

AR Book: Let's Recycle

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CERTIFICATION OF APPROVAL

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Approved by,

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UNIVERSITI TEKNOLOGI PETRONAS

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May 2015

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.

Anis Safiah Binti Mohd Shokor

ABSTRACT

Learning on how to recycle is to be considering as one of the basic knowledge that children should have. Plus, with rapid evolve of technology nowadays mobile applications and augmented reality are merged together that it could be used as one of learning tools for children age of 7 to 9 years old to learn recycling. This document outlines the introduction of the project, literature review study of recycling and augmented reality, methodology and project activities, result and discussion and conclusion of this project.

Various methods have been used to introduce the concept of recycling to young children which includes advertisements on different types of media such as television, billboard on highway, newspapers, seminar and talks. Despite these efforts, level of awareness among them is still considerably low. Thus, the habit of recycling, i.e. the transformation of awareness into action among them is almost virtually none. Children still do not know the correct way (how) and the purpose they need to recycle (why).

Moreover, interesting tools for the children to learn about recycling is very much lacking. Learning through practical experience is an effective approach to learning. Thus, the main objective of this project is to create awareness among children on the importance of recycling. Furthermore, it is also to evaluate the learning of recycling using an augmented reality and traditional storybook and to introduce the augmented reality to the children.

Additionally, this project aims to create recycling awareness through the development of an Augmented Reality (AR) book on Recycling. A mobile AR application and an AR book on recycling were developed using combination of a few different software and open source websites for the project. When both of the mobile application and AR book are used simultaneously, together they creates a fun and interactive environment for learning the concept of recycling which includes “practical experience” through games.

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1.0 CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Basic knowledge of recycling should be developed in children, because the knowledge that they have learned will be one of the basis in their daily lives. Learning how to recycling in kindergartens does not bring any damage or loss, though these could also create an environmental awareness of children as to less wasting and more saving practices. To keep the children interest high in learning of recycling, it is important to present the children with reasons and impact of recycling. Furthermore, nowadays there is a high possibility that in a hand of children holding their personal smartphone or tablet compared to book, as the children find that playing with mobile applications is more eye-catching compared to traditional book that came only with text, figures and colors without any animation or sound impact.

On the other hand, common medium that is used by teachers and parent world widely is book although there are variety of tools and methods available to teach children such as mobile applications, flash cards, legos and others. Nevertheless, one of the most effective learning tools is mobile application which comes in different genres such as games, health or e-book that some of it is made freely downloadable in the market. Plus, developers have made it possible to use mobile applications as one of the learning tools used by teachers, parents even between the children themselves.

In this project, to enhance the learning through the traditional book, an interactive augmented reality with mobile application is embedded together to become the end product. Fleck, Hachet, and Bastien (2015) mentioned that, the augmented reality allows user experiences that open promising opportunities in the educational domain. Thereby, the augmented reality is consider as one of the alternatives that can be applied to combine both virtual (3D object and animation) and reality (book) items to teach children on how to recycle. Other than that, Fleck et al. (2015) also mentioned that augmented reality is to be one of the upmost technology to reach beyond the traditional interaction with digital environment. Furthermore, augmented reality has the capability to produce animation and sound impact that which the traditional book cannot accomplish.

Therefore, the objectives of this project are to develop an interactive augmented reality book and mobile application to use it as a learning tool and entertainment, as well to increase the interest of the children to learn about recycling. In learning, the augmented reality is designed to enable users to interact with digital information embedded within the physical environment (Zimmerman et al., 2015). The end product of this project are augmented reality storybook with the concept of recycling and a mobile application that comes with animation and games to test the children understanding as well as to provide entertainment after they had used application. By completing this project, the end product shall be used by children age of 7 – 9 years old as one of the learning tools to learn about recycling.

The rest of this chapter will be organized as follows: the next section will put forward the brief description of mobile applications trends and usage by children, problem statement of this project, and that will be followed by objectives section comes along with scope of study of the project.

1.1.1 MOBILE APPLICATIONS TRENDS

As time goes by, more technologies and approaches arise to assist children in education learning, such as mobile applications. In the online market, there are countless amounts of mobile applications for the children to learn colors, numbers, shapes and even mathematical equations. However, the applications only last for few days to keep the children interest. From an observation, the children tend to have more interest towards animation, sound impact and moving things which they can interact with.

Other than that, children need to have reward as an encouragement in order for them to complete a task. From the observation, there are family members that need to offer the chance of playing mobile applications in return for the children to complete task or homework given by teacher. Plus, it is not a rare sight anymore that seeing a child at the age of four years old holding a smartphone to watch animations and videos. This is because; most of parents now are open-minded thinking which have given their children with personal smartphones.

Additionally, it is found that in order to feed two years old children a mother had used smartphones to play an animation. This is also an alternative used by many

other parents in order to keep their children from moving around in certain circumstances such as feeding, carrying on shoulders or to keep the children from crying.

1.1.2 USAGE OF MOBILE APPLICATIONS BY CHILDREN

Mostly children these days use mobile applications as a learning tool. There are many free applications available to download in Play Store for Android users and Apple Store for iOS users. The user has the option to download which application that attracts them the most.

By using mobile application, the children have the options to learn about general knowledge, daily basis and to hone their critical thinking. To make the mobile application more interesting, the developer have merge the mobile applications with the concept of common games that are available in virtual world such as crossword puzzle, quizzes, e-book, etc.

1.2 PROBLEM STATEMENT

Lack of awareness to teach children ways of recycling is one of the reasons that children does not know the correct way and the reason behind need of recycling. Although there are various methods used to introduce recycling such as advertising on television, newspaper or billboards beside highway, but not every child know how to interpret the information to an action. As mentioned by Fleck et al. (2015) learning is not an easy practice of transfer knowledge from a teacher or a technology to an individual. Therefore, the children are less prone to learning recycle. Plus, the children also have the difficulty to understand the correct way to recycle without practicing how to recycle. The problems mentioned earlier, will indirectly affect the children by giving a negative impact which causes the lack of environmental awareness.

In addition, children now showing more interest in certain things that may attract and able to keep them concentrate for a long time such as mobile application which it can produce sound and animation compared to a traditional book. Because of these, children tend to have high expectations to use a learning tool compared to book. Moreover, it is difficult to maintain the concentration of children when using traditional book that have only text and color images.

Therefore, this project investigate of teaching children using the mobile application embedded with an augmented reality and book as one of the alternatives to learn about recycling has been conducted. In addition, researchers have reported that design elements of augmented reality can enhance children's data collection as stated by Zimmerman et al. (2015)

1.3 OBJECTIVES

The main objective of the project is to develop an interactive augmented reality storybook and mobile application as an alternative learning tool for children to learn about recycling. Other than that, the project also aims:

- i. To create an awareness among children on the importance of recycling.
- ii. To evaluate learning of recycling through augmented reality.
- iii. To familiarize an augmented reality to children.

1.4 SCOPE OF STUDY

The aim of this project is to develop an end product of the combination of interactive augmented reality book and mobile application related to recycling. The games are used to test children understanding while giving the children an entertainment to keep them attract as mentioned before. The scope of the project comprises several areas that will be used along the development project's end product are as follows:

- i. Children learning and entertainment

As the foundation of children learning, it is important to convey accurate and precise information. Therefore, this project was conducted to

study methods, reasons and effects of recycling to ensure that the children are able to interpret the information easily. The project also aims to transfer the information and knowledge of the storybook and at the same time to provide entertainment to the children.

ii. Augmented Reality

Augmented reality has been developed for a very long time. Somehow in previous years, technologies are not very supportive that the augmented reality is less popular. However, due to the technologies booming era, augmented reality now has been updated and improved with new functionalities such as animation and 3D (3-Dimension) design. Zimmerman et al. (2015) mentioned that current development of mobile devices support augmented reality functionalities in everyday settings, by using photos, text and video into learning space without particular hardware. Prior to this, most of augmented reality has been used in commercials, sports and news. But nowadays, augmented reality also being implemented in navigation, virtual reality games and learning. Among the components in the augmented reality are as follow:

a. 3-D Design & Animation

Software such as Blender and Adobe Photoshop will be used to create all the modeling, rigging, animation and texturing for the character in the storybook. Meanwhile, Unity and Vuforia will be used to create the scene for each page of the storybook and the mobile application.

b. Smartphone user (Android platform)

Augmented reality these days has the capability to run at a low processor such as in smartphones compared to before, which usually run on computer. Because of the rapid development in technologies area, most of parents tend to provide their children with personal smartphones. Thus, it is no longer an awkward situation when seeing 3 years old children playing mobile applications. Zimmerman et al. (2015) mentioned that mobile

technologies were used to enhance data collection. Hence, this project proposed to use an augmented reality in smartphone application that allow children at the age of 7 – 9 years old to learn and at the same time to have fun. Android operating system is one of the operating that offered an open source to developer and thereby has made it the most common used operating system for smartphones. As mentioned before, end product of this project will enable the children to use the mobile application installed on their Android devices while enjoying exploring the interactive augmented reality book.

iii. Physical storybook

To design and create the 2D graphics interfaces and storyline of the storybook an open source website, StoryJumper is used to create storybook.

2.0 CHAPTER 2: LITERATURE REVIEW

2.1 RECYCLING

2.1.1 DEFINITION

According to (Abumama, 2008a); (Wigmore, 2012); ("Wikipedia," 2015), the definition of recycling is an activity which turning items or materials into something valuable to avert it from becoming waste. (Abumama, 2008a);("Wikipedia," 2015); mentioned that recycling also comes in various contexts such as by reducing the usage of fresh materials, energy level, air and water pollution and lesser the greenhouse gas emission. Thus, recycling may come in various definitions as mentioned before, however the definition of recycle can be summarized as to reuse materials or items before converting it into a waste.

Moreover, Abumama (2008a), has mentioned that in a modern waste management, recycling is one of the main items and is the third element in waste hierarchy “Reduce, Reuse and Recycle”.

2.1.2 IMPORTANCE

To reduce and able to produce new materials by using the waste materials that people used every day are reasons that lead to the importance of recycling (Abumama, 2008b). Plus, through recycling, people will able to reduce the amount of trash to dispose without having to send it to the dump sites, thus create a positive affect more than waste disposal. Abumama (2008b) has mentioned a few important reasons for people to recycle such as to saves energy, reduce greenhouse gas emissions, reduce water and air pollution, saves natural resources, creates jobs opportunity and to save spaces in landfill.

Recycling Saves Electricity

As mentioned by Abumama (2008b) sustaining electricity is one of the main concerns in Malaysia because of the increased and unpredictable usage of the electricity. It also mentioned that, to create a new product originally from waste materials always used lesser amount of electricity compared to creating new product from new materials.

Plus, (Abumama, 2008b), also provide a few examples such as, to produce new cans using recycled aluminum is only required up to 4% electricity compared to new aluminum which required more of 96% of electricity to manufacture it from its raw material, bauxite. Meanwhile, recycle plastic bottles uses 76% less electricity, paper uses 45% less electricity and glass uses 21% less electricity compared to make a new product.

Recycling Reduces Greenhouse Gas Emissions

Personal transportation, home energy, and other energy services in Malaysia has generates an average of 12,000 pounds of carbon dioxide each (Abumama, 2008b). To reduce greenhouse gas emission, people can start to recycle from small action which afterwards the action should be maintained and improved. ‘Even little

grains of sand, over time, will build a mighty mountain' represent the value of small amount of effort to recycle can be large if a lot of people start to recycle.

Recycling Reduces Air and Water Pollution

Recycling not only saves electricity and reduces greenhouse gas emissions; it also an effort which people can reduces air and water pollution. By recycling, it reduces the amount of air pollution produced by power plants and water pollution generated by chemical used in manufacturing process (Abumama, 2008b). It also adds a fact, whereby recycling 14 trees worth of paper, reduces air pollutants by 165,142 tons.

Recycling Saves Natural Resources

It is a general fact, that recycling paper can save trees and water. By making a ton of paper from recycled materials can saves up to 17 trees and uses 50% less water equivalent to 7000 gallons (Abumama, 2008b). Plus it also stated that, recycle also reduce the usage up to four pounds of bauxite when every pound of aluminum is recycle. Moreover, by increasing the action of recycling the needs for raw materials can be reduced thus rainforests that commonly use as the source for raw material can be preserved (Abumama, 2008b). Thus, the habitat destruction and global warning that caused by deforestation can be reduced.

2.1.3 HOW TO RECYCLE

Reduce; Reuse and Recycle are key factors on how to recycle. People commonly recall and used these three terms to recycle. In the next Table 1 shows the summary as stated from (Abumama, 2008b).

Table 1 Summary of Reduce, Reuse and Recycle




Reduce	Reuse	Recycle
<p>Waste management can be done by decide on which items to dispose of and reduce the amount of waste that is created daily.</p> <p>Know what to buy and how to manage it after used</p> <p>Reduction of waste begins by slightly making considerations of the shopping list can significantly lesser the amount of waste created in and around the home.</p> <p>Buy only what is necessary</p> <p>Avoid those meaningless purchases that are rarely being used thus it can reduce the unnecessary waste.</p> <p>Buy products that can be reused</p> <p>Items such as glass bottles and rechargeable</p>	<p>Not only reduce the amount of waste, reuse the items also an alternative to recycle. Reuse involves extra using of items when its primary uses are finished.</p> <p>Reusable Items</p> <p>Plastic bags and twist ties</p> <p>Usually shops or supermarket will provides plastic bags to use as carrier bags of purchased items. This items can be used to secure lose items together like paper bags that makes useful wrapping paper and twist ties such as the computer wires can be reused.</p> <p>Envelopes</p> <p>A used and old envelopes can be reuse again by paste labels over the address or using it as scrap paper to make notes.</p>	<p>Recycle enables people to saves resources and significantly contributing towards the environment.</p> <p>Domestic Recycling</p> <p>The first step to recycle is by knowing the method to recycle which is carefully thinking which products are recyclable when buying.</p> <p>Learn ways to recycle various materials</p> <p>Other than paper, metal, glass and furniture; building materials and vehicles also can be recycled.</p> <p>Buy products that are made from recycled materials.</p> <p>Checking the label on packaging and</p>

<p>batteries produce very little waste, as they do not have to be disposed even after they have been used once.</p> <p>Buy products with little packaging It is better to buy things in wholesale because less packaging will be used and less waste to recycle.</p> <p>Sell or give away unwanted items Donating items to others also can reduce waste. Plus, by donating to charity organization also an alternatives to help reducing waste also people.</p> <p>Think Before Throw Normally, things that are have been used up in daily lives are considered as rubbish after finished using it. However, instead of throwing it away, it is also can be used for other purposes.</p>	<p>Newspaper, cardboard and bubble wrap Mostly, people will use newspaper, cardboard and bubble wrap when moving house or to store items by wrapping or packing items.</p> <p>Old clothes Old Clothes can be made into cushion covers or teapot cosines.</p> <p>Scrap paper Misprint paper can be used to takes notes or sketches but do not forget to recycle after no longer need it.</p>	<p>buying an Eco-friendly items is also one of recycling methods.</p> <p>Avoid buying harmful materials. In recycle management, it is difficult to recycle products that comprises of hazardous chemical. Therefore, to ease the recycling process, a safer alternative is suggested by using non-toxic products.</p> <p>Prepare a recycle bins. Keep the recycle bin at an obvious and ease to reach places so that people can often use it.</p> <p>Plant trees Planting trees not only provides habitat for animals, it is also able to reduce global warming which can improve the surrounding environment.</p>
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2.1.4 RECYCLING AT MALAYSIA

Summary of Recycling Bins' Type cited from "Type of Recycling Bins" 2011).

Table 2 Type of Recycling Bins

Purpose: Paper	Purpose: Glass	Purpose: Plastic and tins.
		
Color: Blue	Color: Brown	Color: Orange
<p>Examples: newspaper, magazines, books, catalogue sheets, brochures, calendars, envelopes and cardboard boxes.</p>	<p>Examples: All colored and non-colored glass such as soft drink bottles, food containers, vitamin bottles, and cosmetic bottles.</p>	<p>Examples: All kinds of aluminum and steel tins such as soft drink tins and food product tins. All colored and non-colored tins such as shopping bags, bottle drinks, mineral water bottles, food containers, detergent bottles, and vitamin bottles.</p>
<p>Except: Tissue paper, carbon paper, baking sheets/aluminum, laminated paper, and dirty paper</p>	<p>Except: Crystal, mirrors, window glasses, vehicle screens, porcelain, ceramic, metal, lab items, and jars or toxic glass bottles</p>	<p>Except: Paint tins, toxic containers, lab items, and Styrofoam containers.</p>

Campaign at School Level

F&N Beverages and Majlis Bandaraya Shah Alam (MBSA) have collaborated once again for ninth edition of the 'Kempen Kitar Semula' for Shah Alam schools ("F&N Beverages Marketing Sdn Bhd," 2015). The objectives of the 'Kempen Kitar Semula' is to promote environment preservation through a competition with 4R viewpoint; Reduce, Reuse, Recycle and Rethink. The campaign will be going on for five month which supported by Department of Education Malaysia from 1st April until 31st August 2015.

Moreover, "F&N Beverages Marketing Sdn Bhd" 2015) also stated that primary and secondary schools and kindergartens will be joining the campaign monitored by MBSA. A challenge is given to the participants which require them to collect the largest amount of recyclable materials. At the end of the campaign, rewards will be given to participants with the most amounts of recyclable materials ("F&N Beverages Marketing Sdn Bhd," 2015).

Campaign at Community Level

Other than that, with the objective to encourage further reduction of plastic bag usage across the city, a 'No Plastic Bag Day' campaign initiative was initiated in Selangor on 2nd January 2010 and onwards (Tan, 2010). The campaign starts to implement every Saturday starting on January 2010. As mentioned by Tan (2010), to ease the customers, it is recommended that the customers bring their own shopping bags. However, the customer will be charged 10 cents to 20 cents each plastic bag if they insist to use plastic that is available at the store.

2.2 AUGMENTED REALITY

2.2.1 INTRODUCTION

Augmented reality is a result of rapid development in information technology area. The concept of augmented reality is available in various models and versions after many researches have been done in order to develop and make an improvement of the augmented reality itself. The augmented reality has been applied to different applications areas to help people to improve such as in education, daily life, working areas even in entertainment. Therefore, the augmented reality has been applied in such different ways such as books, smartphones' applications, marketing, architectural, games or the combination of both book and smartphones' application. Even though augmented reality has been widely used, the study and researches is still ongoing to improve and increase the use of it in different application areas.

2.2.2 CONCEPT

Regarding the concept of augmented reality, it appears that most of the research and development have been conducted with the different ideas and notion. The definition of Augmented Reality as mentioned by Zhou, Duh, and Billinghamurst (2008), is a technology which allows a computer to produce a virtual imagery to exactly overlay physical objects in real time. Furthermore, Zhou et al. (2008) revealed that augmented reality is a technology which merges real and virtual imagery, interactive in real time, and registers the virtual imagery with the real world. Therefore, augmented reality gives an opportunity to the users where they can experience a unique way of interacting with virtual images in real time which produced by the computer.

Other than that, Milgram, Takemura, Utsumi, and Kishino (1995) outline in their research that augmented reality has broad and restricted method. In the broad sense, augmented reality defined as “augmenting natural feedback to the operator with simulated cues” (p. 283). Meanwhile, the restricted method underlines the

technology aspect and is “a form of virtual reality where the participant’s head-mounted display is transparent, allowing a clear view of the real world” (p. 283).

Meanwhile, augmented reality is part of the general perspective of Mixed Reality as stated by Silva, Oliveira, and Giraldi (2003) , which the mixed reality refers to a multi-axis spectrum of areas that cover Virtual Reality, augmented reality, telepresence and other related technologies. Mixed reality is where real world environment mixed up with the virtual environment and the augmented reality. Van Krevelen and Poelman (2010), also supported the statement of; augmented reality is one part of the general area of mixed reality. Augmented reality is a crossover between the real and virtual world based on Figure 1, as proven by Paul Milgram’s famous Reality-Virtuality continuum diagram (Butchart, 2011).

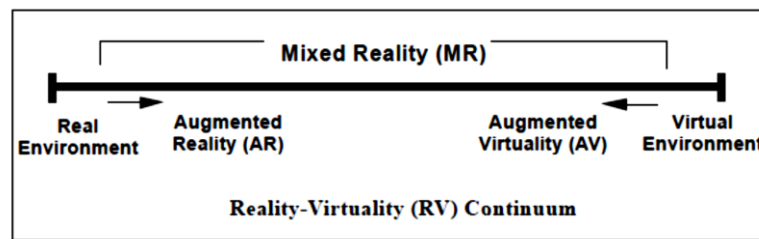


Figure 1 Reality-Virtuality continuum diagram

In addition, virtual reality is defined which a computer generated three-dimension (3D) environments that enable the user to communicate with synthetic environments as stated by Silva et al. (2003). Besides that, telepresence is a human or machine system in which the human operator receives necessary information about the teleoperator and the task environment, presented in a sufficient natural way, that the user able to feels physically present at the remote site (Silva et al., 2003).

Therefore, the concept of augmented reality is one part of the Mixed Reality which consist of virtual reality and augmented reality by relate them with technologies. The technologies that are previously used are computers that produce a virtual imagery (3D environments) to exactly overlay physical object in real world environment. These allow the users to interact with the virtual images and synthetic environments in real time.

2.2.3 HARDWARE

There are a few examples of devices that use Head-Mounted Display (HMD) as their display such as Optical See-Through , Monitor Based AR and Projector Based AR (Silva et al., 2003). Furthermore, handheld display and heads-up display are recent technologies that are also used as a display for augmented reality presentation.

HMD (Optical See-Through)

In Optical See-Through AR, a transparent Head Mounted Display is used to display the virtual environment by directly over the real world (Silva et al., 2003). Plus, Silva et al. (2003) also mentioned that this hardware is used by placing partially transmissive optical combiners in front of the user's eyes. Thus, the user can directly see through them to see the real world. The combiners also has reflective characteristic, where the user can see the virtual images bounced off the combiners originally from head-mounted monitors.

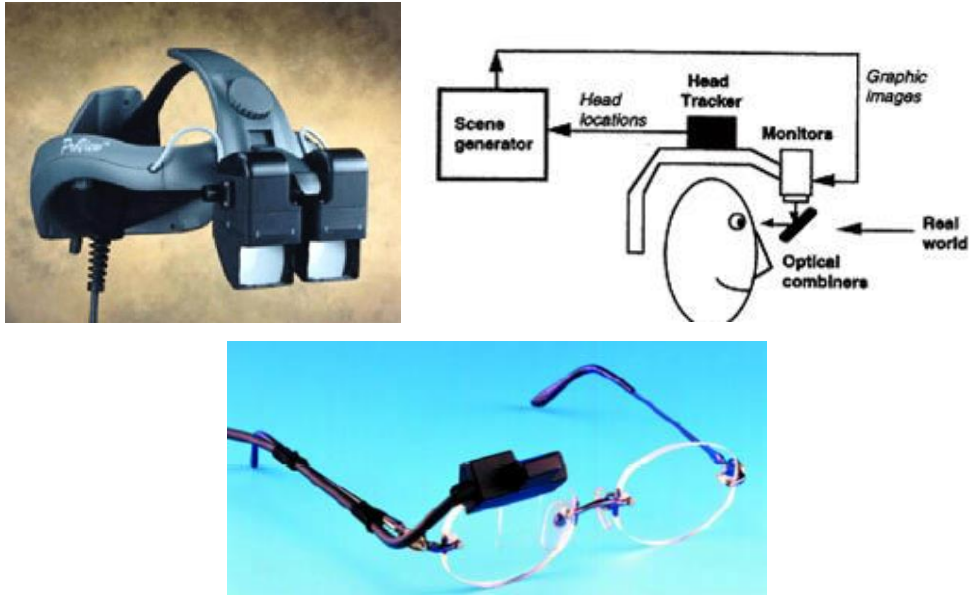


Figure 2 HMD Optical See-Through

Monitor Based

As mentioned by Silva et al. (2003) Monitor Based AR used a more conventional desktop monitor compared to a hand held display, where it merged video streams. In order to merge graphics into real time video stream, Princeton Video Image, Inc. has developed a new technique. This technique usually used as the first down line in American football games on television and by placing advertising logos into various broadcast.

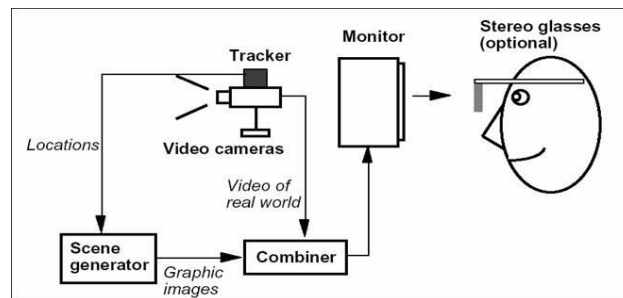


Figure 3 Monitor Based

Projection Display

To project the virtual environment, projector based AR uses real world objects (Silva et al., 2003). This projection display is suitable for industrial assembly, product visualization, and others because of multiple users involve at once. Silva et al. (2003), also mentioned that, to successfully display the applications, the arrangement and accuracy of projectors and projections surface is a high priority task.



Figure 4 Projection Display

From time to time, technologies are rapidly improving. Thereby things that are impossible to implement few years back are now currently available to use such as smartphones. In previous year, wearable device for example HMD is a popular device used to present the augmented reality. Mentioned by (Silva et al., 2003), HMD could be used to show the augmented scene, but other technology also available. However, in HMD technology, portability becoming an issue because the user is not allowed to go around much due to HMD limitation (Silva et al., 2003).

Handheld Display

Handheld display is a small computing device where a user can hold it in their hand to display the augmented reality (Carmigniani et al., 2011). This device use a video-see-through techniques to merge graphics onto the real world and uses sensors such as digital compasses and GPS units for six degree of freedom tracking sensors, fiducial marker systems, , and/or computer vision method.

Carmigniani et al. (2011), also cited that a very promising platform for AR nowadays is smartphones; this is because of the recent advancement of smartphones where the smartphones now are portable, powerful processor, camera, accelerometer, and GPS.

Heads-up display (HUD)

In Heads-up display, the augmented object is projected onto a surface in the real world environment so that the user does not have to look away from their usual view point (Butchart, 2011).



Figure 5 Heads-up Display

2.2.4 TRACKING

Meanwhile, for the tracking system, Silva et al. (2003) found that the objects in the real and virtual worlds must be well aligned with the respect to each other, or the illusion that the two worlds coexist will be affected. As mentioned by Rekimoto (1998), in augmented reality systems, it is decisive to properly register real world computer information with the real world image. Therefore, Rekimoto (1998) has used a method (2D-matrix marker) which identifies real world objects and estimates the objects' position and orientation using both visual markers and a video camera at the same time. Based on Butchart (2011), the 2D-matrix marker is positioned at locations or on objects in the real world.

Besides, he also mentioned which natural feature detection is used to assist object recognition of an intact real world objects for examples book covers, posters or landmarks that have no artificial markers. The 2D-matrix marker is a square shaped barcode, where it can be produced and uploaded codes on a large number, of real world objects at virtually no cost (Rekimoto, 1998). Plus, he also mentioned the augmented reality system use the codes from captured video images to analyze the falsification of the rectangular shape of the matrix code frame for the system to estimates the position and orientation of the video camera to correct the overlay annotating information on the captured video image.

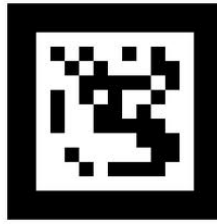


Figure 6 2D Marker

In a smartphones system, a Six Degrees of Freedom method is used to display the 3D images on screen which allow the user to view the objects' image from all directions (forward/back, left/right, and up/down) (Butchart, 2011). Silva et al. (2003), cited that a display component is used when linking both real and virtual world with only two basic choices available which are optical and video technology. According to Butchart (2011), six degrees of freedom is one of the functions of smartphones which the tracking system is used to maintain alignment of a real world object in three dimensional spaces. Meanwhile, location sensors is used to provide all directions using GPS and yaw (compass) and the accelerometer that can determine pitch and roll of the smartphones (Butchart, 2011).

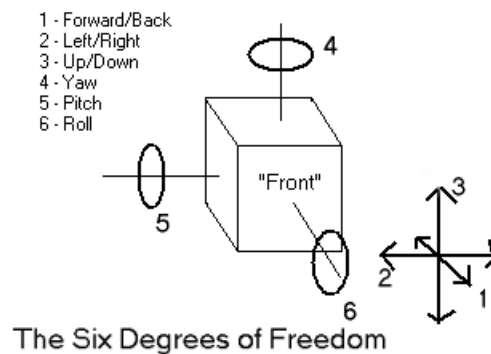


Figure 7 Six Degree of Freedom

In this project, the mobile devices used different images of the storybook's pages as the 2D marker; which each marker consist of different 3D object and animation. The devices in this project also used the concept of six degree of freedom to projectile the 3D object in real world. Since this project does not use any of the real-time building, the location sensors used to detect real-time building's coordinate are not needed.

2.2.5 AUGMENTED REALITY: SOFTWARE (AR BROWSER)

Junaio AR Browser

A German company, Metaio has developed a powerful AR browser which used to support 3D object rendering, location based tracking and both marker and markerless image recognition (Butchart, 2011). Publishing and hosting service are also being offers to publisher to publish their content. Currently, Butchart (2011) mentioned that Junaio has a major advantage over other application because it is the only ‘browser’ style AR application that has built-in optical tracking function. As previously mentioned, all the functionalities in Junaio AR Browser has been able to assist developers to render and used the unique location based tracking to track real-time building.



Figure 8 Junaio AR Browser

Layar AR Browser

Layar AR Browser is the “world’s first AR browser” that offers animated 3D rendering, location based tracking with a highly flexible API and a useful set of tools for developers (Butchart, 2011). The publishers are given an option to create their own content, publish channel and user interfaces where Layar can direct publishers to other 3rd party content management tools and hosting companies.



Figure 9 Layar AR Browsers

WikitudeWorlds Browser and Wikitude API

Other than Junaio AR Browser and Layar AR Browser, WikitudeWorlds from Austrian start-up Mobilizy is a common purpose browser as cited from Butchart (2011). The application support with location based tracking and 2D images. To ease the developer to have an access an open publishing model concept has been introduced by the WikitudeWorlds Browser (Butchart, 2011).

An open source framework, Wikitude API is used to develop a standalone AR application on smartphones where the developers have fulla access to the source code and a few skeletons to get started.



Figure 10 WikitudeWorlds Browser

2.2.6 APPLICATION AREAS

Augmented reality has many benefits if it is implemented effectively in different areas of education, entertainment, advertisement and working areas such as medical, engineering, etc. This implementation can act as an aid for the users to grasp their understanding and get the concept of what the applications trying to relay to the users.

Practical training

In education it is essential to make a practical training to test whether to learners able to apply what they have learned in real world situation. Butchart (2011), has mentioned that an augmented reality training applications able to offer a set of instructions to guide user through completing a difficult assignment with virtual information helping the users to recognize targets and improve decision making. The application has been made to aid and improve users understanding on what they have learned so far. Plus, the applications also can be used as a replacement when in some situations, where equipment or tool is insufficient. The following figure shows the example of augmented reality training application used in BMW workshop.



Figure 11 Practical training

Through the augmented reality application and environment, the user has the possibilities of develop skills and knowledge that can be learned in other technology-enhanced learning environments but in a more effective way (Butchart, 2011). Fjeld and Voegtli (2002), have mentioned in their research that augmented reality overlaying virtual object or information onto physical object or environments enables visualization of invisible concepts or events. For example, airflow, magnetic fields, molecules, vectors, symbol etc. Augmented Chemistry which allowed students to

select chemical elements, compose into 3D molecular models, and rotate the models as mentioned in Fjeld and Voegtli (2002) research paper.

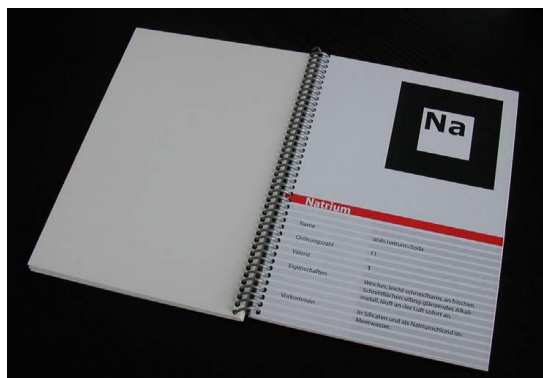


Figure 12 Augmented Chemistry Book

News, Advertising and Entertainment

Nowadays it is hard to keep users from distraction of other things when only using a simple application for quite a long time. Therefore, to keep the users attract with the application for a long time, a simple augmented reality can be added to match the applications with current flow of technology. However, without people realize, it has been a while for a simple form of augmented reality has been in use in the entertainment and news business according to Silva et al. (2003). For example, as the users are watching the news reporter reporting the weather report while standing in front of changing weather maps (Silva et al., 2003). Most of the user already know that the reporter actually standing in front of a full-blue screen. However, they does not realize there is a method used called chroma-keying to projected the real image which is augmented with computer generated maps (Silva et al., 2003).

Besides that, in entertainment the augmented reality is mostly used in game development. For example in Figure 13, where the games are play using the combination of virtual table and synthetic objects (Silva et al., 2003).



Figure 13 Augmented Reality Game

Another example that can be seen the usage of augmented reality is in advertising. Princeton Electronic Billboard has made it possible to use augmented reality with advertising where they have developed an augmented reality system that allows broadcaster to insert advertisements into their desired areas of the broadcast image as such in Figure 14 (Silva et al., 2003). In the Figure 14, an image is appears on the outfield wall of the stadium while a baseball game is broadcasting.

Also, Silva et al. (2003), has stated that the electronic billboard needs adjustment with the stadium by capturing images using typical camera angles and zoom settings to draw the map of the stadium and positions of the images where advertisements will be placed. Plus, by using pre-specified reference points in the stadium, the system automatically determines the camera's angle and referring to the pre-defined stadium map to inserts the advertisement into the correct place (Silva et al., 2003). Through the advertisement, the advertise company has taken advantages of the viewers of the match and had made the augmented reality as the medium to promote their product.



Figure 14 Advertising Augmented Reality

Book (The House That Jack Build)

Although today is the rapid changes in information technology development, the primary tool for teaching and learning is book. Book is widely used all over the world to relay users with useful information and knowledge. However, to improve relaying the information, many research and development has been done to increase the effectiveness of relaying the information by implementing the books with augmented reality. Through this, the users able to receive the information well and have deeper understanding of the book easier compare to ordinary book which contains text, picture and colors only.

Grasset, Dünser, and Billinghamurst (2008), has extend the general concept of augmented reality by adding virtual visual and auditory enhancements to an already published book named *The House That Jack Build*. The selected book is an illustrated storybook which used in schools to discuss historical and cultural of European settlement. The result of merging real object with augmented reality is a mixed-reality book, which the consideration of the importance of the aesthetics of real illustration. The aim of the research is to investigate how to design better relationship between new technology and a traditional medium and also a less disruptive reading experience.

As the first step of the research, an in-depth page per analysis with the author has conducted, which have given the researchers a better understanding of the content that the author is trying to convey with the story. The result from the analysis is that each of the books' pages provides a different interactive experience such as in Figure 15.

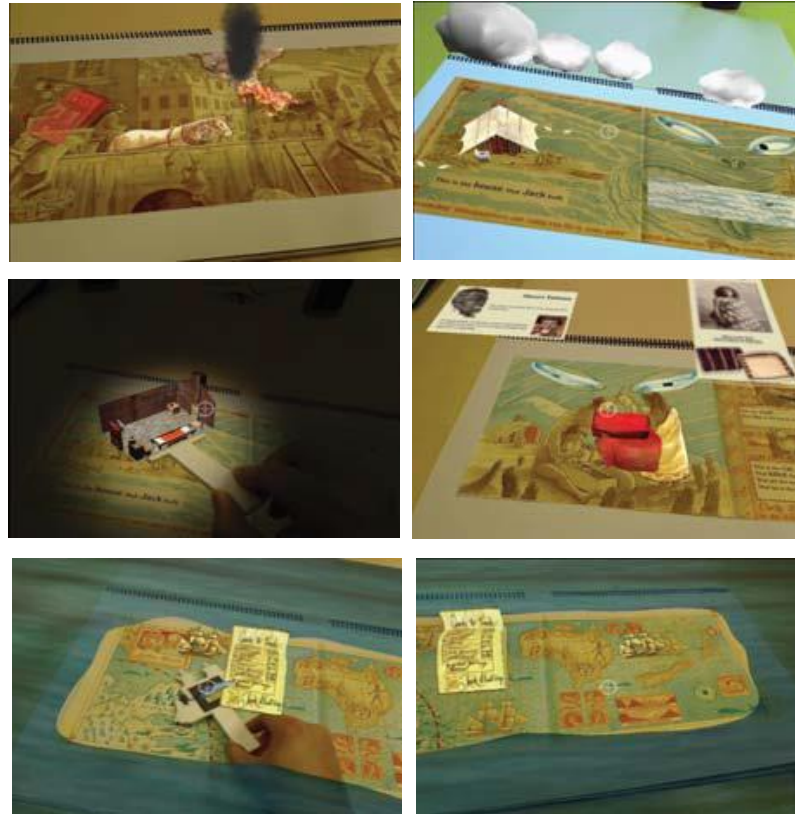


Figure 15 Books (The House That Jack Build)

- a) 2D pictures and 3D smoke
- b) 3D model (house) and immersion through augmentation of the surround (clouds)
- c) Cinematic effect (darkened area)
- d) Pop-up text box with gaze interaction
- e) + f) animation of a virtual boat through paddle interaction and augmented sea in the surround

According to Figure 15, the researcher has developed the pages with virtual content, interactive features and their associated meaning. When the user open the page as Figure 15, the user able to hear the bells of Big Ben and port sounds other than that, the user able to see a virtual sea (Grasset et al., 2008). Grasset et al. (2008), mentioned that the book is usually shown on a table paired with speakers for ambient and 3D sound. Meanwhile, for visualization and tracking the researchers offers the user either to use an augmented reality hand-held device with attached camera or a computer screen behind the book (Grasset et al., 2008). The researchers also

implemented different sound effect, virtual 2D objects, and darkening effect. Figure 15 shows the examples of the implementation.

Book (eyeMagic Virtual Story)

Other than that, Woods et al. (2004) has mentioned that an eyeMagic Virtual Storybook is one of the projects developed by applying different techniques of augmented reality at Human Interface Technology Laboratory in New Zealand. The eyeMagic has been developed as a new type of children's storybook where the users able to read like any ordinary picture book. Plus, the book is replaced with fully animated characters acting out the story, soundtrack and narration in a virtual environment when the users hover over the pages using a handheld visor (Woods et al., 2004). This technique is similar as previous book mentioned, where a handheld visor is used. However, nowadays, there is smartphones that are capable to provide efficient hardware to support the software needed for augmented reality that also comes with high quality video and audio. Furthermore, Woods et al. (2004), also cited that the book is applying a similar idea of traditional 3D pop-up books that flat planes of background are covered near back of the scene to enrich the environment.

While the book simultaneously allow the users to read as a common storybook while having an augmented reality played, the visual impact of the 2D matrix-marker's size was reduced as much as possible (Woods et al., 2004). This was completed by applying a new extension to the ARToolKit named Natural Feature Tracking, which simply uses a small (3cm) 2D matrix-marker for initial adjustment, thus tracks from features it has been programmed to identify on the surface of the page. Three-dimensional modeling was programmed by the studio One Glass Eye, on the other hand the character rigging, animation and export to the application was prepared by the software developer (Woods et al., 2004).



Figure 16 Book (eyeMagic Virtual Story)

3.0 CHAPTER 3: METHODOLOGY & PROJECT ACTIVITIES

3.1 METHODOLOGY

In this project, methodologies used to collect required data and information is Observation and Questionnaire. The target participants for the methodologies are surrounding people. The methodologies objectives are to verify the awareness and importance of recycling towards people and also the usage of mobile application as one of the learning tools for children. Most of the locations mentioned in the observation method are around University Technology PETRONAS (UTP). Meanwhile, the questionnaire is passed around through online platform and social networking such as email and Whatsapp application. The results from the observation and questionnaire will be discussed in Chapter 4 of this report.

3.1.2 OBSERVATION

The observation methodology has been conducted in a few scopes such as to observe people awareness of recycle. This observation was conducted without planning of the location, time and specific participants. Plus, there were no specific details, such as age and gender of participants were recorded.

However, the details of the observation place, time and general information of participants were recorded throughout the observations. The recorded notes and captured images of the observation's locations will be discussed in the next Chapter 4.

3.1.3 QUESTIONNAIRE

The questionnaire methodology aims to survey people's behavior of recycling, mobile application as a learning tool for children and also augmented reality experience. The questionnaires were spread to participants through an online platform and social network such as email and Whatsapp mobile application.

The questionnaire was created with the help of Google Spreadsheet which consist of 10 multiple choices questions. In this case, the participants' age were recorded in order to collect various data and information.

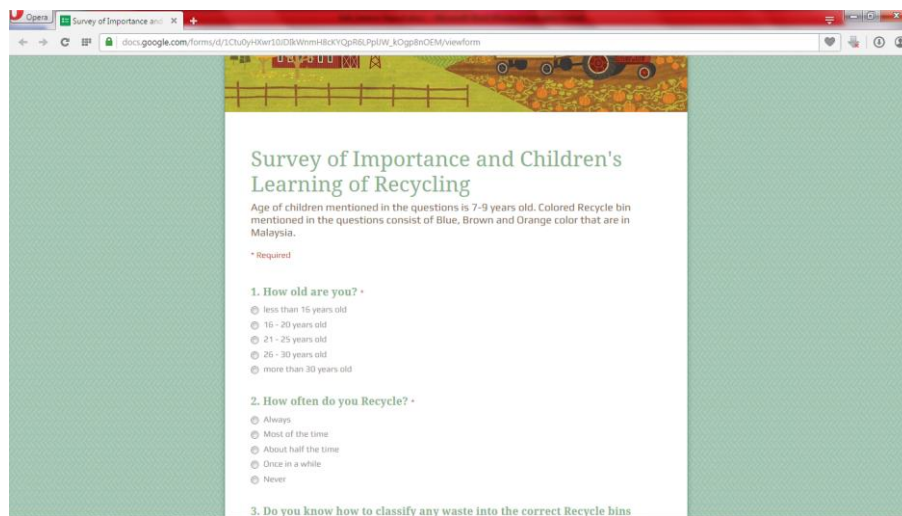


Figure 17 Survey of Importance and Children's Learning of Recycling

3.2 PROJECT ACTIVITIES: SOFTWARE DEVELOPMENT & LIFE CYCLE

There are many different models available in Software development models such as Waterfall model, V model, Rapid Application Development (RAD) Model, Incremental model, Agile model, Iterative model and Spiral model. Each of these models has different cycle of documentation, development, testing and demonstration. Therefore, after consider the project cycle, requirements and time constraint; the combination of part from Waterfall model and Iterative model methodology will be used alongside the project.

In the iterative model, the life cycles start by specifying and implementing only a few part of the software, which can then be review later on in order to specify further requirements. This process is then repeated, producing a new version of the software for each cycle of the model. Therefore, without having full requirements of the software, the iterative lifecycle model still able to start.

In the following diagram, creating rough design, review and improve the project will be done iteratively with implement and analysis cycles. The iterative

model also will be used repeatedly in design, implement and analysis order accordingly throughout the project.

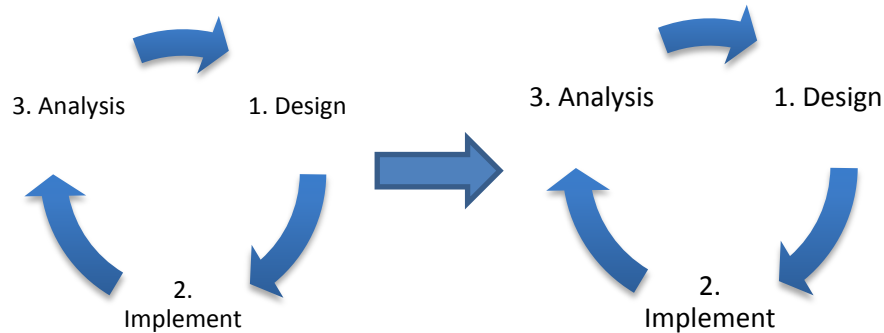


Figure 18 Iterative Model

The advantages of using an iterative model are:

- Defects are possibly to detect at an early stage because building and improving the product is done step by step accordingly.
- The iterative model more focus on designing compared to documentation.
- Reliable user feedback able to gather at each end of the implement phase when presenting the prototype. Thus an analysis to improve the end product will be done and implement in design phase.

However, as mentioned before the iterative model started without having full requirement of the software. Hence, it can lead to misdirection of project's objectives. Therefore, to cover up this part, the waterfall model is suggested. The waterfall model is commonly used because it is very simple to understand. In waterfall model, each of the phases has specific deliverables and review process that need to complete before moving to the next phase. The diagram below shows the phases in Waterfall Model.

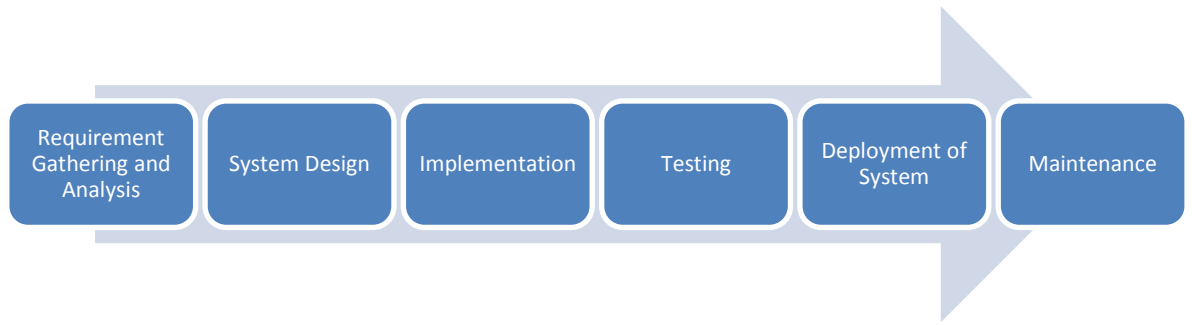


Figure 19 Waterfall Model

Though, the Waterfall model also has disadvantage which it is difficult to go back to make any changes in requirement. Therefore, in this project the combination part of Waterfall model and Iterative model will be used. The following Figure 20 showed combination of Waterfall and Iterative models.

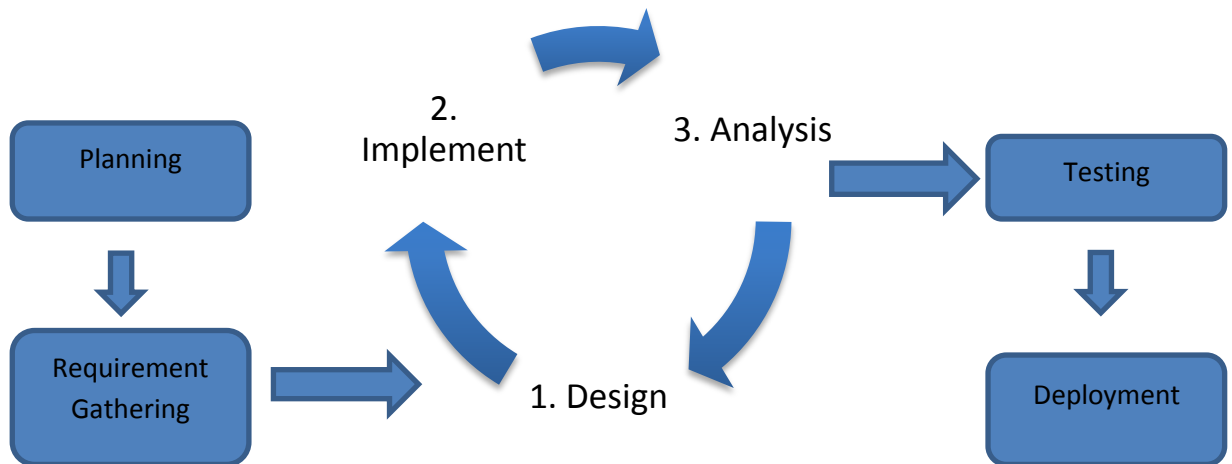


Figure 20 Combination parts of Waterfall and Iterative Model

3.2.1 PLANNING PHASE

It is one of the common steps that each project should have a planning project to ensure the project in control within context and time. In a planning phase, background of the project is written; problem statements are discovered; objectives are determined and scopes of study are defined. The planning phase has been well defined and described in more details as in Chapter 1 in this report.

Furthermore, in the planning phase the software and development cycle model to be used as guidance along the project is chosen. After many considerations of models, the combination of part Waterfall model and Iteration model is made. This is to ensure that the project has correct planning and phases so that this project can proceed smoothly.

Moreover, the planning of Gantt chart also has taken place in planning phase. The following Table 3 shows the Gantt chart of the project.

Table 3 Project Gantt Chart

ID	Task Name	January			February				March				April			May		June				July				August			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Planning																												
1.1	Project Overview	█	█																										
1.2	Gantt Chart		█																										
1.3	Software Development Life Cycle		█																										
2	Requirement Gathering																												
2.1	Literature Review Study		█	█	█	█	█	█	█	█	█	█																	
2.2	Observation											█																	
2.3	Questionnaire											█																	
3	Design																												
3.1	System Architecture						█																						
3.2	Flow Chart						█	█																					
3.3	Storyboard						█	█	█	█																			
3.4	User Interface						█	█																					
3.5	Characters and Items											█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
3.5	Sound											█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
4	Implementation																												
5	Analysis																												
6	Testing																												
7	Deployment																												

3.2.2 REQUIREMENT GATHERING PHASE

It is important to gather project's requirements because through the requirements the project's objectives can be achieved. Therefore, to gather the requirement of the project, an observation and questionnaire methodologies have been used as mentioned in previous Methodology section.

In addition, to gather more information about project's requirements, a literature review of the augmented reality has been done as per in Chapter 2. The literature review is used to make comparisons of similar product on market to define new ideas that can be applied in the project.

3.2.3 DESIGN PHASE

According to the software development model used in the project, after requirement gathering phase, the project will then enter the cycle of design, implement and analysis accordingly. Design of the product will be improve each of design cycle until the product is complete developed. In design the phase system architecture and flowchart are initially defined before storyboard, user interface, character, items and sound are develop.

System Architecture

In order to present the interior part of the mobile application system, an image representing is illustrated such as system architecture. The system architecture represents the relation and data flow between the camera, image capturing module, image processing module, marker tracking module, rendering module and screen of the system.

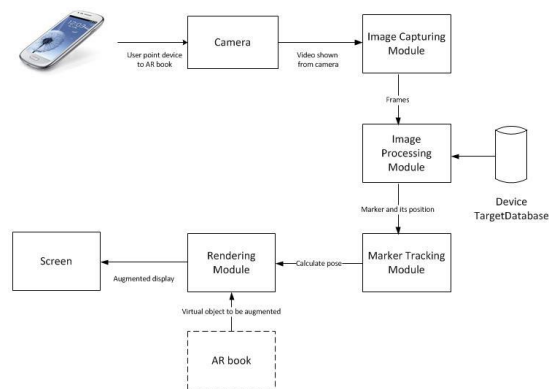


Figure 21 System Architecture

1. Camera:

The camera part is used to capture every preview frame and passed efficiently to the image capturing module. The user only needs to initialize the camera application and point the device (smartphones) to the AR book. Thus, the camera frame will automatically deliver in a device-dependent image format and size.

2. Image Capturing Module:

The Image Capturing Module receiving its input from the live video feed of the smartphone’s camera. The module task is to analyze each frame in the video feed, thus generates binary images (digital images) that comprises only two possible values for each pixels. Only two colors are used for a binary image are black and white. These binary images are provided as an input to Image Processing Module.

3. Image Processing Module:

The binary images then process using an image processing technique to detect the AR marker. Detection of AR Marker is essential to determine the position, where to place the virtual object. Once the AR Marker is detected, its location is provided as an input to the Tracking Module.

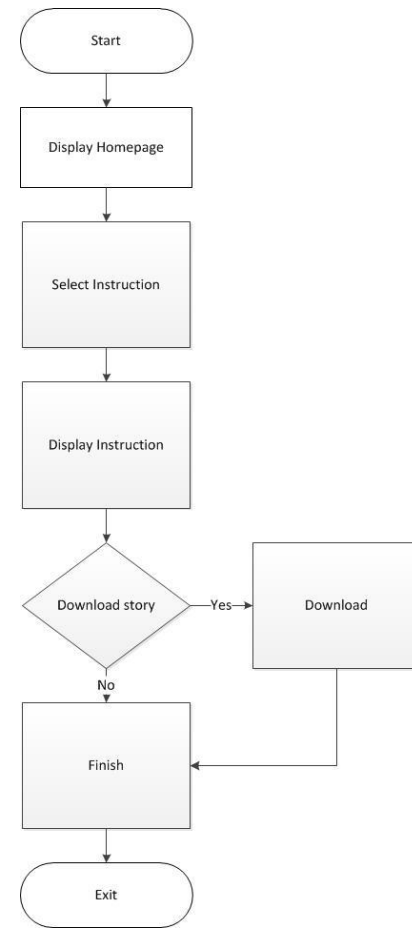
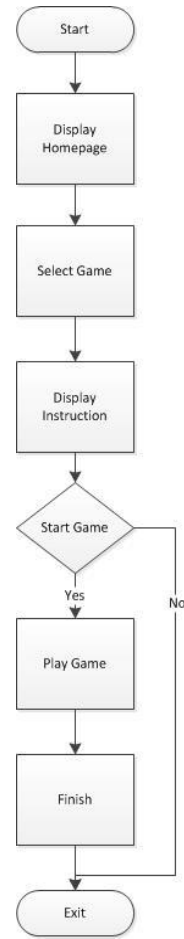
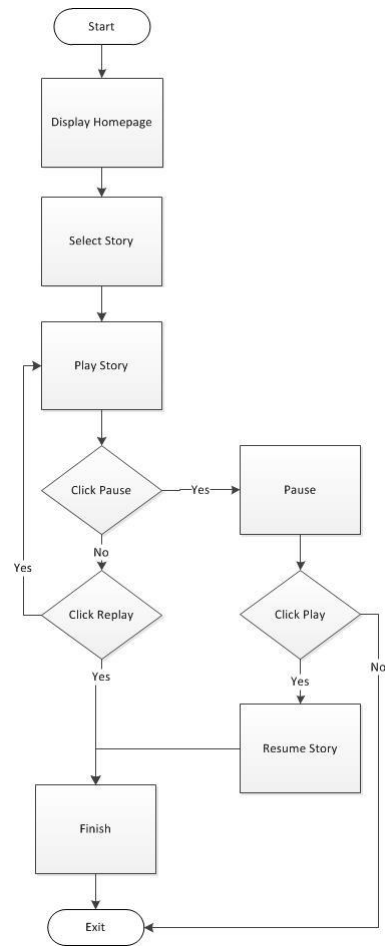
4. Marker Tracking Module:

The tracking module is main part of the augmented reality system; it calculates the relative pose of the camera in real time. The term pose means the six degrees of freedom (DOF) position, i.e. the 3D location and 3D orientation of an object. The calculated pose is provided as an input to Rendering Module.

5. Rendering Module:

There are two inputs to Rendering Module. First is the calculate pose from the Tracking Module and other is the Virtual Object to be augmented. The Rendering Module combines the original image and the virtual components using the calculated pose and renders the augmented image on the display screen of the mobile device.

Flow Chart



Storybook

The storybook that is being used along the project is *Let's Recycle*, an illustrated storybook which has been written purposely for this project with the assistance of the project's supervisor. With simple English storyline, the children should be able to understand and enjoy the storybook's content. The story unfolds the children story of a pair of siblings learning about the need and the practice of reduce, reuse and recycle. At the last two pages of the book, simple games are provided for the children to test their understanding of using correct recycle bins colors as well as to provide an entertainment. With the help of StoryJumper website, the design of the storybook is made to possible.



Figure 22 Storybook Design

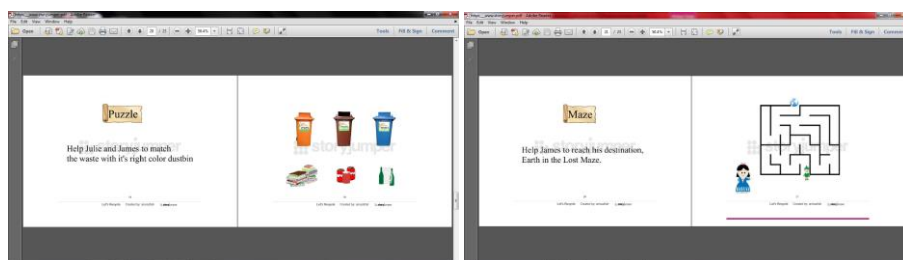


Figure 23 Games

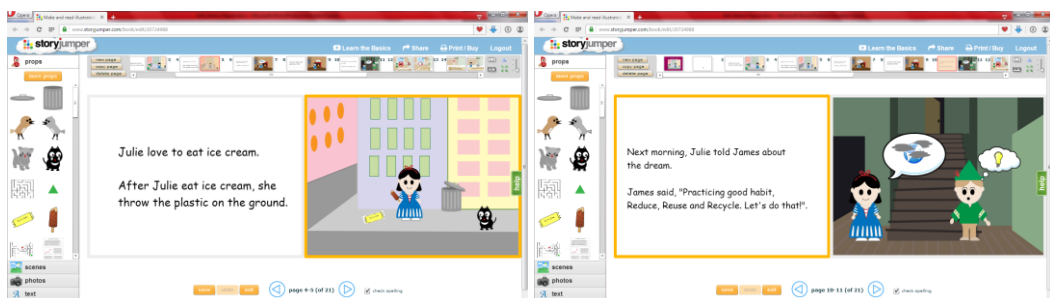


Figure 24 Storybook Design using StoryJumper

User Interface

In design phase of the project, first draft of the user interface of the project's end product is designed. Figure 25 shows the first draft of the user interface. The designed user interface will be used in the prototype of the product. Initial design of the product is very crucial for the product design, because the prototype will be used to interact and gain user interest towards the product. Therefore, the user could have higher expectation of the end-product.

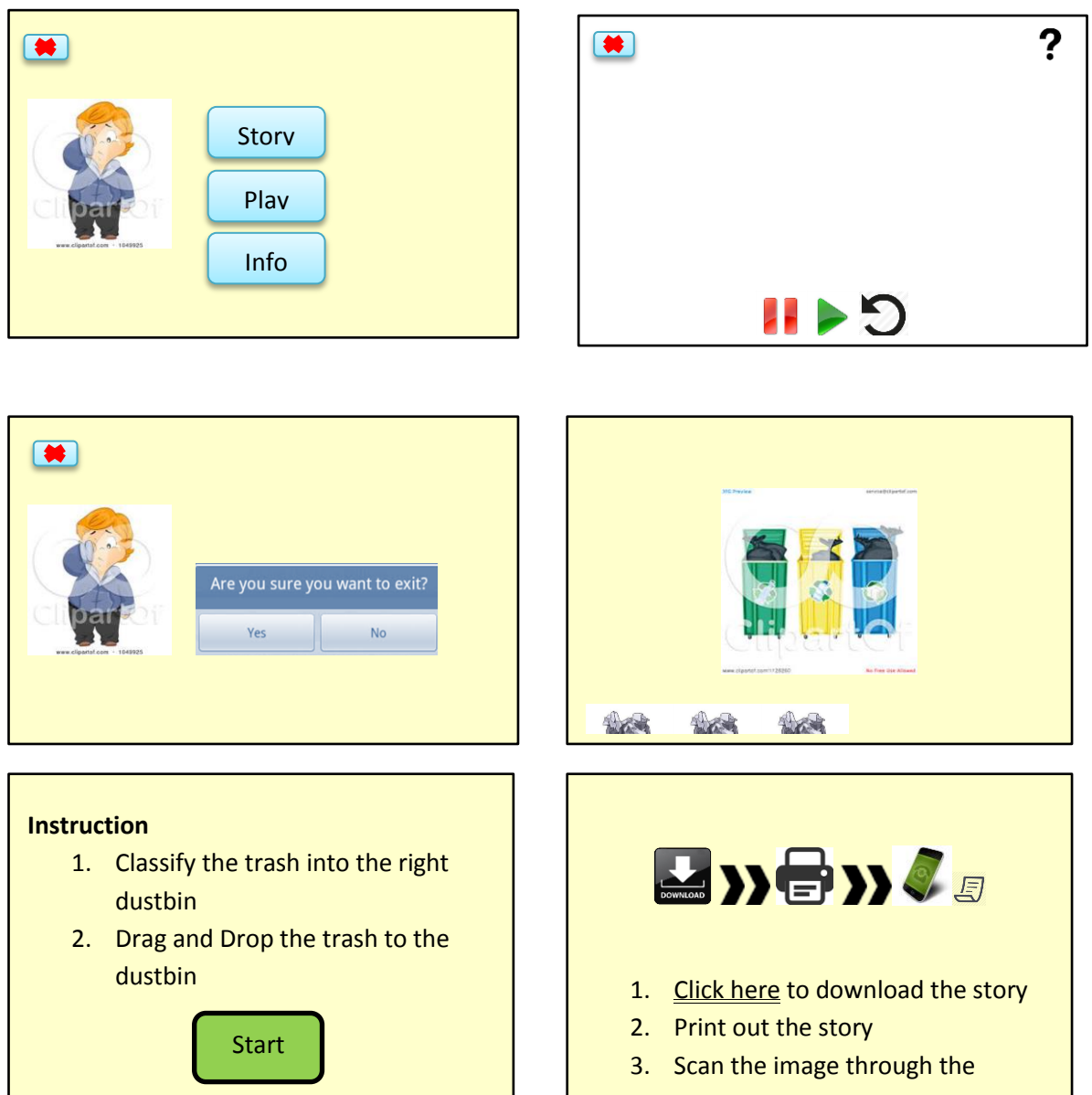


Figure 25 Mobile Application User Interface

Characters and Items

In the same design phase, prototype of items and character to be used in this project also designed and modeled using open source software, which is Blender v2.71. The prototypes are modeled through several steps consequently such as modeling, texturing, rigging and animation of the items and characters.

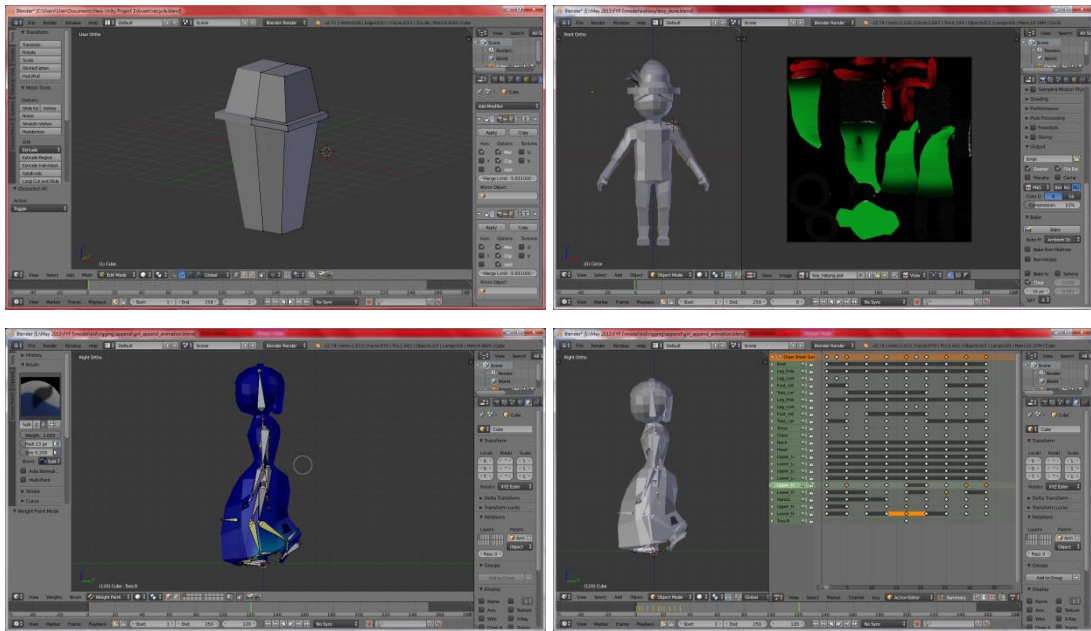


Figure 26 Top-left: Modeling. Top-right: Texturing. Bottom-left: Rigging. Bottom-right: animation

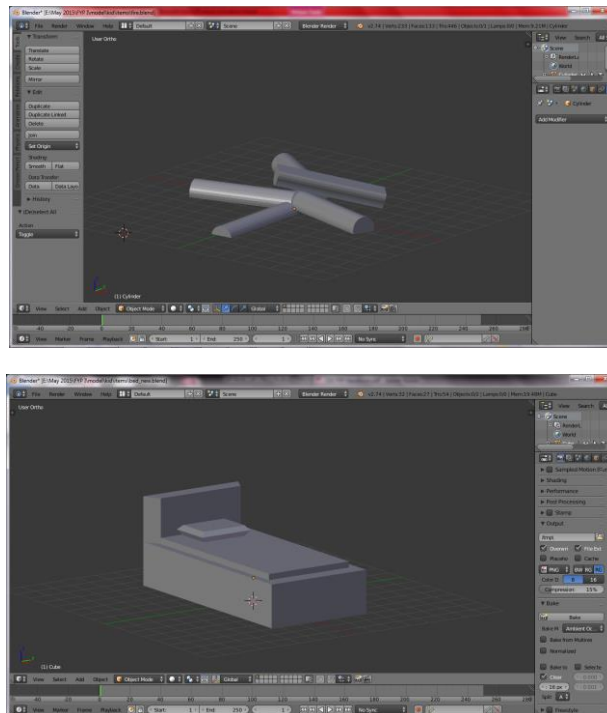


Figure 27 Items used in Storybook

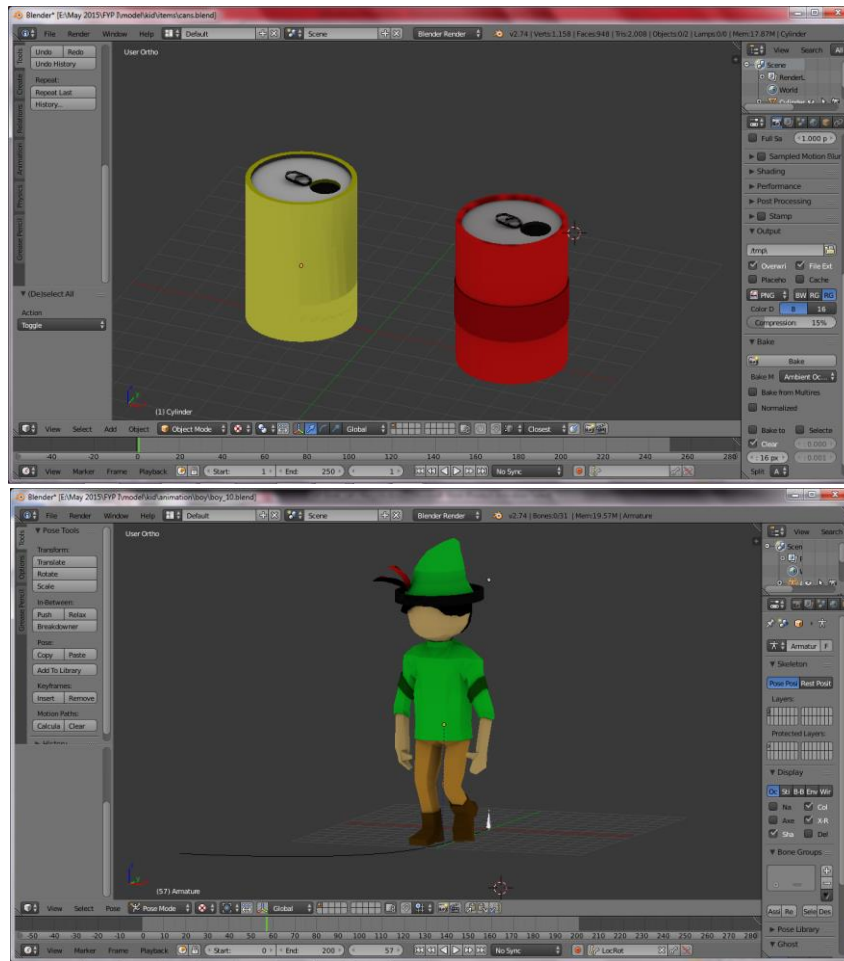


Figure 28 Finished Cans and Character with animation

Sound (narration)

In the application, there will be narrator that will narrate the story based on the book. Each page of the storybook consist of different context, which also came with different narrations. The narrations were recorded and edited using an open software, Audacity. The narrations are edited in detail, as to make sure that the narrator's voice is clear and easy to understand. It is also to match the narration with the animation of the storybook.

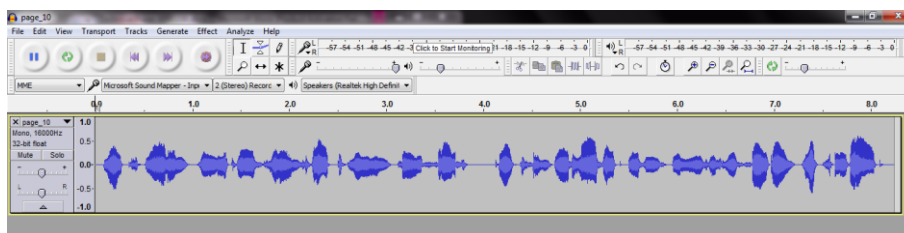


Figure 29 Edit Sound using Audacity

Websites and Software

StoryJumper (website) : Is an open source website, which the user need to create an account to freely designed and created the book storyline.

Vuforia (website) : Is an open source website which the user need to sign-in as a developer in order to generate license to be used in unity extension module and to create markers for device to detect.

Blender (software) : Is an open source software which models and animation is designed, textured and rigged.

Adobe Photoshop (software): Is a software that is used purposely for texturing of the models.

Unity (software) : Is an open software to create the mobile application by compiling all the models, markers, animation to create scene of each storybook's pages.

Audacity (software) : Is an open software that allow to edit soundtrack to be used as narrator voice in the mobile application.



Figure 30 Website and Software Icons

3.2.4 IMPLEMENTATION PHASE

After each design phase, the implementation of the prototype will be developed according to any changes occur in previous phase. In this phase, the implementation of the project will be presented using the Unity software. The Unity allows developers to choose their own platform. To ease the testing of the prototype PC (Personal Computer) standalone platform is chosen, which allowed the developer to test out their prototype on the PC that the developer is currently using.

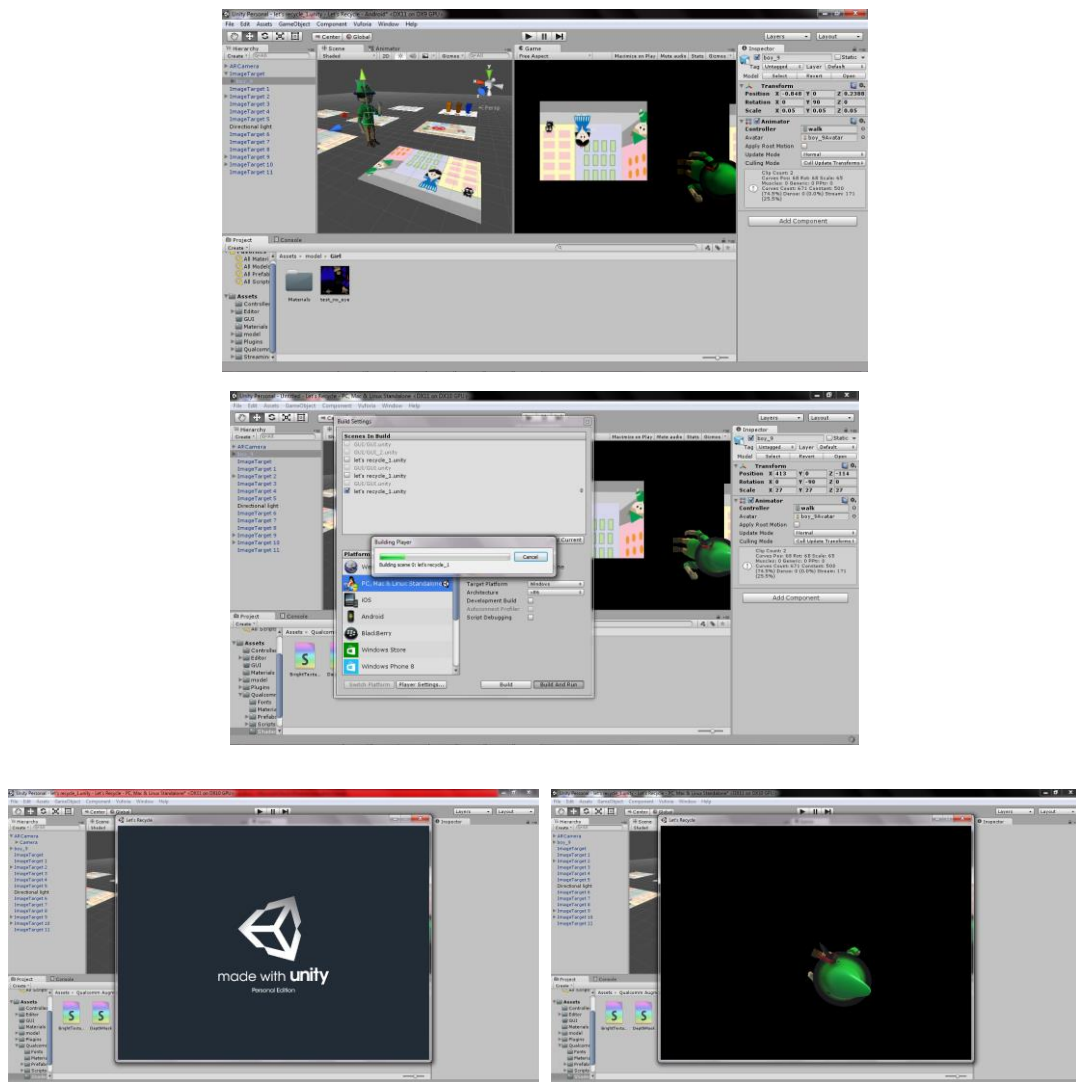


Figure 31 a) Game View. B) loading state of Build and Run. Bottom-left: Build and Run using PC. Bottom-right: Running application

3.2.5 ANALYSIS PHASE

An analysis of each revolving prototype will be conducted every cycle. The aim of the analysis phase is to improve the design, functions and the usability of the product. Moreover, in the analysis phase also to seek and solve any flaw that contains in the prototype. The analysis of the component, system and user testing will be carried out accordingly to make sure that the prototype is applicable every time any changes have been made.

3.2.6 TESTING PHASE

After the design, implementation and analysis has reached its end, final testing of the product will be conducted. This is to ensure that the product is complete and reached the project's objectives and requirements. System testing will be conducted. The result will be discussed in Chapter 4.

3.2.7 DEPLOYMENT PHASE

In the last phase of the software development model, deployment of the system will be launched for the user to use the finished product. The user should be able to enjoy the product and at the same time to learn about how to recycle.

4.0 CHAPTER 4: RESULT AND DISCUSSION

4.1.1 OBSERVATION'S RESULT AND DISCUSSION

Recently, UTP's residential villages have placed two similar dustbins next to each other however with different label. The labeled shown on each of the dustbin is for recyclable items and food waste. The initiative taken by management to separate the items into recyclable items and food waste is a good effort. However from an observation, the residents tend to ignore the label on the dustbin, as the label cannot be seen clearly in a standing position. In addition, the residents also found no difference between the two labeled dustbins because there is no clear difference in its design. The following Figure 30 show the two dustbins located at one of the residential village in UTP.



Figure 32 Dustbin at UTP residential village

Furthermore, a notice of recycling theme was stated on notice board around residential villages, UTP. From the notice, a 'Ten-finger Formula' on recycling has been stated, comes with list of recyclable items and keywords for the list. Nevertheless, most of the content in the notice, display Chinese writing, where most

of the residential find it difficult to read the language. Plus, the residential village consists of different races such as Malay, Indian and even International Students also find it is hard to read the notice because the writing is in Chinese language. Therefore, the notice has failed to delivered it intended message of recycling. Figure 25 show the notice stated on a notice board.



Figure 33 Notice on Recycling

Additionally, in cafe or food court it is likely that customer is given an option to dine in or take away based on their preference. From my observation in UTP's cafeteria it is found that all cafeterias offer the option of take away using plastic container. To ease the customer, the cafeteria also offer a free plastic bag where the customer to use it as holder of the container. Without any consideration of natural environment, most of the customers take away their food. The customer also does not care where the plastic containers and bag at end process. Some of the customers also take the option to eat in the plastic container instead of plate with an excuse of dirty plate.

In addition, the observation has taken place in one of the residential village in UTP on 26th March 2015. The observations were carried out for 5 hours by observing the dustbin's user from 9 a.m. until 1 p.m. The checklist used in observations' documentation is based on the objectives of the observation which is to observe surrounding people's behavior of recycling.

4.1.2 QUESTIONNAIRE'S RESULT AND DISCUSSION

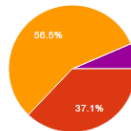
The questionnaire consists of ten questions, which nine questions are compulsory to fill and the remaining question is not compulsory. With total of 62 people those responses to the questionnaire, which made the data more accurate to be analyze. Recycle bins mentioned in the questions consists of Blue, Brown and Orange colors that are in Malaysia. Plus, it is stated that the targeted children mentioned all along in the questionnaire is 7 to 9 years old.

62 responses

[View all responses](#) [Publish analytics](#)

Summary

1. How old are you?

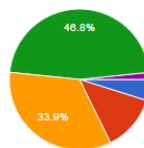


less than 16 years old	0	0%
16 - 20 years old	23	37.1%
21 - 25 years old	35	56.5%
26 - 30 years old	0	0%
more than 30 years old	4	6.5%

Figure 36 Question 1

Based on question one, the age group is divided into five clusters, which are less than 16 years old, 16 to 20 years old, 21 to 25 years old, 26 to 30 years old and more than 30 years old. The total of 16 to 20 years old is 23 respondents, 21 to 25 years old is 35 respondents, more than 30 years old is 4 respondents and the remaining clusters have the total of 0 respondents.

2. How often do you Recycle?

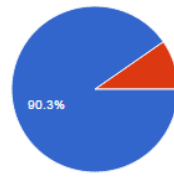


Always	3	4.8%
Most of the time	8	12.9%
About half the time	21	33.9%
Once in a while	29	46.8%
Never	1	1.6%

Figure 37 Question 2

Question two aims to determine the frequency of respondents' recycling activities. The answers provided consist of five choices which are; always, most of the time, about half of the time, once in a while and never with the result of 4.8%, 12.9%, 33.9%, 46.8% and 1.6% consequently. The highest percentage with total of 46.8% (Once in a while) had shown that people are less concern with recycling activities. These can be compared with the 4.8% (Always), which shown only few people are concern with recycling activities.

3. Do you know how to classify any waste into the correct Recycle bins color (Plastics and tins, Glass, Paper)

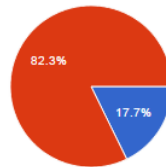


Yes	56	90.3%
No	6	9.7%

Figure 38 Question 3

Based on question three, it is to discover the respondents' knowledge of classifying any waste with respective color Recycle bins. With the result of 90.3%, most of the respondents had known the fact of how to classify any waste into the correct Recycle bins color. However, there are still respondents (9.7%) does not know the fact on how to use the color Recycle bins.

4. Do you think there is enough campaign/event related to Recycle?

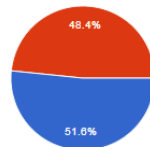


Yes	11	17.7%
No	51	82.3%

Figure 39 Question 4

Question four aims to know the respondents' opinion of the amount of campaign or event related to Recycle. The highest percentage is 82.3% which correspond to 'No' as the respondents' answer, with the remaining of 17.7% answered 'Yes'. This demonstrates the lack of recycling campaign or event.

5. Have you ever teach children on how to use colored Recycle bin?



Yes	32	51.6%
No	30	48.4%

Figure 40 Question 5

Based on question five, 51.6% of the respondents have agreed that they have taught children on how to use the color Recycle bins. Though, there are still 48.4% of respondents had denied. This has proven that, there are still respondents do not care enough to teach children about recycling.

6. Do you think it is important for children to learn about Recycle?



Figure 41 Question 6

For question six, all of the respondents have agreed that it is important for children to learn about recycle. This had proven the importance of children to learn about Recycle.

7. If there is a mobile application to learn about Recycle, would you like to recommend it for children?



Figure 42 Question 7

Refer to question seven, the majorities (91.9%) of the respondents have agreed that they would like to suggest for children if there is a mobile application to learn about Recycle. However, others (8.1%) had disagreed to recommend the application for the children. Based on the majorities, this had verified that the mobile application can be used as learning tool for children to learn about recycle.

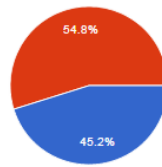
8. Do you think by learning Recycling can create environmental awareness?



Figure 43 Question 8

Through question eight, all (100%) of the respondents had agreed that by learning Recycling, environmental awareness can be created. Through the positive feedback, the respondents had indirectly agreed with one of this project's objective, which to create environmental awareness through recycling.

9. Have you heard about Augmented Reality?

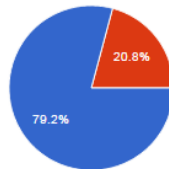


Yes	28	45.2%
No	34	54.8%

Figure 44 Question 9

Based on result of question nine, most (54.8%) of the respondents does not know the existence of augmented reality technology. Meanwhile, the other 54.8% have heard about the augmented reality. These has proven that the chance of augmented reality to be introduced is high to keep the users attract with the project's mobile application.

10. If yes, do you think that the Augmented Reality is suitable as a learning tool for the children?



Yes	38	79.2%
No	10	20.8%

Figure 45 Question 10

The respondents have the options to leave the question ten with no answer which because it is related to question nine for those who answered 'Yes'. Question ten aims to gain respondents' opinion (that had known about augmented reality) about the relevancy of using augmented reality as a learning tool for children. 79.2% of respondents had agreed that it is relevant, meanwhile 20.8% of respondents disagreed. These had proven that, augmented reality can be used as a learning tool for the children.

4.1.3 LET'S RECYCLE MOBILE APPLICATION

Let's Recycle mobile application and storybook are the end product of this project. The application could be installed in any of minimum version Android 2.3.1 with minimum API level 9 (Gingerbread) and above.



Figure 46 Screenshots from User's device

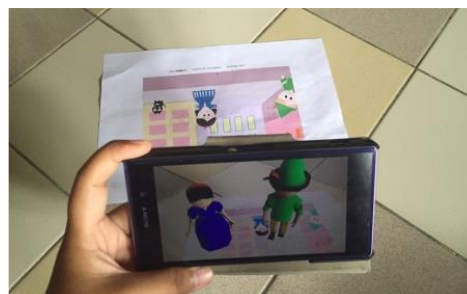


Figure 47 Running application on User's Device

5.0 CHAPTER 5: CONCLUSION AND RECOMMENDATION

Although there are different methods used to introduce the concept of recycling; not every child knows how to interpret the information into an action. The study of this project aims to create an environmental awareness of children through recycling. It is also to indicate that learning recycling is needed in early education of children. Plus, with the rapid evolving of learning tools for children, a mobile application is introduced along an augmented reality.

Therefore, an augmented reality along with mobile applications is merged together into one product where the children at the age of 7 to 9 years old able to used it simultaneously with the traditional book.

By the end of this project, the Let's Recycle mobile application and storybook have been able to create an environmental awareness on the importance of recycling for the user. Thus, it is also should be able introduced the augmented reality to the user. Through the games of the mobile application, the user should be able to entertain their self and test their understanding of the storybook's content.

Moreover, in developing mobile application, it is important to keep improving the application as to increase user's interest by adding more user interactions with the application. Furthermore, the application also can be improve by create a unique and creative story as to keep the user entertain and at the same time to be able to provide necessary information.

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APPENDICES

Survey of Importance and Children's Learning of Recycling

Age of children mentioned in the questions is 7-9 years old. Colored Recycle bin mentioned in the questions consist of Blue, Brown and Orange color that are in Malaysia.

* Required

1. **1. How old are you? ***

Mark only one oval.

- less than 16 years old
- 16 - 20 years old
- 21 - 25 years old
- 26 - 30 years old
- more than 30 years old

2. **2. How often do you Recycle? ***

Mark only one oval.

- Always
- Most of the time
- About half the time
- Once in a while
- Never

3. **3. Do you know how to classify any waste into the correct Recycle bins color (Plastics and tins, Glass, Paper) ***

Mark only one oval.

- Yes
- No

4. **4. Do you think there is enough campaign/event related to Recycle? ***

Mark only one oval.

- Yes
- No

5. **5. Have you ever teach children on how to use colored Recycle bin? ***

Mark only one oval.

- Yes
- No

6. **6. Do you think it is important for children to learn about Recycle? ***

Mark only one oval.

Yes

No

7. **7. If there is a mobile application to learn about Recycle, would you like to recommend it for children? ***

Mark only one oval.

Yes

No

8. **8. Do you think by learning Recycling can create environmental awareness? ***

Mark only one oval.

Yes

No

9. **9. Have you heard about Augmented Reality? ***

Mark only one oval.

Yes

No

10. **10. If yes, do you think that the Augmented Reality is suitable as a learning tool for the children? ***

Mark only one oval.

Yes

No

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