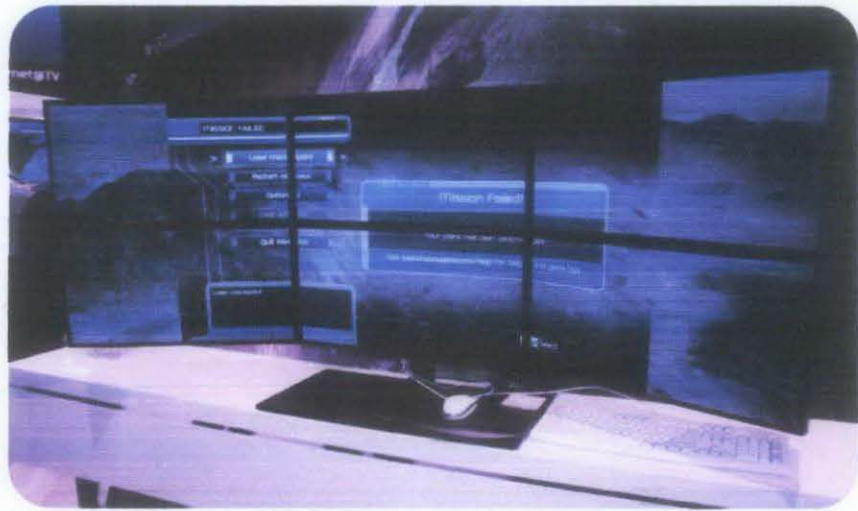
- **Computer**

To process camera images, a powerful CPU and considerable amount of RAM is required. [5]

- **Tracking**

Tracking devices that are used for today's AR technology are digital camera and/or optical sensors, accelerometers, GPS, gyroscopes, solid state compasses, RFID, wireless sensors. Each device will provide different results of accuracy and precision. [5]

2.2.2. Software

There is several open source software that can be used for application development for Augmented Reality. Application development environment is needed to embed and combined 3D modeling. In the codes, the marker and pattern are coded to compare for matching purposes between which 3D models.

- **Development tool**

  - **ARToolKit**

ARToolKit is a software library for building Augmented Reality (AR) applications. These are applications that involve the overlay of virtual imagery on the real world. This software allows virtual imagery to be superimposed over live video of the real world. [6] To make it all happen, a marker with a certain pattern is used. Figure 2.4 below is an example of a marker to be used in augmented reality.

Figure 2.5: Example of a marker.

There are some difficulties to develop this application. One of it is that it has a problem to track the user's viewpoint. For virtual images to appear, the application needs to know from where the user sees from the real world. [6]

- **MXR Toolkit**

MXRToolkit is the other software that can be used to help with all aspects of building mixed reality applications. It is an open source now and was made in Singapore. An understanding of C++ syntax is not required as all of the code is called using c style function calls and c style structures. A detailed user guide of more than 100 pages is available for user that wishes to use MXRToolkit. [7]

Two major types of users are anticipated:

- o Users who are primarily concerned with developing mixed reality applications
- o Users who are primarily concerned with developing new low-level tracking solutions using computer vision techniques.

- **Flartoolkit**

What is Flartoolkit? Flartoolkit is AS3 ported version of ARToolKit. It is actually based on NyARToolkit, Java ported version of ARToolKit. It uses the same technique for input identification as it recognizes the marker from input image. Once the marker is found, the software calculates its orientation and position in 3D world. [8]

- **SLARToolKit**

SLARToolKit comes from the word Silverlight Augmented Reality. It is based on the established NyARToolKit and ARToolKit. This toolkit has a flexible Augmented Reality library for Silverlight. Its aim is to make easy and fast real time applications as good as possible. In Silverlight 4, a webcam API was installed and it can be used in SLARToolKit or SLARToolKit can also user any other CaptureSource or WriteableBitmap. [20]

2.2.3. 3D Modeling tool

In Augmented Reality, the output images are mostly in 3D forms. Below are examples of software that can be used creating 3D modeling.

- **Autodesk 3Ds Max**

Autodesk 3Ds Max, formerly 3D Studio MAX, is a modeling, animation and rendering package developed by Autodesk Media and Entertainment. It has the capability to integrate 3D modeling, animation, rendering, and compositing that enable artists and designers to more quickly ramp up for production. This software is able to be used in the Microsoft Windows platform. The second version, Autodesk 3Ds Max Design enable the software to offer differentiated experiences and specialized toolsets for game developers, visual effects artists, and graphic designers on the one hand, and architects, designers, engineers, and visualization specialists on the other.[9]

- **3DLive**

3DLive is a lightweight application introducing a breakthrough 3D paradigm for on-line collaborative intelligence. This product enables collaborators in a global enterprise to use 3D as the universal language for creating innovative products that can be launched more quickly to the market. Leveraging the best digital technology in the market today, companies are now able to effectively harness the collective intelligence from their stakeholders while resolving product and manufacturing issues early in the development cycle when the change cost is low and the potential to innovate is high. [10]

2.2.4. Virtual Reality Modeling Language

Virtual Reality Modeling Language or in short terms VRML (pronounced as vermal or by its initials, originally before 1995 it is known as Virtual Reality Markup Language), is a language that allows one to create a "virtual world" networked via the Internet and hyperlinked with the World Wide Web. [21] VRML is a standard file format for representing 3- dimensional (3D) interactive vector graphics. The filename extension is .wrl for a plain file and .wrz when the file is compressed. Previous VRML is version 1.0 and in 1997, a second version VRML07 or also known as VRML2 or VRML has become an ISO standard. It has been superseded by X3D [22].

2.2.5. AR Application

The AR applications can be divided into two categories:

a) Marker based / Image recognition

A camera is being used to recognize a marker or an image in a real world. Its position and orientation is then calculated to augment the reality. In other words, they overlay the marker / image with some content or information. [19]. Figure 2.5 and 2.6 shows an AR application that uses marker and Figure 2.7 and 2.8 shows how an image marker is used.[24]

• Marker based AR application demo

Figure 2.6: A man is showing a marker to computer monitor.

Figure 2.7: A 3D model is overlaying the marker.
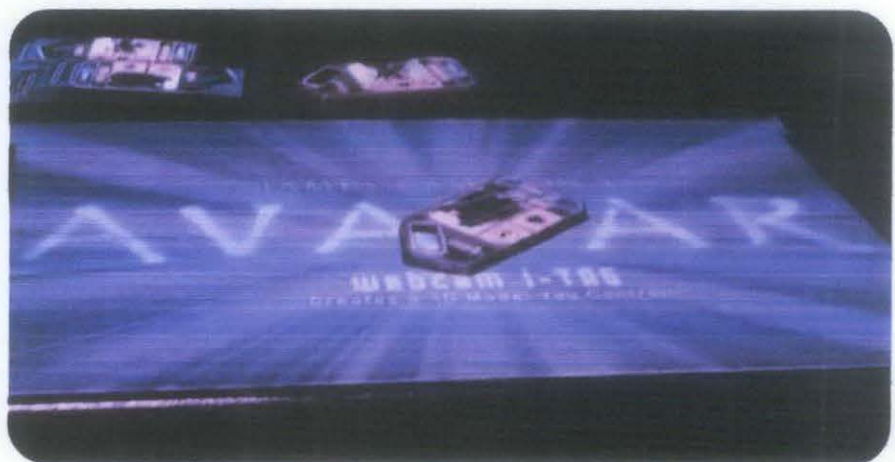
- Image based AR application demo

Figure 2.8: An image marker is shown to a webcam.

Figure 2.9: A robot model is overlaying the image marker.

b)   GPS based

Nowadays, mobile phones have a Global Positioning System [GPS] tools embedded in it. These applications take advantages of these tools by using the position/location of your phone to find landmarks and any other point of interests [POI]. Once the POI or landmark is detected, the user can get additional information about location they are at or get directions to reach there. These applications can help learners to get real time learning by using their mobile phones about various places for example like a tourist attraction location. [24]

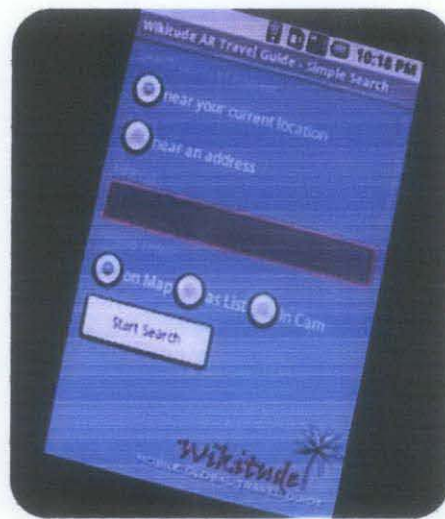Figure 2.10: Information about the location is revealed.

Figure 2.11: A search is conducted to detect the location using GPS.

2.3. Application

As time goes, people have already getting interested in the world of augmented reality. Being able to integrate virtual scene in a real world is really fascinating indeed especially if it can benefits the human kind in various ways. In recent years, many kinds of application in different fields are made up using Augmented Reality.

2.3.1. Medical

For a doctor to be skilled in surgery, they need to gain experience by operating patients because the medic's students only know the patients based on theory, CAT scan, MRI scan, X-ray, corpses and with any technology that can portray image whatever inside a human body . For this, AR can help by providing visualization in 3D (Figure 2.5) for training purposes for them to see the internal view of a human body.

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Figure 2.12: The internal view of an ankle

Some researchers at University of Carolina are developing a system that allows a physician to see directly inside a patient using AR (Figure 2.6).[11] This system uses ultrasound echo-graph imaging, laparoscopic range imaging, video see-through head-mounted displays (HMDs), and high-performance graphics computers to create live images that combine computer-generated graphics with live video images of a patient. This system could be used to assist and to guide physicians during various types of ultrasound-guided and laparoscopic procedures.

Figure 2.13: A tracked needle (green line) is used to target a small lesion within the abdomen.

2.3.2. Advertising

Nowadays, lots of companies are using augmented reality as their ways to advertise their products. Instead commercialize it in TV, consumer can now just sit at home and see the products marketed straight to their home through internet. Company such as Tissot (a watch's company) makes the consumer actively play around with new technology which the customer can experience the Tissot Touch collection right on the customer's own wrist as you can see in Figure 2.7. [12]

Figure 2.14: A customer testing out Tissot watch collection.

As much as what Tissot company is doing; have their customer experience whichever products they have, other company adopt the same strategy too, for example products like cars where people customize the design and choose whatever color they want and they can decide whether they like or not. This gives so much freedom to the customer. Moreover, now, they don't have to go to the actual store to experience the products.

2.3.3. Education

When talking about education, there are very broad perspectives to it. From Sociology, Psychology, to Economics, there are many types of knowledge that people can educate from. In Wikipedia, Education is defined as "any act or experience that has a formative effect on the mind, character or physical ability of an individual." [13]

In Education system today, the formal one that people are obligated to attend to are preschool, primary school, secondary school. For Higher Education (university), students can choose whether to start working or further their study.

- **Traditional way**

Education in the traditional way is more focused to master contents rather than increases students' skill development and nurturing their inquiring attitudes. The current system of education is more of teacher oriented where the teacher is centered and are more focused on giving information about "what is known" and not with "this is what you should know". On the receiving end, the students will just received whatever material is given and does not need to inquire any more information.

Today way of learning is more of exam based where all the students thinks is to get straight A's as the assessment of the learner is focused on the importance of "one right answer." Traditional education is more concerned with preparation for the next grade level and in-school success than with helping a student learn to learn throughout life. They just don't know what is more important anymore. All they care is get good grades, enter good collages and has a pretty decent job after they graduated.

A traditional classroom focuses on learning about things and tends to be closed systems as the use of resources is limited to what is available in the

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classroom or within the school. The use of technology is more focused on learning about the technology rather than its application to enhanced learning. Moreover, lesson plans are used to organize the various steps in the learning process for the whole-class approach and not on one person basis because if there any questions that would tend to cause deviations from the plan are met with, the teacher will said "We will get to that later."

2.3.4. Learn ABC

- **Kindergarten approach**

Kindergarten are said to be a natural scientist. This is because the children devote much of their energy to learn all aspects of their own culture for example language, stories, music and many more. That is why most of the parents and teachers expected children to see that spontaneous playing because as they are playing, the children investigate things with all their senses. Their skill emerges when they speak is correct with what they mean, when certain behaviors are appropriate and when they should refrain from certain behaviors, where things come from and what they are for etc. [14]

Appropriate curriculum and teaching methods for teaching kindergarten feature the importance of children's feelings, behavior and emotions in classroom and other group settings. "Lessons can be games", and in fact, many lessons can be games when teaching kindergarten. The curriculum invites children to explore their world in multiple ways. [16]

Sensory stimulation is rich and triggers investigations into themes and topics. They are a few learning style which tells us that children can learn in so many ways. For instance a visual learner's watch closely when the teacher demonstrates an activity and they tend to draw and play with shapes and puzzles. Auditory learners understand ideas and concepts because they remember

information they have heard, follow spoken directions well and remember songs easily. Curiosity and interest set the tone for questions and discoveries. Children and teachers reflect on the meaning of each activity and explore the underlying phenomenon together; in doing so, each child makes the experience and learning personal. [15]

- **Multimedia / Flash Application**

Some developer created flash application for inquiry based learning where the students themselves learn and the teacher being the facilitator. One of the learning applications for kids using flash is 1up apps where the author and a group of friends created this application for a software engineering project. Figure below show a blackboard full of alphabets. When a child clicks on one of the alphabets, for example an A, the alphabet A and their associate symbol or picture will animate and a voice saying "A for Apple" can be heard.
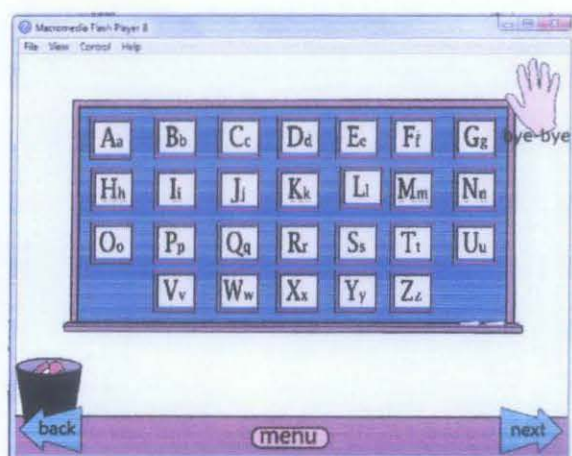

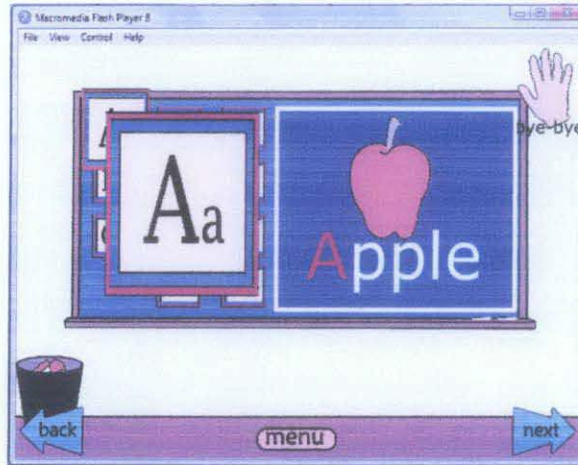Figure 2.15: Interface of learn ABC of flash Apps

Figure 2.16: When a user click on a letter

- **Augmented Reality**

In a standard classroom, when student in a group are given work that involves using computer, they go to a separate computer and even though they are side by side, they do not perform as well as they are sharing one computer. This is because when using one computer they discuss together the answer to the problem. This scenario points that there exist seamless interaction between each other. However, with Augmented Reality, people can learn a lot better as it provide active interaction between the user and the subject.

Just like theMagicBook by BillingHurst[17] (Figure 2.17), the younger children can turn their fantasy into reality by using a normal book as the main interface object. They can turn the pages, read aloud and see 3D images in the book. This makes story telling a lot more fun than before.

Figure 2.17: Reading an AR book.

AR also is useful for science students who are taking biology to study the human body parts (Figure 2.18). For example it can help them to memorize the scientific name of the bones and also their purposes.

Figure 2.18: Example of how students can study from AR applications.

CHAPTER 3

3. METHODOLOGY/PROJECT WORK

3.1. Structured Design

3.1.1. Prototyping

A prototyping methodology is a software development process which allows developers to create portions of the solution to demonstrate functionality and make needed refinements before developing the final solution. For this project, I think it is best to use prototyping-based methodology. This is because a prototyping performs the analysis, design and implementation phases concurrently, and all the three phases are performed repeatedly in a cycle until the system is completed.

The reason why I used this development cycle is because it can quickly provides a system that can be interacted with and if there is something with the system, I can always go back to analysis stage to analyze the coding or if there is a problem with 3D modeling, I can do a new design for it. It is said that this methodology is especially good for designing good human-computer interfaces. [18]

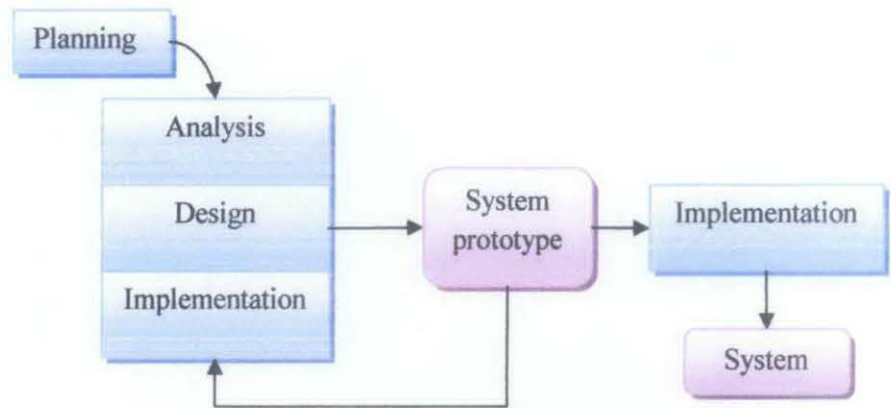Figure 3.1 below shows the cycle of a prototyping-based methodology.

Figure 3.1: A Prototyping-based Methodology

3.2. Planning phase

During the planning phase, in order to complete this project, firstly I need to study the theory of Augmented Reality and the technical parts of the software that I will use for developing the system. Apart from this, I have to make researches regarding topics that revolve around augmented reality and find journals or articles which other researcher have build similar system during the past years. Since my scope is education for children below 5, I have to find more detail regarding my subject.

3.3. Feasibility Analysis

3.3.1. Technical Feasibility

- Familiarity with Application:

As just a user, it is very easy to use the application. Just using a marker and point it on the camera, a 3D object will come up. As simple as that! But, as a developer, the difficulty level skyrocket but even that it is so, with the online tutorial and documentation available online, I think it is possible to be familiar with the application.

- Familiarity with Technology:

For the hardware part, a webcam should suffice to run the application. For the software part, deep understanding with development tool (ARToolKit, Flartoolkit or MXRtoolkit) and 3D modeling is needed.

- Project Size:

Time allocated for this project is 12 months (1 year) which has been divided into 2 major sections; first half for documentation preparation and second half for application development. Even though I will develop this project alone, but with enough duration (1 year), I confident that I will achieve the objective at the end of this project and deliver the application.

- Compatibility:

This application highly depended whether the user has a camera available with flash plug-in. Flash player system requirement: Windows 2000 and later with Intel® Pentium® II 450MHz, AMD Athlon® 600MHz or faster processor (or equivalent).

3.3.2. Economic Feasibility

For developing the software, no cost is inflicted because the development tools itself is open source. As for the operating costs, because this is an individual final year project, there is no need to pay wages to somebody else.

3.3.3. Project Management

3.3.3.1. Gantt Chart

Figure 3.2 below is a Gantt chart that shows the duration for planning, analysis, design, implementation and delivery phase.
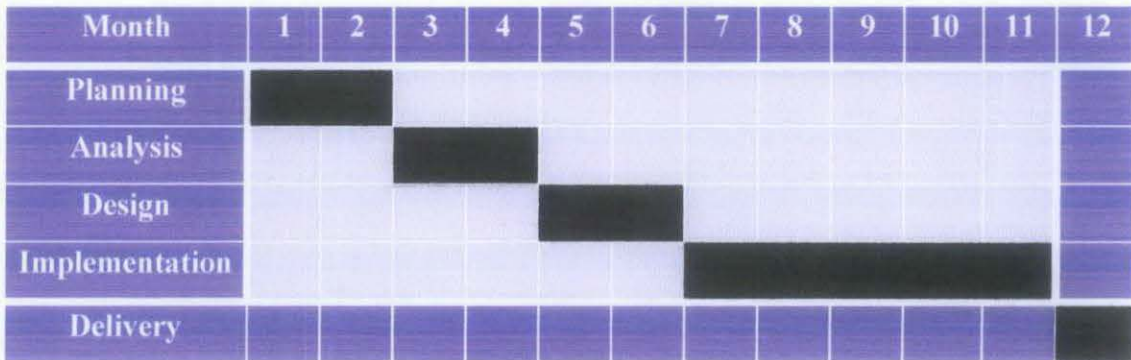
Month	1	2	3	4	5	6	7	8	9	10	11	12
Planning	■	■										
Analysis			■	■								
Design					■	■						
Implementation							■	■	■	■	■	
Delivery												■

Figure 3.2: Gantt chart

3.4. Design Stage

3.4.1. The Basic Concept

This book will have a total of 28 pages including the cover page. In each page, the letter of an alphabet will be in a huge font. A picture that signifies the letter will be placed along with associated words underneath the picture. Beside the letter and picture, a huge marker will be put in order for the user to play around with Augmented Reality. Figure 3.3 below shows the example of interface of a page.
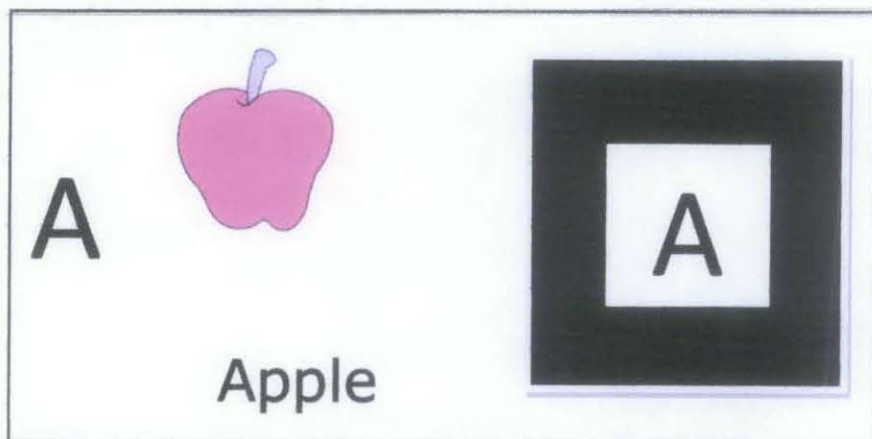
Figure 3.3: Example interface of a page

Table below is an overview of what picture, words and 3D graphics to be included in each page.

Alphabet	Picture	Picture Associated	AR 3D modeling
A		Apple	Alligator
B		Boy	Bag
C		Car	Candy
D		Duck	Dolphin
E		Elephant	Earth
F		Flower	Frog

G		Guitar	Giraffe
H		Hat	Horse
I		Ice – Cream	Igloo
J		Jug	Jaguar
K		Key	Kangaroo
L		Lamp	Lion
M		Mom	Monkey
N		Newspaper	Net
O		Orange	Ostrich

P		Pencil	Penguin
Q		Queen	Quail
R		Rabbit	Ring
S		Sun	Seal
T		Train	Tiger
U		Umbrella	Ultra man
V		Vase	Van

W		Women	Whale
X		X-ray	Xylophone
Y		Yoyo	Yak
Z		Zebra	Zoo

Table 1: Lists of A until Z objects.

3.4.2. Flow diagram of user interaction.

First thing first, the user has to make sure that they adopt the basic requirement to play Augmented Reality on their computer. See 3.3.1 for the compatibility for software requirement. As for hardware, the user only requires to have a webcam or any USB camera installed in their computer (desktop or laptop) with flash plug-in. A handheld display for example IPhone that has AR system installed can also be used. If the user complies with all of the

requirements, now, they can adopt actions stated in the flowchart to interact with Augmented Reality.

Figure 3.4: Flowchart of interacting with Augmented Reality book.

3.5. Testing phase

3.5.1. System Usability Scale

The System Usability Scale or SUS is a subjective assessment of usability which using a simple, ten-item attitude Likert scale. It was developed by John Brooke [19] at Digital Equipment Corporation in the UK in 1986 as a tool to be used in usability engineering of electronic office systems.

As defined by the ISO standard ISO 9241 Part 11, the usability of the system can be measured only by taking into account the context of use of the system :-

- Who is using the system,

- What they are using it for,

- The environment in which they are using it.

Moreover, measurements of usability have several different aspects which are effectiveness (can users successfully achieve their objectives), efficiency (how much effort and resource is expended in achieving those objectives) and satisfaction (was the experience satisfactory).

In general, SUS has been seen as providing a high-level subjective view of usability and is thus often used in carrying out comparisons of usability between systems. SUS can be used to compare even systems that are outwardly dissimilar because it yields a single score on a scale of 0-100. This one-dimensional aspect of the SUS is both a benefit and a drawback, because the questionnaire is necessarily quite general. [19]. Please look at appendix for example of SUS.

3.5.2. Video Method Observation

Video method Observation is a formal observation technique. Often with these methods, a time-sampling is used where the observer will record the behavior of the user at random time. For a more accurate approach, a video camera is used. To make it a non distraction to be observation (children will definitely thrilled to see a video camera), it is placed where the user cannot see and are set to record for a fixed time. The rarer the activity to be counted, the longer the recording should go for - but many small video cameras can record for less than an hour. The observation will be tested according to the how much the user pays attention to the software. [23]

3.5.3. Preference Test

Basically a preference test is conducted to test the participant to choose what software they more prefer. For example, is it Software A or Software B? The participants have the freedom to choose whichever as this test is more opinionated for the user. After they done choosing, they should give some reason on why they choose the preferred software and why they dislike the latter.

CHAPTER 4

4. RESULTS AND DISCUSSION

4.1. First Prototype

A book with a colorful cover page is design to attract the reader to read the book. The title with big fonts is drawn on the cover page with "Let's learn ABC with AR!" Figure 4.1 below shows the story board of the book.

Story Board:

Figure 4.1: Cover page of the book

At the back of the cover page, there is a CD that stores the whole application. With the help of the parents or teacher, the CD can be installed onto a desktop computer or a Laptop. After finish installing, the application is run and the

children can start learning! Figure 4.2 below show the interface inside of the book.

Figure 4.2: Interface inside of the book

As you can see, the huge letter of E defined the Elephant shown in the picture. These show that this book embodies two entities. One for book, two is AR technology. For AR technology, the E in the black box is what we called a marker. For this application to be able to work the book is shown to the camera and as long as the marker can be identified, the output will be shown like in Figure 4.3.

Figure 4.3: 3D output of E for Earth

4.2.Second Prototype

When designing the first prototype, I found some bugs and weaknesses in the system.

Weaknesses: -

- Consistency of 3D module and Marker
    o In first prototype, for easier recognition of the marker and its function, I design the marker that represent alphabet A, is A.
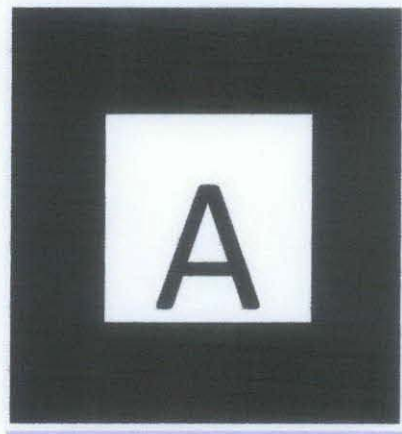
Figure 4.4: First prototype marker

But, because of some similarities in the structure of the alphabets for example L and I, the system has a hard time to determine either each of them.

- The realism of 3D module
    o For the first prototype, I design the 3D Module using VRML and 3Ds Max. The product that I produce is just a static but have a 3 dimension. So it is rather boring and passive. Please refer to Figure 4.4.
- Ways of handling the marker
    o In the first prototype, I've designed the marker to be on the right side of the book. But for it to be printed within the book, the children will

have to pick up the book and point it to the camera. Well, for a 3 to 6 year old children to do that, is a bit unrealistic because the book is very big and maybe a bit heavy for them to constantly pick up to show to the camera.

Enhancement:-

- Consistency of the 3D module and marker
    - o To maintain its easy recognition between the design and the function of the marker and to make the system more distinct in differentiating the markers, I took the liberty to customize it for a bit.
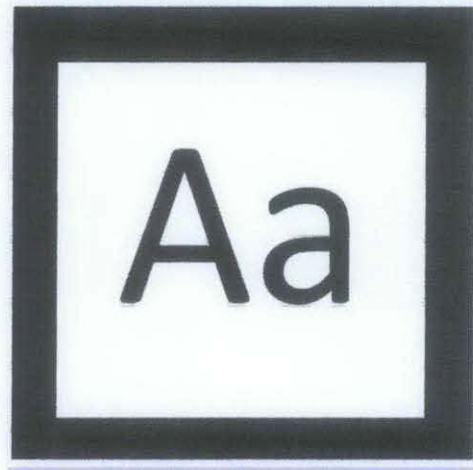

Figure 4.5: Second prototype marker

- The realism of 3D module

    Do some animation to the 3D module. For example, if it is B for ball, what you will see in the screen, the ball will bounce back and forth.

- Ways of handling the marker

    Instead of just print it with the book, I can separated it. The new idea that I have come up with is to make like a bookmark and the children can just pick up the bookmark and show it to the camera.
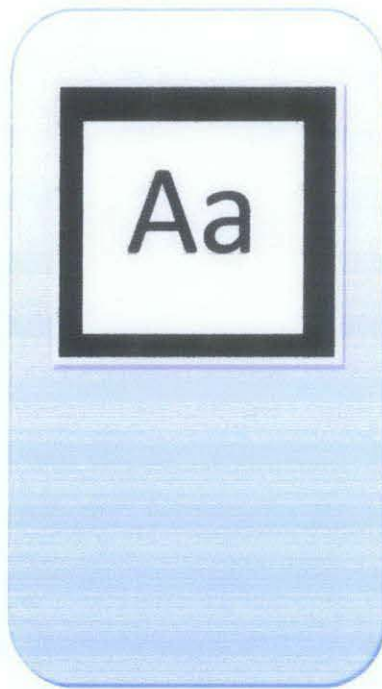
Figure 4.6: Marker on a bookmark

So, in the let's learn ABC with Augmented Reality book, there is a very big capital letter of an alphabet. Next to the letter, there is an image and words that associated with the letter. Next to it, there is a pocket with a bookmark that contains a marker on it. When the camera display appears, user can take out the bookmark and show it to the camera. When the marker is shown to the camera, an animated 3D model associated to the letter/marker will appear. The figure 4.7 and 4.8 below are the figures of the book cover and an interface inside of the book. In this figures, a 3D model associated with the alphabets can be seen floating beside the letter.

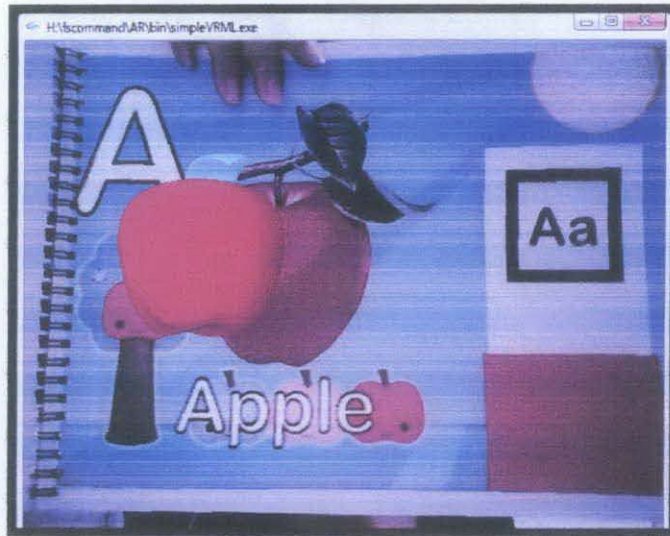Figure 4.7: Let's learn ABC with Augmented Reality cover book interface.

Figure 4.8: Let's learn ABC with Augmented Reality inside of the book interface.

4.3. Tools / Hardware

Tools that are needed for this project are:

- A webcam
- Monitor (to view from)
- Learn AR book which embedded with marker.
- A CD-Rom: to embed the program into the CD.

4.4. Software

- **Development tools**

For the development tools, I am using AIR marker generator to develop my own marker. I also use ARToolKit to match up all the premade 3D models and their marker. For example, an A marker will match with a 3D model of an Apple. All the 3D is designed using Virtual Reality Modeling Language or using 3Ds Max to animate it. The entire extension format is in .wrl. The figure 4.9 below shows how the technicality things that happen when the marker is shown in front of the camera.
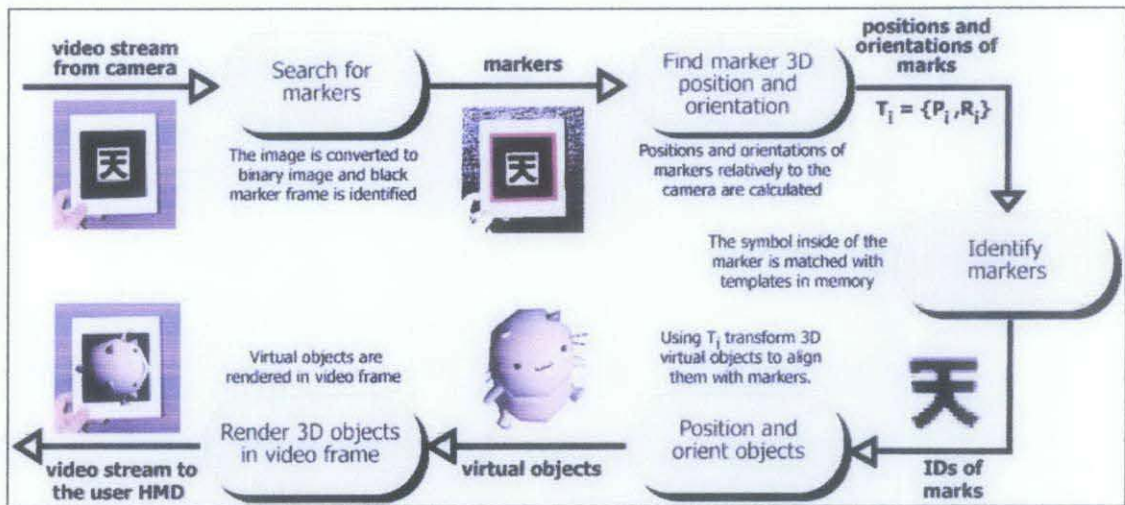
Figure 4.9: A technical flowchart on using Augmented Reality

4.5. Result and analysis

On 8th of April 2011, I went to a Kindergarten "Tadika Pasti Al- Jaa'miah" in Bandar Universiti Seri Iskandar to do a demonstration of the software as children 6 and below was the target group for this project. Figure 4.10 below is a picture of the kindergarten.

Figure 4.10: Tadika Pasti Al-Jaa'miah

In the kindergarten, there were a total of 33 students and 7 teachers. The students are divided into 6 year old and 5 year old student. Every student and teachers was given the chance to use both of the software: Flash based learning ABC application and Augmented Reality based learning ABC application. The testing conducted during this demonstration is video observation and after the demonstration are system usability scale and preference test.

4.5.1. System Usability Scale

For the SUS, the target participants are the teachers who will be the facilitator and target market for the system. What they were to do was to rate the Augmented Reality based learning ABC application. A total of 7 participants participated in SUS. In SUS, there is a 10 item questionnaire with 5 response options. Please look at appendix for example of SUS.

The SUS uses the following response format:

Strongly Disagree 1	2	3	4	Strongly Agree 5
O	O	O	O	O

Figure 4.11: Response format of SUS

Scoring SUS

- For odd items: subtract one from the user response.
- For even-numbered items: subtract the user responses from 5
- This scales all values from 0 to 4 (with four being the most positive response).
- Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.
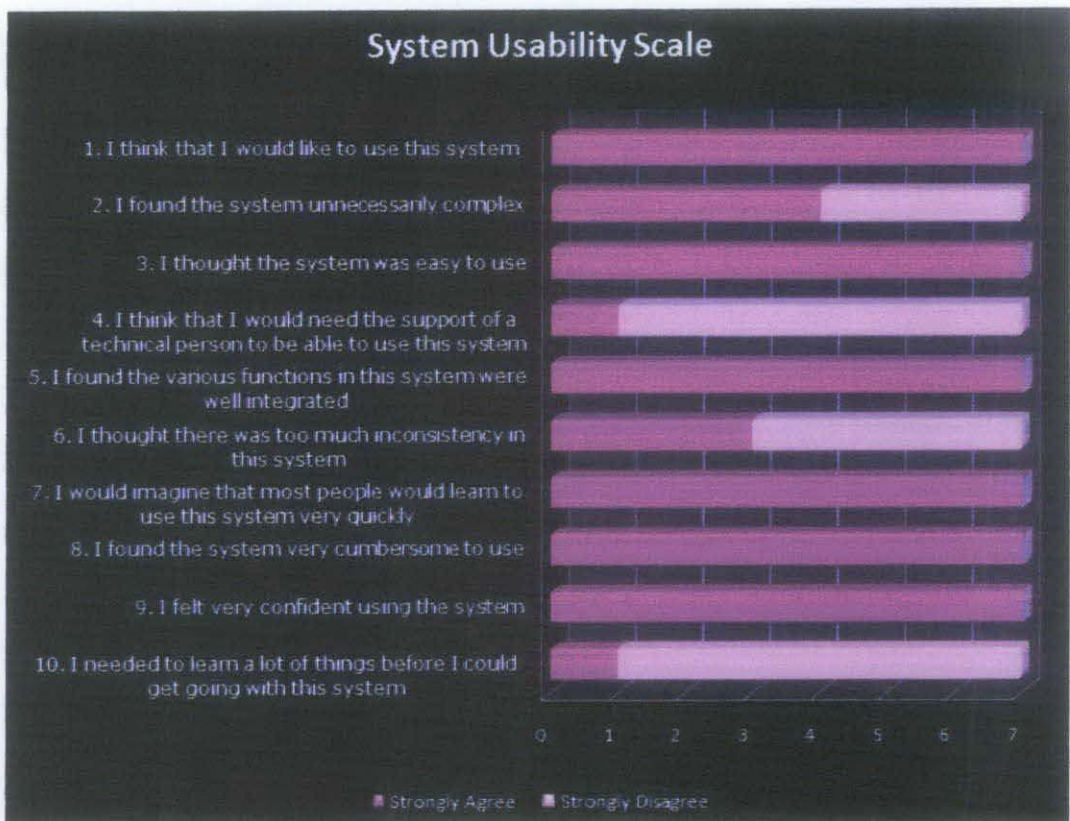
Figure 4.12 is the result of SUS.

Figure 4.12: Result of System Usability Scale

A good SUS score is to get the average of 68. The total score of SUS for Augmented Reality based learning ABC application is at 86th percentile. This indicates that this system has a good usability. This is also at the point where users are most likely to recommend the product to a friend. [25]

4.5.2. Video observation

During the testing, a video was recorded to see the response of the participants. The result of this testing is that, the participants are very excited and thrilled to use both software. For Flash based learning ABC application, the participants are very excited when they click on the alphabets, a voice associating with the alphabets can be heard. For AR based learning ABC application, the participants are very excited because they can see themselves in the camera. In addition to that, when they show a marker to the camera, an animated 3D appeared. This makes them to get excited even more. Figure 4.13 and Figure 4.14 are snapshots from the video observation for both systems.

Figure 4.13: A snapshot when participants using Flash based learning
ABC application.

Figure 4.14: A snapshot when participants using Augmented Reality
based learning ABC application.

4.5.3. Preference test

For the preference test, all students that participate in the testing were asked a
simple question. Did they like this system (Flash based learning ABC
application) or they like that system? (Augmented Reality based learning ABC
application). From 33 participants, a total of 9 participants picked this system
and a total of 24 participants picked that system. Among those 33, 5 random
participants were picked to give their opinion why they like the system. Figure
4.15 shows what the participants had to say for both systems.

Preference Test

Flash based Learning ABC Application	Augmented Reality Learning ABC Application
• This is easier. Just clicking the mouse will do. "Yang ni senang. tekan - tekan je da keluar"	• I like this one better. "Adik suka yang ini" • I like this but it'll be better if it have sound. " Adik suka yang ini tapi kan bagus kalau ade bunyi" • Because I can see myself in the camera! "Sebab adik boleh nampak muka adik depan kamera!" • Because it's look real! Sebab die nampak macam betul - betul "

Figure 4.15: Result of Preference Test

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CHAPTER 5

5. CONCLUSION AND RECOMMENDATION

5.1. Recommendation

After testing the Augmented Reality based learning ABC application, many feedbacks says that the system will be even more interactive if sounds were to be included into the system. As much it is very interesting to see, it will be much more interesting if the user can hear the sound of alphabets and the words associated with it are being pronounced as well. Furthermore, it will be even more interesting, if the animations of each 3D model to be longer and more complicated so that it can captivate the audience more. To enhance the system more, the rendering time for the video to load should be decrease.

5.2. Conclusion

Based on the result and discussion, this system has a good usability. Many participants prefer Augmented Reality based Learning ABC application because it is more interactive and interesting. All the objectives have been met and the result is just as expected. I hope in the future, there would be more advanced feature that can be included in the software and many more applications will be developed using Augmented Reality technology.

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APPENDICES

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5