

BORANG PENGESAHAN STATUS TESIS*

JUDUL : IMPLEMENTATION OF PHOTOREALISTIC AUGMENTED REALITY
TECHNIQUE ON ANDROID PLATFORM IN COLOR LEARNING
PROCESS FOR TODDLERS

SESI PENGAJIAN : 2012/2013

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**IMPLEMENTATION OF PHOTOREALISTIC AUGMENTED REALITY
TECHNIQUE ON ANDROID PLATFORM IN COLOR LEARNING PROCESS
FOR TODDLERS**

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

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2013

DECLARATION

I hereby declare that this project report entitled
**IMPLEMENTATION OF PHOTOREALISTIC AUGMENTED REALITY
TECHNIQUE ON ANDROID PLATFORM IN COLOR LEARNING PROCESS
FOR TODDLERS**

is written by me and is my own effort and that no part has been plagiarized
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DEDICATION

To my beloved parents, lecturers and friends...

ACKNOWLEDGEMENT

First and foremost, I would like to thank my supervisor, Miss Syariffanor for giving me guidance and encouragement to complete this project. Beside this, I would like to thank to the Faculty of Information and Communication Technology for giving me this chance to carry out this project. I would like to express my appreciation to the lecturers of the Faculty of Information and Communication Technology. I couldn't complete this project without the knowledge that deliver from them to me. Next, I would like to thank my friends for giving me support and help whenever I need. This project wouldn't complete without their help. Last but not least, I would like to thank my family for giving me support and motivation throughout the project.

ABSTRACT

Toddlers are the beginner for everything in their life. Color indirectly deliver all the information to us through visualization. Hence, an effective color learning tool is hope to help toddlers in learning color. Augmented reality is a technology used to integrate virtual content into real-time environment. On the other hand, the photorealistic augmented reality technique is a technology used to produce a high quality of a virtual scene that augmented into real-time environment. This project aimed to develop an interactive color learning tool which explores photorealistic augmented reality techniques for color classification on the Android platform. A few areas of study are included in this project. These areas are mobile augmented reality, markerless augmented reality, photorealistic augmented reality technique and color classification in augmented reality. A little comparison of existing product on the Android platform also been made in order to understand the requirement of an interactive color learning tool. The research methodology that used in this project is prototyping model. The intent of this method is to develop a high quality and efficient application. Hence, prototyping is the most suitable methodology. The final product is an interactive color learning tool that can potentially benefit toddlers and can also be enhanced in the future development of AR applications on the Android platform. The effectiveness of the product is determined based on the result of testing and observation. The testing process and results are included. Based on the result obtained from the testing, Finding Pixie was determined as an effective color learning tool. However, the weaknesses that discovered from testing is hoped to be improved in future. In a nutshell, this project is aimed to help toddlers in learning colors while achieving all the objectives.

ABSTRAK

Zaman kanak-kanak merupakan titik permulaan bagi hidup seseorang. Warna menyampaikan maklumat secara tidak langsung menerusi visualisasi. Oleh itu, satu alat yang berkesan diharap dapat membantu kanak-kanak dalam proses pembelajaran warna. “*Augmented reality(AR)*” merupakan satu teknologi yang mengintegrasikan kandungan maya ke dalam alam nyata manakala teknik “*photorealistic AR*” adalah satu teknologi yang menghasilkan satu skrin maya yang berkualiti tinggi dalam alam nyata. Projek ini bertujuan untuk membangunkan satu alat pembelajaran warna yang berinteraktif dan menerokai teknik “*photorealistic AR*” dalam klasifikasi warna pada platform Android. Beberapa aspek kajian telah dikaji dalam projek ini. Aspek-aspek tersebut adalah mobil AR, “*markerless AR*”, teknik “*photorealistic AR*” dan klasifikasi warna dalam AR. Perbandingan antara produk sedia ada pada platform Android telah dibuat untuk memahami keperluan alat pembelajaran warna yang berinteraktif. Metodologi kajian yang digunakan dalam projek ini adalah model prototaip kerana kaedah ini paling sesuai dalam pembangunan aplikasi yang berkuailiti tinggi dan cekap. Oleh itu, produk akhir untuk projek ini adalah satu alat pembelajaran warna yang berinteraktif yang dapat memanfaatkan kanak-kanak dan masyarakat dalam pembangunan aplikasi AR dan aplikasi android. Keberkesanan produk ini ditentukan berdasarkan hasil ujian dan pemerhatian. Proses dan keputusan ujian telah dimasukkan ke dalam laporan ini. Berdasarkan keputusan tersebut, *Finding Pixie* telah disahkan merupakan satu alat pembelajaran warna yang berkesan. Walaubagaimanapun, kelemahan yang ditemui dalam proses ujian diharap dapat diatasi. Secara ringkas, projek ini bertujuan untuk membantu kanak-kanak dalam pembelajaran warna sementara mencapai semua objektif.

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CHAPTER 1

INTRODUCTION

This project aims to develop an Android application to help toddlers in learning colors. This application was developed using a photorealistic augmented reality technique. Toddlers are the beginner for everything in their life. Color indirectly deliver all the information through visualization. Color is important in life and plays a big role in everything. Color has an enormous impact on the way people think and feel about almost every aspect in life. This is the reason why learning color is important for toddlers at the beginning of their exploration of the world. Hence, an effective color learning tool is important to help toddlers in learning color.

1.1 Project background

Toddlers refer to kids age 1 - 3 years old. Hence, the knowledge that gain on this stage is very important. There are many color learning tools in the market but these products still need some improvement to deliver the tutorial effectively. Hence, this project is aimed to help toddlers learn color in an efficient way by using a photorealistic augmented reality technique on the Android platform.

Colors are important in the life. Learning color is important and that is the reason for many publishers, developers, educators introduce many color learning tools to the world nowadays. However, these color learning tools come with some inefficiencies. Some of it was not an interactive learning tool, lack of tutorial and so on. All these become the factors for learning color inefficiently.

Hence, a research question was identified to carry out this research. The questions were stated as below:

- How effective is delivering a color learning tool on the Android platform?

Color is the visual perceptual property of light with different wavelength. Colors carry meaning, feeling and so on. We judge, we differentiate, we feel everything with colors. Thus, color is important in our life. Augmented reality refers to the technology that augment virtual content to the real-time environment. The virtual content can be any computer sensory input such as graphic, sound and so on. Photorealistic technique is used to render the virtual scene in a very good quality integrating different properties. In other word, photorealistic technique is to produce the image with same visual response as a scene.

1.2 Problem Statement

Colors are important in our life. It is important for toddlers to learn color at the beginning of their exploration of the world. Many publishers, developers, educators introduce many color learning tools to the world nowadays. However, these color learning tools come with some inefficiencies. Some of it was not an interactive learning tool, lack of tutorial and so on. All these become the factors for learning color inefficiently.

1.3 Objective

The objectives of this project are:

- i. To explore photorealistic augmented reality techniques for color classification**

Several studies will be conducted for the exploration of photorealistic augmented reality technique. A few research papers were referred in order to complete the studies. Photorealistic augmented reality technique was aimed to help in color classification.

- ii. To implement a color classification application on the Android platform**

A color learning tool will be developed to implement color classification applications on the Android platform. The color learning tool will be developed using a photorealistic augmented reality technique in order to benefit its users.

iii. To develop a prototype mobile augmented reality application using photorealistic technique

Mobile application can be easily found on the market. However, a photorealistic augmented reality mobile application will be rarer in the market. Hence, a prototype of photorealistic augmented reality mobile application was aimed to develop this project.

1.4 Research Questions

The research question that determined to carry out this project is stated as below.

- How effective is delivering a color learning tool on the Android platform?

Mobile based learning tool was one of the famous application as it is more convenient compare to computer based application. However, most of the learning tool for android platform still comprises with a lot of inefficiencies. Hence, a game-based color learning tool was planned to develop for Android platform. Photorealistic augmented reality technique was planned to use for this application. The efficiency of this application in delivering the learning element will be investigated.

1.5 Project Scope

This session will discuss about the area or aspect that will be covered in this project. However, this session will only explain the target audience and limitation of the project.

1.5.1 Target Audience

The target audiences for this project are toddlers which refer to the kids among 1 – 3 years old.

1.5.2 Limitation

The accuracy of the detection of RGB value was not covered in this project. Next, some of the animation might fail to play due to the limitation of the device used.

1.6 Project Framework

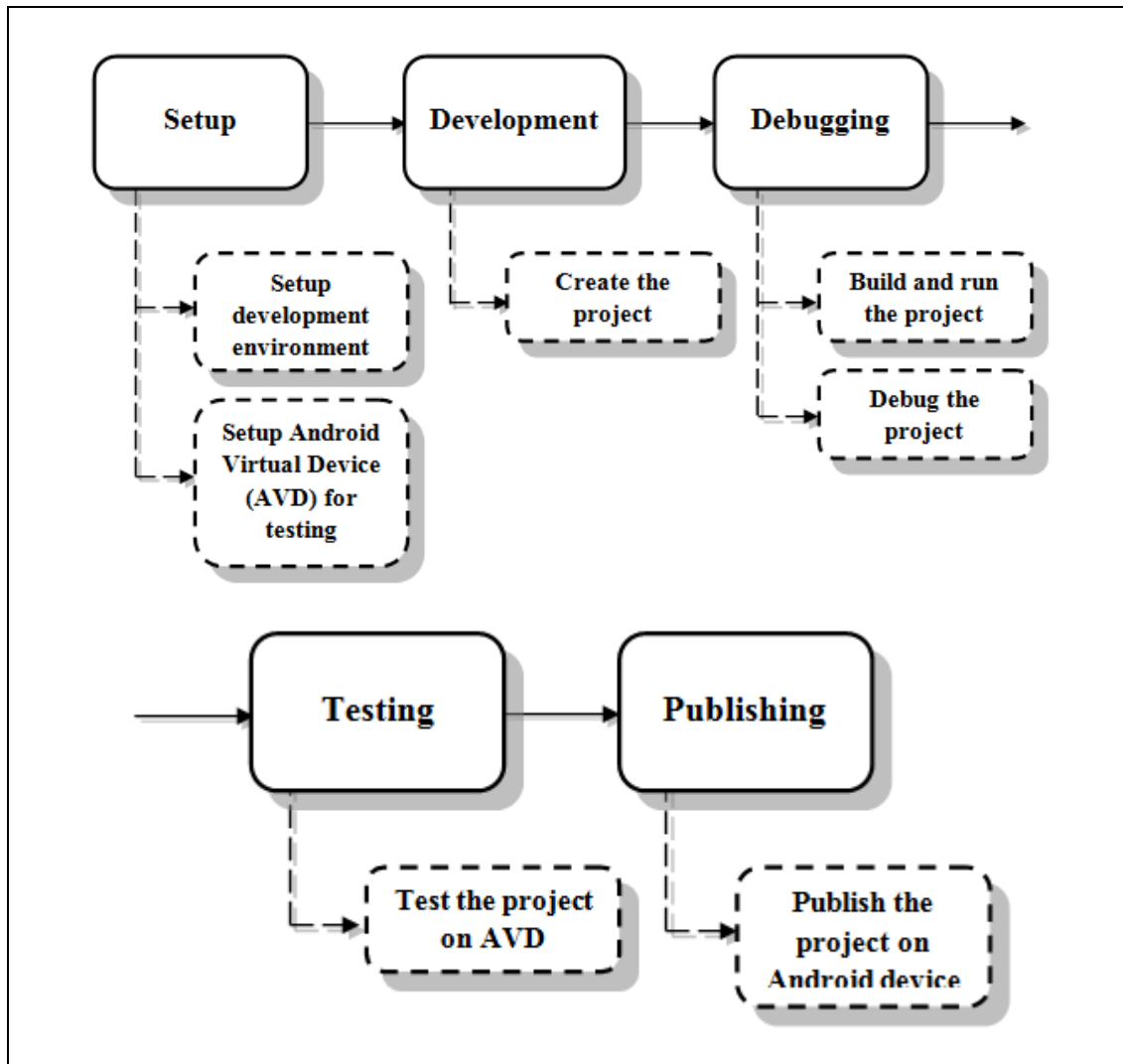


Figure 1.1 Project frameworks for this application.

Project framework was shown in figure 1.1. The stages involving in this framework include setup, development, debugging, testing and publishing. These stages discussed about the process of development of the application. The details of each stage will be further explained later.

1.7 Project Significance

The project significance of this project is to propose an effective color learning tool using a photorealistic technique on the Android platform. This project will benefit toddlers as this color learning tool is designed for them. They can learn the color of the rainbow from the provided tutorial and practice from the game developed with photorealistic augmented reality technique.

Summary

In a nutshell, an interactive color learning tool is expected to produce with photorealistic augmented reality technique in this project. Photorealistic augmented reality is aimed to help in developing this interactive color learning tool. This product is hoped to deliver the tutorial in an efficient way.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss the literature reviews in details. Resources from the journal or research paper will be used to find information for the chapter. The next part of this chapter will discuss about the existing system that available in the market.

2.1 Area of Study

To develop the interactive color learning tool using augmented reality technique, some information related to the technique needed to be investigated. Since the domain of this project focused on augmented reality, hence, a few studies regarding to augmented reality was carried out. These include mobile augmented reality, markerless augmented reality, photorealistic augmented reality technique and color classification in augmented reality. Explanation of each study provided below.

2.1.1 Mobile augmented reality

Augmented reality is an environment in which the virtual world will supplement with physical world. The integration between real and virtual world is quite an intriguing idea. Mobile AR began in 1997. Previous research of El-Zayat (2012) shows that mobile AR has been used in a wide range of field. It includes 3D mobile AR system for exploring urban environments, location based mobile AR for indoor environments, enhanced computer generated objects rendering using environment illumination. Mobile AR make the development of AR application move toward the ultimate goal which can operate in any environment. Mobility and optimization factors were significant while developing the AR platform. Figure 2.1 shows the AR mobile platform architecture designed by El-Zayat, 2012.

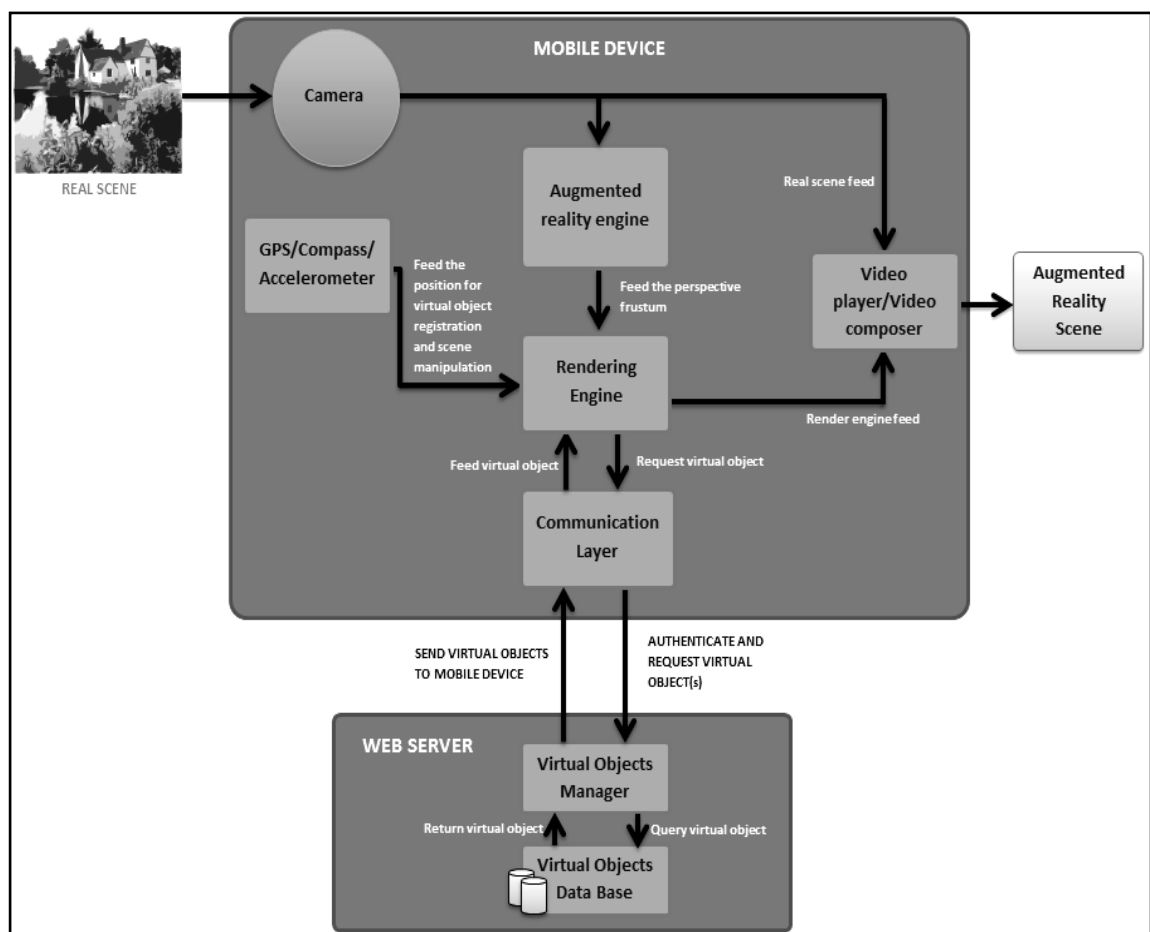


Figure 2.1: AR mobile platform architecture designed by El-Zayat, 2012

2.1.2 Markerless augmented reality

Markerless AR tracking much more complicated compared to marker AR. Marker AR used the marker to perform image tracking. The marker provides some features such as edges and texture that can be identified through image recognition. Markerless AR uses image processing technique which one of the technique of artificial intelligent. Recent years, a few markerless AR approaches have been developed. The most promising technique that currently applied in the AR application was the Model-based tracking approaches. In this technique, an object model is used to identify the features in the image (Maidi, 2011).

2.1.3 Photorealistic augmented reality technique

According to Ferwerda (2003), there are three different varieties of realism. These realisms are physical realism, photo-realism and functional realism. Physical realism means that the visual stimulation is exactly the same as the real scene. Photo-realism means that the visual response same as invoked in the scene. This is the realism that used by most of the AR application. Lastly, the functional realism means the image will provide visual information which same as the scene. On the other hand, Michael (2004) mention that most of the AR application focuses on the improvement of tracking but not rendering quality of augmented quality. AR rendered scenes can be improved by taking consideration of shading, shadows and bump mapping in the rendering stage.

2.1.4 Color classification in augmented reality

Hue was a rare term that people think of when classifying color. The name of common color will come into their mind whenever they need to classify color. Common color mentioned including red, yellow, green, blue and so on.

Human color vision is accomplished in part by three different types of cone cell in the retina; this shows that all these three values are necessary to define any color. These three values can be used as coordinates of a three dimensional point which make up a color space.

Hue, saturation, luminance (HSL) is one of the examples of the coordinate system. It is easy to convert RGB values to HSL values and vice versa. Next, it is easy to examine the hue value of unknown color whenever we have the HSL value (Jack, 2004).

In order to quantify a color, Jack (2004) developed a few color specification systems. Figure 2.2 is a color diagram of the hue circle that discovered by Jack (2004) by taking a slice through the cone in the HSL diagram. The diameter of the cone represent the saturation while luminance represented by the height of the cone. Jack (2004) concludes that, the HSL color system is convenience in term of classification of color.

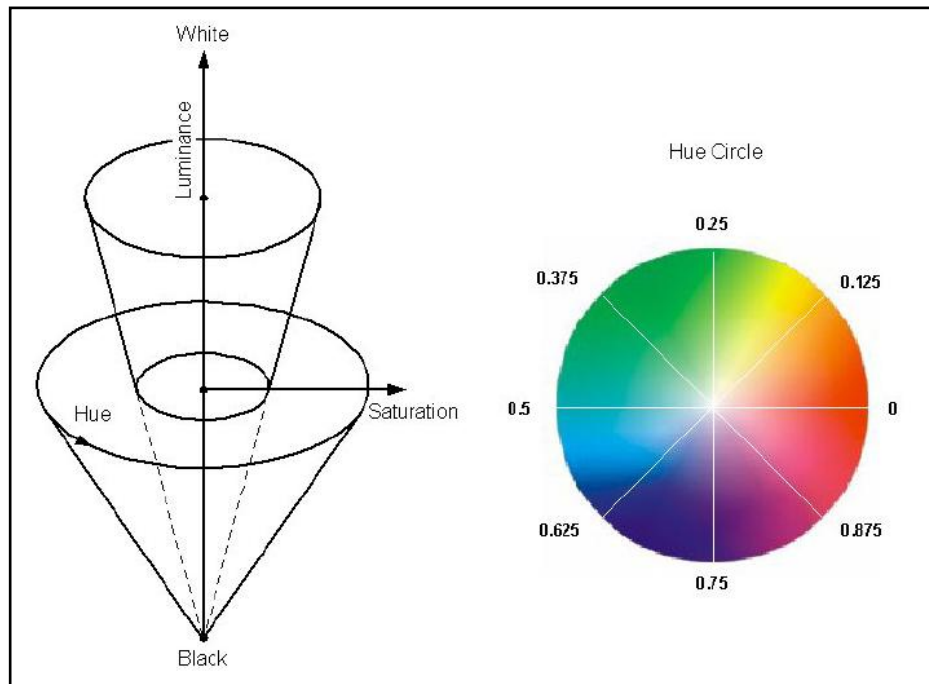


Figure 2.2: HSL diagram with Hue circle by Jack, 2004

2.2 Current Systems/Tools/Output

There are many color learning tools that available on the Android platform. However, each of learning tool comes with different functionality and design. Three of the learning tools were chosen from the market and was analysis in order to understand the requirement of a color learning tool. The chosen learning tools were “learn Colors for Kids”, “Colors for Kids” and “Puzzle for kids learn colors”. The analysis and comparison of the system mentioned will be covered in the next session.

2.2.1 “Learn Colors for Kids”

“*Learn Colors For Kids*” is a mobile application designed for kids to learn colors. The rainbow was used as the main theme of this application. However, the colors that involve in this application, including some non-rainbow color. These colors are pink, black, yellow, green, purple, red, brown, blue and orange. This application provides two types of game for user namely “Game 1” and “Game 2”. “Game 1” requires users to find the specific color while “Game 2” requires users to choose a color for a specific object.

2.2.1.1 Advantages and Drawbacks

The main attraction of “*Learn Colors For Kids*” was the interface. “*Learn Colors For Kids*” provide a high resolution interface which might attract users at the first glance. Next, “*Learn Colors For Kids*” provides two types of simple games for users. The simple games will ease the users in understanding the instruction. The screenshot of each interface and games will be provided in the next session.

“*Learn Colors For Kids*” still comes with some drawbacks. Overall, “*Learn Colors For Kids*” lack of storyline, interaction, instruction, information and feedback. Lack of storyline may reduce the attraction of “*Learn Colors For Kids*” for users. Next, button was the only interaction between users and the application. This condition will minimize the desire to continue exploring the application. On the other hand, users may not able to understand the requirement of the game as the game lack of instruction, information and feedback.

In short, the advantages of “*Learn Colors For Kids*” are listed below.

- i. Provides two types of games for the user.
- ii. High resolution interface. It may attract users at the first glance.
- iii. Simple games that ease the users in understanding the requirement.

Meanwhile, the drawbacks of “*Learn Colors For Kids*” were :

- i. Lack of storyline.
- ii. Lack of interaction. The button was the only interaction between users and the application.
- iii. Lack of instruction and information. Users may not understand the requirement of the game.
- iv. Lack of feedback. The picture was the only feedback if and only if the user clicks on the right button.

2.2.1.2 Screenshot

The screenshot of each interface of the application of “*Learn Colors For Kids*” will be shown in this session. Figure 2.3 shows the main interface for the application and figure 2.4 shows the main menu for the application. Figure 2.5 displays the menu for Game 1 while figure 2.6 shows the answer for Game 1. Next, figure 2.7 would be the menu for Game 2 and figure 2.8 was the interface of answer for Game 2.



Figure 2.3: Main interface for “Learn Colors for Kids”



Figure 2.4: Main menu for “Learn Colors for Kids”



Figure 2.5: Interface for Game 1



Figure 2.6: Interface for answer of Game 1



Figure 2.7: Interface for Game 2



Figure 2.8: Interface for answer of Game 2

2.2.2 “Colors for Kids”

“Colors For Kids” is a mobile application designed with tutorial and a few games for kids with age 1++ to learn colors. The target of this application is to work as a medium for children to learn colors in a quick way. This application provides four types of options for the user. These options are “Learn Colors”, “Rainbow”, “Games” and “Colors Mixing”. “Learn Colors” is a tutorial for this application. It displays the name of the color, color and sample objects. Next, “Rainbow” only display the colors of the rainbow which without name of color and any other information. “Games” provides three types of games. One of the games is “Find a pair”. Users need to match two of the stars with the same color. The other two requires user to purchase in order to play. The last option will be the “Color Mixing”. Users require purchase in order to unlock this feature.

2.2.2.1 Advantages and Drawbacks

Just like other applications, “Colors For Kids” also comes with a few advantages and drawbacks. “Colors For Kids” provides different types of games or tasks for users. There are a few options for games or tutorial. Next, “Colors For Kids” having interesting interface. It uses color that may attract users. It also provides simple games that may attract users. One of the simple game provided by “Colors For Kids” was the game named “Find a pair”.

The drawbacks may encourage future improvement. “Colors For Kids” also consists of a few drawbacks which may be improved in the future. “Colors For Kids” lack of storyline and interaction. These may affect the interest of users towards the application. “Colors For Kids” lack of interaction for the option of the rainbow. This application only shows the color of the rainbow and does not provide any additional information or interaction. Last but not least, “Colors For Kids” comes with another two drawbacks that is spelling error and incorrect information. The example of

alligator shown is green in color. In real, alligator was grey in color. There were some spelling error in this application, for example, “gray” was used instead of “grey”.

In a simple form, the advantages of “*Colors For Kids*” was listed below.

- i. Provides different types of games or tasks for users.
- ii. Interesting interface. It uses the color that may attract users.
- iii. Simple games that ease the users in understanding the requirement.

On the other hand, the drawbacks of “*Colors For Kids*” includes:

- i. Lack of storyline.
- ii. Lack of interaction. The button was the only interaction between users and the application. Sounds available upon purchase.
- iii. Incorrect information. Some of the information provided in this application was incorrect. For example, an alligator was in green color in this application.
- iv. Error in spelling. There was some error of spelling in this application. For example, “gray” was used instead of “grey”.
- v. Lack of interaction for the option of “*rainbow*”. Only the color of the rainbow was shown. Interaction and information should be added to this option.

2.2.2.2 Screenshot

Each interface in the application of “*Colors For Kids*” will be discussed in this session. Figure 2.9 was the main interface for the application. Figure 2.10 was the interface for the option of “Learn Colors” while figure 2.11 was the interface for

the option of “Rainbow”. Figure 2.12 was the menu for games and figure 2.13 was the display of the game of “Find a pair”.



Figure 2.9: Main interface for “Colors for Kids”

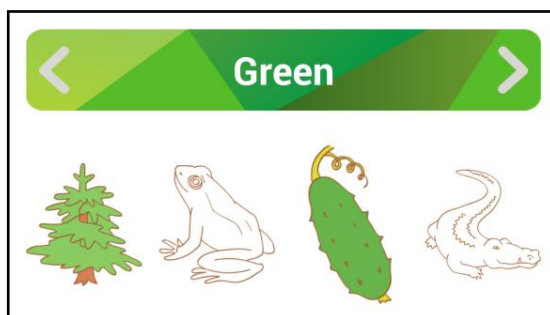


Figure 2.10: Interface for “Learn Colors”



Figure 2.11: “Rainbow” option displaying the color of the rainbow.

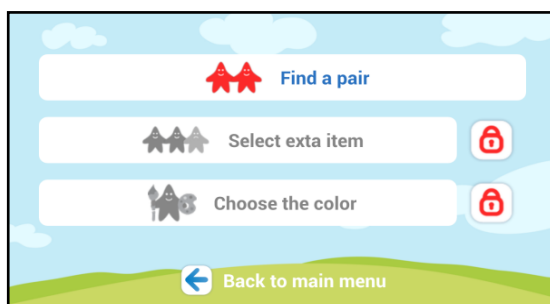


Figure 2.12: Menu for “Games”.



Figure 2.13: “Find a pair”.

2.2.3 “Puzzle for Kids Learn Colors”

“*Puzzle for Kids Learn Colors*” is an educational mobile application designed for learning colors with objects. It is a medium to let users learn in a simple and fun way. It comprises the games in the form of puzzles. User needs to drag and drop the shape with a different color to the assigned place. It includes the shape of animals, alphabets, numbers, transportations and so on.

2.2.3.1 Advantages and Drawbacks

“*Puzzle for Kids Learn Colors*” comprises with simple games which is puzzle games. Puzzle games were easy to understand and play. Next, this application provides different types of puzzle games. Users can choose to play with the puzzle of animals, shape, number, alphabet and so on.

“*Puzzle for Kids Learn Colors*” only provide drag and drop function. No storyline, instructions, informations, interactions and feedbacks provided in this application. The menu button and drag and drop function was the only interaction provided. No audio or sounds compatible with this application. No feedback provided no matter the users success or failed to match the puzzle.

The advantages of this application were concluded in the list below.

- i. Provides different types of puzzle games for the user.
- ii. Comprises with simple games. Puzzle games were comprised in this application.

Meanwhile, the drawbacks of the application listed below:

- i. Lack of storyline.
- ii. Lack of instruction. No instruction was provided in this application.
- iii. Lack of information. No information was provided.
- iv. Lack of interaction. The interactions provided in this application were menu button and users have to drag and drop the shape for the game. No sound was compatible with this application.
- v. Lack of feedback. No feedback comprises in this application.

2.2.3.2 Screenshot






Figure 2.14: Main menu of “Learn Colors”.

2.2 Comparison of Existing Systems

The system that discussed in previous sessions was compared in this session. The result of the comparison was summarized in the table 2.1.

Table 2.1: Comparison of Existing Systems.

	<i>Learn Colors For Kids</i>	<i>Colors For Kids</i>	<i>Learn Colors</i>
Screenshots			
Tutorial	N/A	Provided in the option of “ <i>learns colors</i> ”	N/A
Audio	Instructions were delivered in the form of audio and text.	Provided upon purchase.	N/A
Sound Effect	Provided upon button is clicked	Provided upon purchase	N/A
Interaction	- Button	- Button - Click on object	- Button - Drag and drop the shapes
Storyline	N/A	N/A	N/A
Instruction	Provided with less information.	N/A	N/A
Feedback	A picture is shown after the user completes the task	N/A	N/A

Summary

Findings show that there are some considerations should be taken into account in the development of a photorealistic augmented reality color learning tool on the Android platform. The technology and platform used must be chosen precisely in order to achieve the objectives of this project. Beside, the requirements needed to develop a color learning tool must also need to take into account in order to deliver the tool effectively. Next, this project will focus on the methodology that needed for this project.

CHAPTER 3

METHODOLOGY

This chapter will continue in discussing on the research activities and methodology that used in this project. The method to gather data and analyze data will be further explained in this chapter. Next, the methodology that used to conduct this project also will be discussed in this chapter.

3.1 Research Activities

This session covered the research activities for this project. Method to collect data and the way to analyze the data also further discussed in this session. A few methods were used for data gathering. These methods will be explained in details later. Besides, several methods also used for analyzing the data. The methods will also be discussed in details.

3.1.1 Data Gathering/Collection

A few methods were discovered to collect data. The data gathering was made through online searching, observation and analyzing data for this project.

First of all, the basic requirement of a learning tool is to investigate from the internet and books. A learning tool should meet with a few basic requirements in order to deliver the lesson effectively.

Next, observation is made to analyze existing applications. As discussed in the previous chapter, a few existing systems were analyzed and evaluated for data collection. These existing systems were chosen based on their platform, function and target users. Next, these systems were compared in order to analysis the functions of the systems. These systems were also compared to check whether it met the basic requirement of a learning tool.

3.1.2 Analysis of the data

Data shows that, a learning tool should provide the interaction between users, activities and environment. To develop an effective learning tool, developer has to answer a few questions. Who are the users? What are the objectives of the activities? What is the activity that suitable for the learning environment? What is the expected outcome? (Lorna, 2007) Developer has to take themselves as the users and think from the view of the users in order to deliver the learning tool effectively. Last but not least, the data that gathered for the developers need to be analyzed in order to produce a good learning tool.

Next, the comparison result shows that most of the color learning tool available in the market comprises with some inefficiencies. The data that gathered has been discussed in the previous chapter. Hence, product development

methodology will discuss on the next part of this chapter in order to develop an interactive augmented reality color learning tool on android platform.

3.2 Product Development Methodology

Figure 3.1 shows the prototyping model that used as the methodology for this project. There are 8 stages involved in this model. Each stage will be explained later.

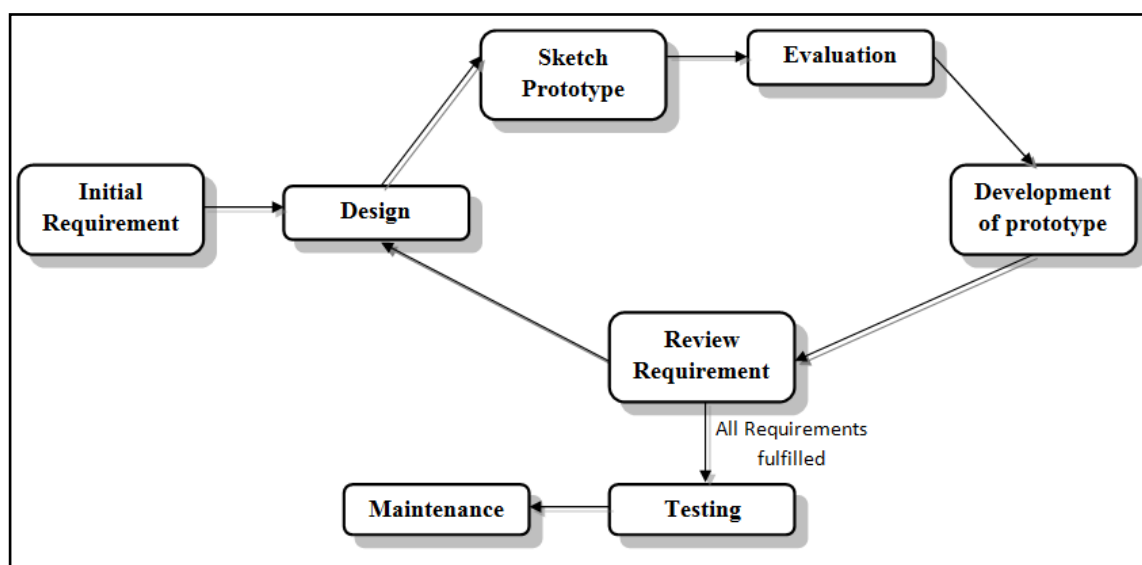


Figure 3.1 Prototyping model for “Finding Pixie”

3.2.1 Initial Requirement

All requirements of the application were listed based on the user needs. Beside this, the requirements were also identified by comparing existing system. The requirement was stated to overcome the inefficiency of existing systems. Basically, the requirement needed listed below:

- Interactive interface to attract users.
- Storyline to make the application more interesting.
- Interaction to keep users attracted.
- Feedback to provide information.
- Audio to help in terms of interactivity.
- Games to help users learn better.
- Tutorial to expose the knowledge which is the colors that aimed to deliver to users.
- Instruction to help users in term of ease of use of this application.

3.2.2 Design

A few elements will be designed at this stage. The characters, background image, layout, interaction, interactivity, storyline will be design at this stage. All these elements are hoped to help the user in understanding the color of the rainbow. The element is designed based on the requirement stated in the previous stage.

3.2.3 Sketch Prototype

A prototype will be sketched in this stage. The prototype will be a sketch based on the requirement and design in the previous stage.

3.2.4 Evaluation

Prototype builds in previous stage will undergo evaluation in this stage. If the prototype is approved, the project will continue to the stage of development.

3.2.5 Development of prototype

The prototype will build based on the element in previous stages. The development process will include the IDE, JDK, SDK and so on.

3.2.6 Review Requirement

The application will undergo review to check whether it fulfills the entire requirements. If the application fulfills the entire requirements, the application will be undergo stage of testing. Else, it will continue with the stage of design of next requirement.

3.2.7 Testing

The application will be tested on the users. Twenty users will be requested to do the testing of the application. The testers will be selected randomly from a day care center or a kindergarten. The result of testing will be recorded to evaluate the effectiveness of the application. However, the result of testing will also record for maintenance if there is any need for maintenance.

3.2.8 Maintenance

Lastly, the application will undergo maintenance if and only if there is any need to update the application.

3.3 Project Requirement

This session discussed all the information required in the development process of this project, including the hardware requirement and software requirement. Next, the analysis of each hardware and software requirement also been done in this session.

3.3.1 Hardware requirement

The hardware required to carry out the development process are:

- Laptop with processor of 2.4GHz and 2GB of RAM
- Android Smartphone with version of 4.1.1 or above for testing

3.3.2 Software requirement

The software needed to conduct the development process are:

- Android SDK
- Eclipse IDE
- Adobe Illustrator CS4
- Adobe Flash CS4
- Java development kit
- OpenCV 4.2.2 library

3.3.3 Hardware and Software Requirement Analysis

The hardware and software that described below needed to help in developing this project. The analysis of the hardware and software were attached in the table 3.1 and table 3.2.

Table 3.1: Hardware requirement analysis

Hardware	Specification	Description
Laptop	<ul style="list-style-type: none"> • 2.4 GHz processor • 2GB RAM 	A laptop with the specification needed to install all the required software in order to carry out the development process
Android Smartphone	<ul style="list-style-type: none"> • Version of 4.1.1 or above • Camera • Installed OpenCV library Manager 	OpenCV library manager needed to install in order to support the launching of application of OpenCV in the device.

Table 3.2: Software requirement analysis

Software	Description
Android SDK	<ul style="list-style-type: none"> • Android SDK version 4.2.2 with API level 17. • Contain API libraries that needed to build Android application. It comprises with emulator, Android SDK manager and so on.
Eclipse IDE	<ul style="list-style-type: none"> • A platform to enable developer to develop application using source code • Eclipse 3.6.2 (Helios) or greater needed to suit Android SDK 4.2.2 • Eclipse 4.2.0 (Juno) was used in this project
Adobe Illustrator CS4	<ul style="list-style-type: none"> • Version of CS4 was used. • A graphic editor used to create and design all the graphic needed for this project
Adobe Flash CS4	<ul style="list-style-type: none"> • Version of CS4 was used. • An authoring tool used to create and design all the animation needed for this project
Java development kit	<ul style="list-style-type: none"> • JDK 6 or greater needed to compatible with Android 4.2.2 • JDK 7 was used in this project.
OpenCV library	<ul style="list-style-type: none"> • Designed for real-time application • Version of 2.4.4 was used in this project.

3.4 Gantt Chart / Milestone

Gantt chart for this project will be attached as Appendix A.

Summary

In a nutshell, methodology that discussed above is important to help developer in developing the application smoothly. The methodology that used was prototyping model. All the hardware and software chosen must be compatible with each other in order to optimize the performance. In next chapter, analysis of product will be discussed.

CHAPTER 4

ANALYSIS

Analysis of product was done in this chapter with the help of data collected in the previous chapter. The analysis of the collected data is fundamental in order to keep the project in the right track. Hence, user requirement and system requirement was covered in the analysis of product.

4.1 Project/Product Analysis

Analysis of user requirement and system requirement was done in this session. Each of the analysis of user requirement and system requirement was explained in details based on the needs of the project.

4.1.1 User requirement

To gather the data for user requirement, a few existing systems have been tested and analyze in order to identify the element that should comprises in a color learning tool. Beside this, resources from the internet also used as a guideline to identify the element should be included in a learning tool.

The target user for this project was toddlers. Since toddlers were kids among 1-3 years old, all the elements in the application such as interaction, user interface, feedback and so on must be well designed. There are so many existing color learning tool that's available in the market, however, these color learning tools did not deliver the learning element effectively. Hence, an interactive color learning tool that enables users to learn while having fun is needed to be created.

In order to deliver the message effectively, the interface must be simple and easy to understand to ease the users. The user interface should be menu driven, which means that instruction, menu or help screen should be provided to guide users.

The application should comprise with interactive elements such as a sound effect, feedback, interaction and story to attract users. Last but not least, the tutorial should be provided for the user as it is a color learning tool. At the end of this project, users of the application were expected to gain knowledge regarding the color of the rainbow.

4.1.2 System requirement

First and foremost, Android platform was chosen while there are many other options that can be chosen. To develop a system on the Android platform, Android SDK is needed to be setup on the device that used to develop the system. The Android SDK enables the access of libraries and API for Android platform. Next, a laptop with windows XP, Vista or Windows 7 needed in order to compatible with the Android SDK 4.2.2 that is used for developing the application. In this case, an Asus A42Jv laptop that's running on the operating system of windows 7 with 2.4 GHz processor and 2GB of RAM was chosen. OpenCV library required to be imported into the workspace in order to access the feature provided by OpenCV manager. Last but not least, OpenCV manager also required to be installed on the device that used for testing.

4.1.3 Photorealistic Color Implementation

Photorealistic color was chosen to implement in this project. This technique was chosen to produce high quality virtual scene in the real-time environment. First of all, the technique of color detection was implemented in the application. Color was detected in the format of HSV. However, the value of HSV was converted to the value of RGB in the project. Next, a range of RGB value of each color was defined and set as the color range in the application. Lastly, the RGB value that converted from the detected HSV value was compare with the range of an RGB value in the application. If the value of the RGB colors was matched, then the application will proceed to the next task. However, if the value of RGB was not matched, an error message will be displayed on the application.

Summary

User requirement and system requirement play an important role in developing an application. Both of user requirement and system requirement play an important role in term of efficiency. However, system requirement also play an important role in accessing the application. The efficiency of the application maybe affected if the system does not compatible with the application.

CHAPTER 5

DESIGN AND IMPLEMENTATION

This chapter elaborated the design and implementation of this project. Design and implementation is important as it shows that the project will undergo the stage of developing in methodology. Design is important as it play an important role as it involving in exposing the application to the users. Implementation will focus at the back-end of the project. The functions of the application will develop in this stage.

5.1 Design/Product Process

This session discussed about the process of design. A design architecture was done in order to proceed with the development process. Navigational structure, initial design and final design was done in this session. Next, the process of development of the product will be covered in this session.

5.1.1 Design Architecture

Before entering the phase of implementation, design for the application needed to be done to smoothen the project. Hence, this section described the design of the character and interface. The design must be simple to ease the users in understanding the system. The main theme of “*Finding Pixie*” is set to be rainbow and blue color as it will guide the users in learning the color of the rainbow.

5.1.1.1 Navigational Structure

The navigational structure of the application of *Finding Pixie* was firstly created in order to keep the development process on track. Navigational structure will also ensure that all requirements of the application completely identified.

The application of *Finding Pixie* consists of three modules which are main module, tutorial module and game module. From the main module, users can choose to enter the tutorial module or game module. If the tutorial module was chosen, a menu for the tutorial will be displayed. From the menu of the tutorial, users can choose to view the tutorial of each color of the rainbow randomly. Next, if the users choose game module instead of tutorial module from main menu, menu of the game will be shown. Once the users choose to play the game, the users requires to complete all of the game for each color of rainbow in sequence. The sequence of the color of rainbow were red, orange, yellow, green, blue , indigo and purple. Figure 5.1 shows the navigational structure of the application of *Finding Pixie*.

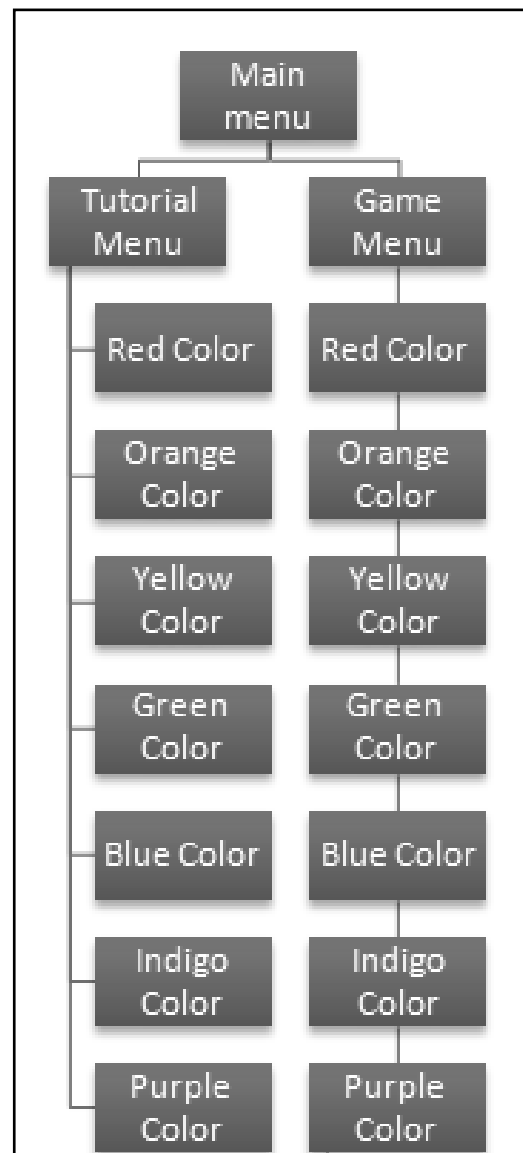


Figure 5.1: Navigational structure of Finding Pixie

5.1.1.2 Initial Design

Design was important in the development process of an application. Every single element of the application needed to be well designed in order to help the users. In the application of Finding Pixie, there are a few elements needed to be designed before the development process. These elements include the main object and main character of the application.

Rainbow was chosen as the main theme of Finding Pixie as this application aimed to help toddlers in learning color of rainbow. Hence, a rainbow was sketch to use it in future. Figure 5.2 shows the initial design of the rainbow.

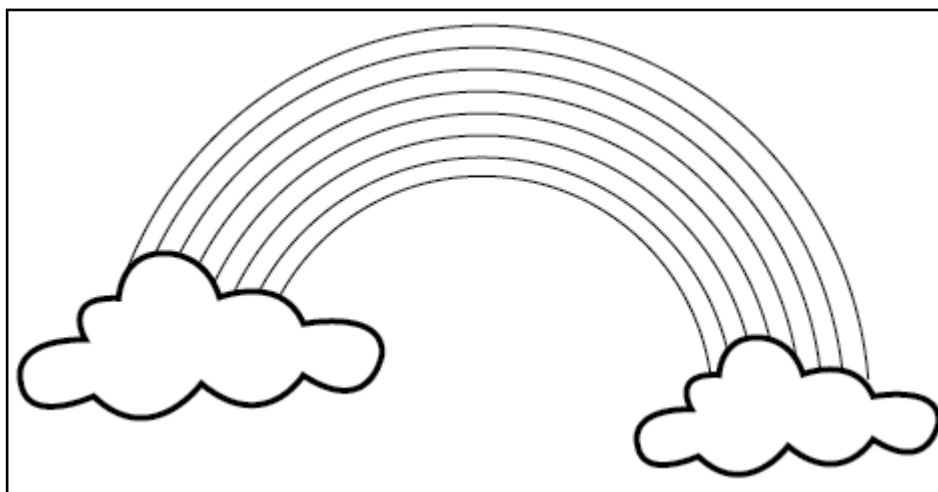


Figure 5.2: Sketch of rainbow

Next, a character was designed to use as the main character of the application. Figure 5.3 shows the initial design of the main character of *Finding Pixie, Pixie*.

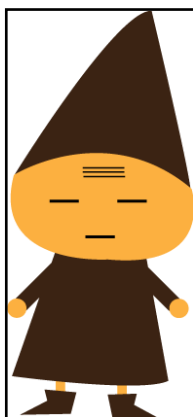


Figure 5.3: Main character of “Finding Pixie”, Pixie.

The process of design proceeds to design the little Pixie which used to represent each color of the rainbow. Figure 5.4 shows the design of little Pixie, starting from the left, Rexie, Oxie, Yexie, Gixie, Blixie, Inxie, and Purxie.



Figure 5.4: Children of Pixie.

5.1.1.3 Final Design

This session discussed the final design that used to proceed with the development process of the application. Each of the initial design that discuss in previous session was further update with the final design.

The initial design of the rainbow that shows in figure 5.2 was further designed by adding the color. Figure 5.5 shows the final design of the rainbow.



Figure 5.5: Final design of Rainbow

There is a minor change in the design of the character Pixie. This change is hoped to let toddlers able to differentiate the character of Pixie and his children. Figure 5.6 shows the final design of Pixie.

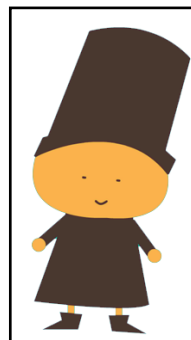


Figure 5.6: Final design of Pixie

Although there are minor changes for the design of Pixie, there are no any changes made to the children of Pixie. Figure 5.7 shows the final design of children of Pixie that free of changes.



Figure 5.7: Final design of children of Pixie.

5.1.2 Product Development Process

This session discussed the product development process of *Finding Pixie*. System architecture and the flow of development process will be further explained later.

5.1.2.1 System Architecture

Figure 5.8 shows the system architecture used to develop the application. There are six elements involves in the system architecture. Each of the elements in the system architecture will be further explained.

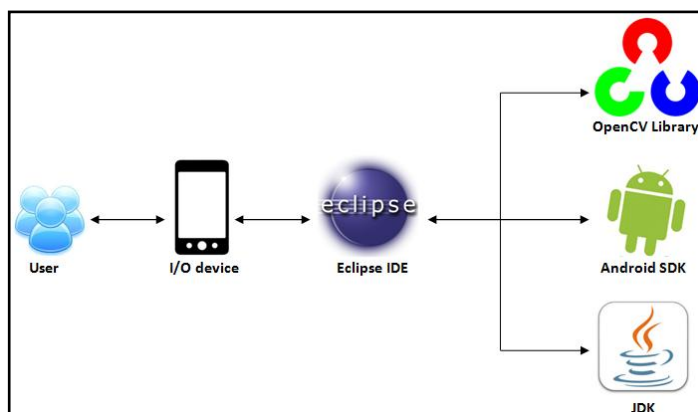


Figure 5.8: System Architecture

According to figure 5.5, there are six elements in the system architecture. Each of the elements was further elaborated in the list below.

- User

User acts as the user of “*Finding Pixie*”. The target user of “*Finding Pixie*” was toddlers who were the children from age 1-3 years old.

- I/O device

I/O device was the android device for this application. The version of the device should be 4.2.2 and above.

- Eclipse IDE

Eclipse integrated development environment (IDE) were used in developing this application. Eclipse IDE act as the editor and integrate library, SDK and JDK needed for this application.

- OpenCV library

OpenCV library version 4.2.2 was used for this application. View of camera was done by using the class of JavaCameraView in this library. Next, detection of color was done in this class of camera view.

- Android SDK

The Android SDK enables the application to run on the android platform. It includes the required library for developing an Android application.

- JDK

The Java development kit was installed in order to use the Java language to develop interface and create interaction for the application. Java was used in Android Activity for the development of application. Last but not least, Java was used to retrieve the classes available in OpenCV library.

5.1.2.2 Development Process for android application

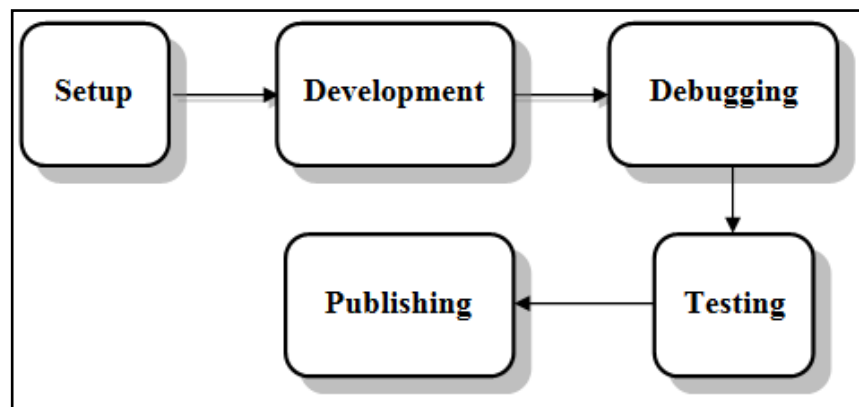


Figure 5.9: Development Process

There are five stages in development process of an Android application as shown in figure 5.9. Details of each stage will be further explained in the next session.

- Setup

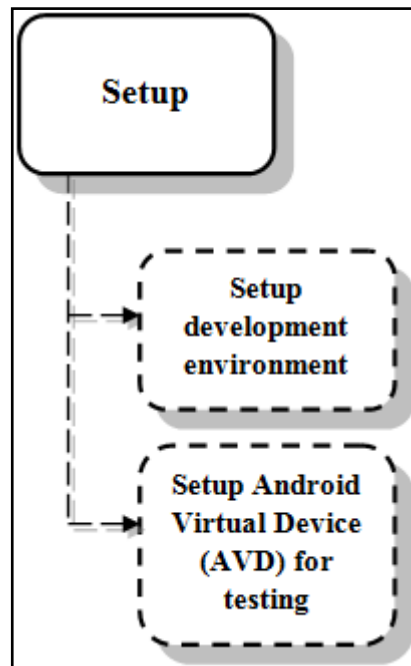


Figure 5.10: Process of setup

As shown in figure 5.10, the process of setup involving two stages.

First, it is a need to setup the development environment in Eclipse IDE. OpenCV library, Android SDK and JDK were imported to Eclipse IDE in order to proceed with the development process.

Next, Android Virtual Device (AVD) was set up in order to test the application in the phase of testing. Android SDK comprises of Android emulator. However, the emulator was not used in this project as the emulator can only display the interface for the application. The camera of the emulator was not functioning. Hence, an Android device was connected with Eclipse IDE to act as AVD for this project.

- Development

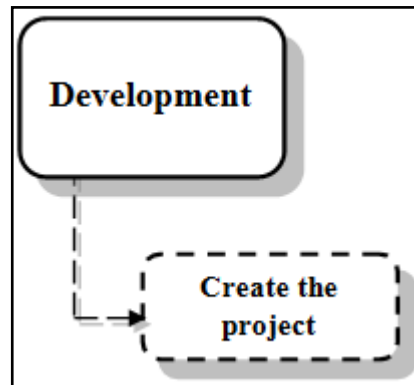


Figure 5.11: Process of development

Figure 5.11 shows the process of development. After setup the entire element for development environment, this project was continuing with the process of development. The project was created with JDK and the classes from Android SDK and OpenCV library. The project was developed by using Java as the source code. All the media such as picture and sound was added to the source file in order to retrieve in the project. Interaction of this application created by using Java programming language, integration between the project and android device done by using Android SDK. Last but not least, the color detection part done by using OpenCV library. The detected color was in the format of HSV, however, it then convert to RGB by using the predefined classes of OpenCV.

- Debugging

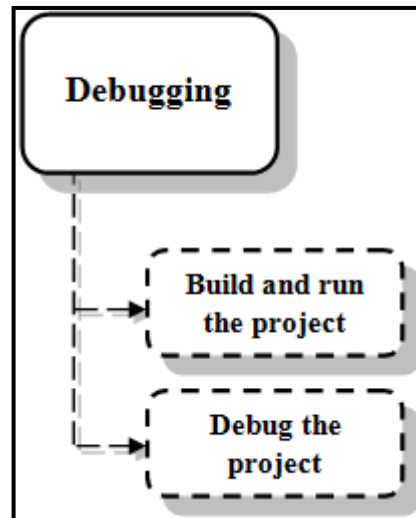


Figure 5.12: Process of debugging.

After create the project in the phase of development, the project will enter the phase of debugging. This phase involving build, run and debug the project. Any detected of error needed to solve in order to proceed.

- Testing

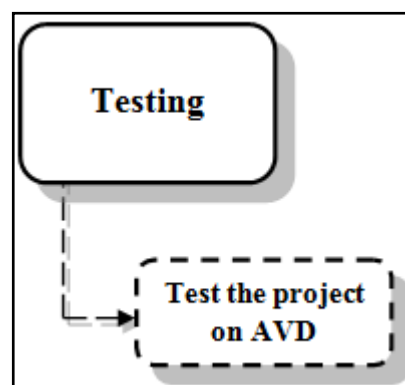


Figure 5.13: Process of testing

Next, the project was tested on AVD that have been set up in the phase of setup. If the project able to run on the AVD, the project will be continue with the phase of publishing. Else, the project will be re-enter the phase of debugging. Error needed to be traced and solve in order to proceed.

- Publishing

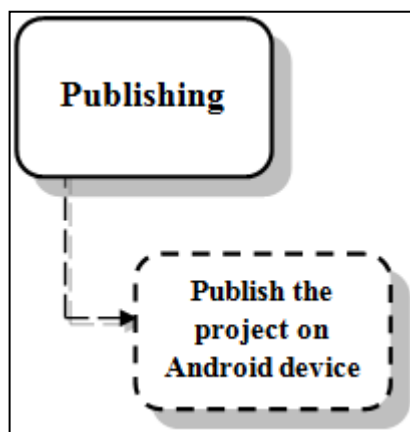


Figure 5.14: Process of publishing

Last but not least, the project will enter the publishing phase. It is publish in order to distribute to other user.

5.2 Summary

Design and implementation of this project has been discussed in this chapter. In a conclusion, a good design and implementation can optimize a color learning tool. Hence, this element should be taken into serious consideration as it involving the whole development process.

CHAPTER 6

TESTING AND EVALUATION

This chapter discussed the testing process for this project. The application has to pass the testing and ensured that it is well developed. A test plan which consists of several testing approaches was prepared and conducted to ensure that the application has pass all the tests and meet its requirement. The testing approaches will be further discussed later. At the end of this chapter, the collected testing result was analyzed and reviewed on the effectiveness and user acceptance towards the application.

6.1 Test Plan

A test plan is the initial of a testing process. It acts as the main concept of all testing process. A good test plan can help the developer in enhancing their application into a better application. This test plan covered unit testing, integration testing, testing organization, testing environment, and testing schedule

6.1.1 Unit Testing

A unit testing is a development process where developers conduct testing of the developed application. The intention of unit testing is to verify each unit of the application can perform as designed. Unit testing of this project will be done based on the requirement of the project. This session will cover the hardware and software used, and unit test case.

6.1.1.1 Hardware

Hardware used in this testing involved a personal laptop and a personal smartphone. Personal laptop chosen was Asus A42J with Windows 7 Intel Core i5 and 2GB of RAM. Additional devices that come with the laptop was mouse and speaker. On the other hand, the personal Smartphone used to be Samsung Galaxy S3 I9300 with android of version 4.1.1. USB wire was used to connect the personal Smartphone and laptop.

The details of the personal laptop and personal Smartphone were listed in the table below.

Table 6.1: Summarize of details of hardware.

	Personal Laptop	Personal Smartphone
Model	Asus A42J	Samsung Galaxy S3 I9300
Specification	Windows 7, Intel Core i5, 2GB RAM	Android version 4.1.1
Additional device	Mouse, Speaker	USB Wire

6.1.1.2 Software

There are a few softwares that involved in the testing process. These softwares are listed below:

i. Android SDK

Android SDK was imported into the workspace in the Eclipse in order to run the application on the Android platform. Android SDK act as a medium to integrate the connection between Eclipse and the Android Virtual Device (AVD).

ii. OpenCV Manager

OpenCV manager enable the camera view on the device while running the application.

iii. Eclipse IDE

Eclipse IDE generate the application in the format of apk. Apk file is used to install the application in the AVD.

iv. Microsoft Office

Microsoft Office was used to record the results of the testing.

6.1.1.3 Unit Test Case

Unit testing in this project is designed to test whether the application of Finding Pixie fulfills the requirement that stated in the previous chapter. Basically, Finding Pixie requires to deliver the tutorial and game of each color of the rainbow. Beside this, Finding Pixie has to provide instruction and explanation in the form of animation and audio. It also has to provide the feedback for every interaction. Each of the requirements was explained in the unit test case. The unit test case is attached as Appendix B.

6.1.2 Integration Testing

Integration testing is the process to confirm that each interaction can perform according to their requirement. Integration testing for Finding Pixie carried out based on the module available. Integration testing done with testing the feature function based on the navigation of each module. The modules that available in this application was listed in the session of critical modules. This testing also covered the navigational structure, interfaces among modules, order of integration and integration test case.

6.1.2.1 Critical Modules

There are three types of module involve in this application. Figure 6.1 shows the navigation between each module and the modules were listed below :

i. Main Module

From the main module, users can choose to proceed to tutorial module or game module.

ii. Tutorial Module

Tutorial module consists of the tutorial of each color of rainbow. Details of this module will be covered in the session of 6.1.2.2.

iii. Game Module

Game module consists of games. The flow of this module was in the sequence of color of rainbow. Details of this module will be further elaborated in the session of 6.1.2.2.

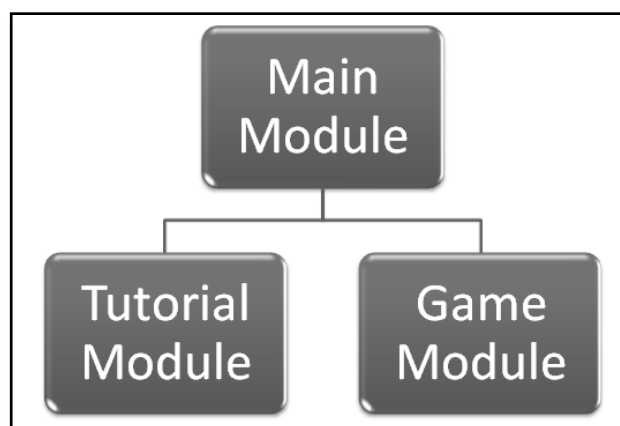


Figure 6.1: Navigation between each module.

6.1.2.2 Interfaces among modules

Each module has a different structure and interfaces. The flow of each module was further explained using diagrams.

Firstly, the application was launched in the main module. If launching success, the application will enter the main menu. User can navigate to tutorial module or game module in the main menu. Figure 6.2 shows the flow in the main module.

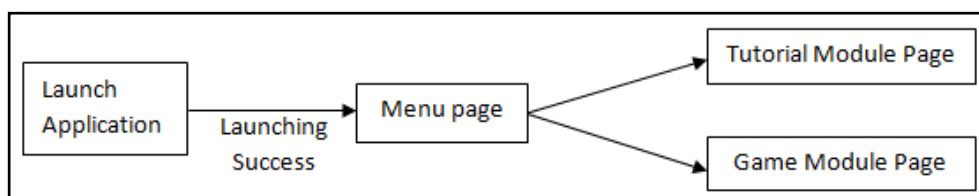


Figure 6.2: Flow of main module

Next, the application will enter the tutorial module if the tutorial button was chosen by the user. From the menu of tutorial module, user can choose to view the tutorial on each of the colors of the rainbow. Figure 6.3 illustrates the flow of tutorial module.

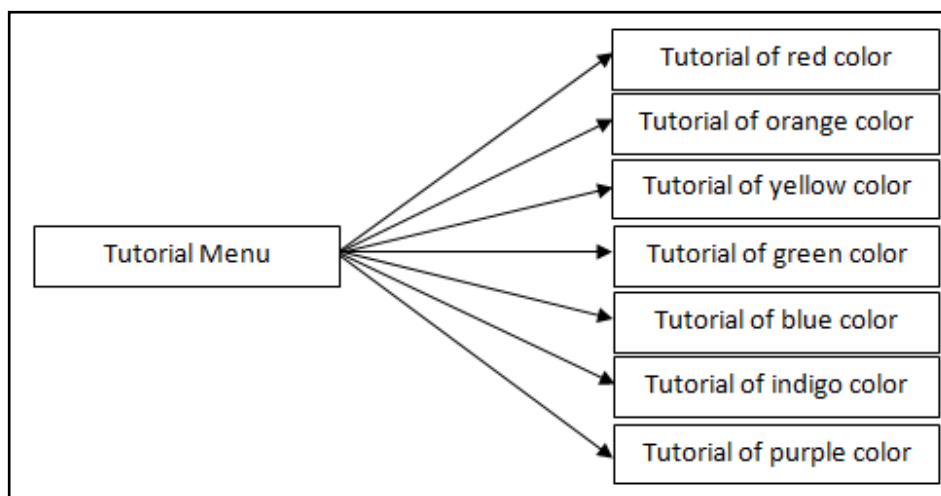


Figure 6.3: Flow of tutorial module

Lastly, the application will enter the game module if the game button was chosen from the main menu. From the menu of game module, user can choose to start the game or back to main menu. The color games will be shown according to the sequence of the color of the rainbow. The flow of game module illustrated in figure 6.4.

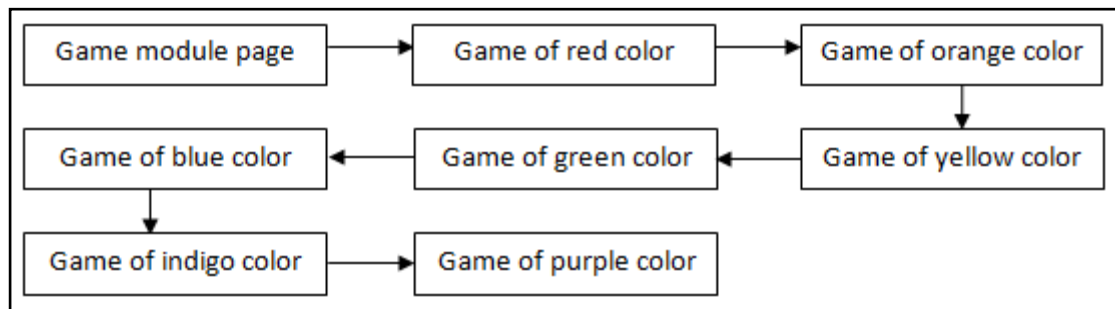


Figure 6.4: Flow of game module

6.1.2.3 Integration Test Case

Integration testing in this project is aimed to test whether the flow of the application was on the track as designed. Each of the navigational elements was explained in the integration test case. The integration test case was attached as Appendix C.

6.1.3 System Testing

After completing the unit testing and integration testing, the application undergo system testing which involve the whole complete system. System testing test for every input to check for the desired output.

6.1.3.1 System Test Case

The system test case focuses on the fully integrated system. This testing aimed to verify each input command. A color palette was prepared for this testing. Lastly, a test case was designed to carry out system testing. System test case is attached in the Appendix D.

6.1.4 Acceptance Testing

In acceptance testing, twenty toddlers were chosen to carry out this testing. Other than the developed application that is Finding Pixie, a color learning tool was selected from the market to be used in this testing. Testers will explore each of the application and answer a question sheet after each exploration.

The statistics of the results will be counted based on the answers provided by the users. The effectiveness of each application will be identified based on the statistics.

6.1.5 Testing Organization

Testing organization is to identify the user type that takes part in the process of testing for this application. Basically, there are two parties will be involved in the testing process of the application of Finding Pixie, which are the developer and the testers. The testers were a group of 15 toddlers that made up from the three main races in Malaysia. Five toddlers will be selected from each race as the testers.

There are a few testing approaches that involved in the whole testing process. The developer will involve in all of the testing approaches of the application. However, testers will only involve in the acceptance testing.

6.1.6 Testing Environment

Test environment concern about the configuration and setup of the location and environment of testing to be performed. Different testing approaches may require different testing environment.

For the testing of this application, unit testing, integration testing and system testing were done on a workstation. The proper workstation should be equipped with the hardware and software that stated in the unit testing.

Meanwhile, acceptance testing is carried out at kindergarten Chung Hua Pasir Panjang, Negeri Sembilan and Taska UTeM which located in the main campus of UTeM. Users will be tested with an existing application that is available in the market and the developed application which is Finding Pixie. Users are required to explore each of the application and answer a few of color related questions.

6.1.7 Testing Schedule

Testing schedule is prepared to organize the testing into a proper timeline. The schedule is shown in the table below.

Table 6.2: Testing schedule

Task	Date	Duration (min)
Unit Testing	12 th August 2013	30
Integration Testing	13 th August 2013	30
System Testing	14 th August 2013	30
Acceptance Testing	16 th August 2013	300

6.2 Test Implementation Process

This session discussed the process on how the testing was carried out. Overall, the testing involves only two organizations, which are developer and testers. The testing implementation process was further explained in the session of 6.2.1.

6.2.1 Test Description

Generally, the testing was divided into two parts and involves three places. Unit testing, integration testing and system testing takes place in a room which set up as a workstation. However, acceptance testing takes place in two places which are Taska UTeM and Kindergarten Chung Hua Pasir Panjang.

Unit testing, integration testing and the system testing perform by developers using the developed prototype and test cases in the test plan. The test result was recorded in the test cases. Unit testing was performed while the developer is developing the source code. This is to determine whether a specific function of the code working properly. Integration testing is to ensure the entire module and the function is working together properly after unit testing complete. System testing will test the application as to verify its functionality. The developer will continue to work on the source code until the desired output is obtained if there is any testing failed. At the end, a complete prototype was developed and is ready to be tested in acceptance test.

After the system testing, the prototype will be tested for acceptance testing to ensure the prototype satisfied the detail requirement. In this project, 20 testers were selected to carry out acceptance testing. First of all, 10 students from each place was selected and divide into two groups. First of the group was tested with an existing color learning tool from the market, *Color for kids*. Another group of students explored the developed prototype which is *Finding Pixie*. After the exploration of the application, the students required to answer a few color related question. The question will be attached in the next session. The level of effectiveness of the application was determined by the result and observation.

6.2.3 Review Question for Acceptance Testing

A set of seven simple question was prepared for the tester to evaluate the effectiveness of the application. Testers required to answer the question after they explore the application. The question was attached as Appendix E.

6.2.3 Test Data

The test data are based on the answer provided by the tester, which is according to the following criteria:

- Number of correct answers provided by the tester

A total of seven questions was answered by the testers. The effectiveness of each application will be determined with the data collected which is the number of correct answer provided by the tester.

6.3 Testing Results and Analysis

This section will cover the analysis of data collected from users during the acceptance test. The detail of the participant of the acceptance test can be summarized as follows:

Table 6.3: Details of tester

Number of tester	20 persons
Age	3 and 4 years old
Race	10 Malays, 6 Chinese, 4 Indians

6.3.1 Analysis of Test Results

Test results were determined based on the number of correct answers provided by the tester. The number of correct answers provided by testers that use the developed application, *Finding Pixie* and available application from the market, *Color For Kids* was calculated and compose in two graphs. Figure 6.5 shows the analysis of results provided by the tester of *Finding Pixie* while Figure 6.6 shows the analysis of results provided by the tester of *Color For Kids*.

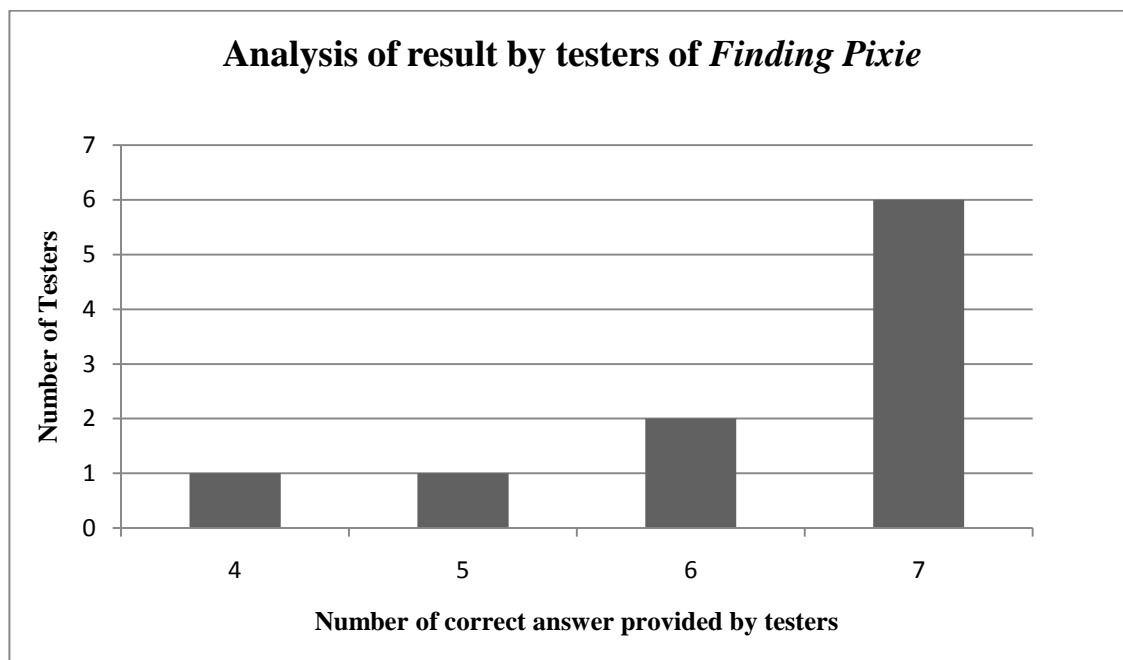


Figure 6.5: Analysis of the result by the testers of *Finding Pixie*

Based on figure 6.5, there are six out of ten testers answering all the question correctly. The remaining of four testers provide different numbers of wrong answers. There are two testers answer six out of the seven questions correctly. However, there are two testers provide one wrong answer and two wrong answers respectively.

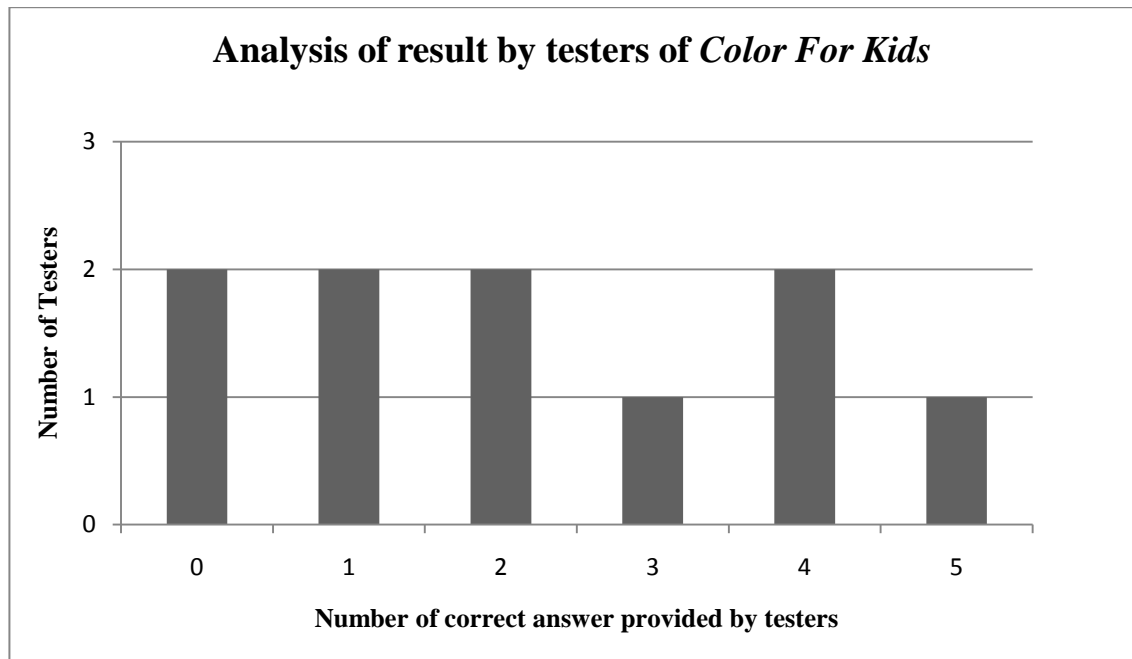


Figure 6.6: Analysis of the result by the testers of *Color For Kids*.

The analysis of results provided by the testers of *Color For Kids* are much more different compare to *Finding Pixie*. Based on figure 6.6, one out of ten testers answering five the question correctly and one of the testers answer three questions correctly. The remaining of eight testers provide different numbers of correct answers. There are two testers answer four questions correctly and two of the testers provide two correct answers. Last but not least, the number of testers that provide one correct answer and none correct answer were two respectively

Based on the results of the analysis, *Finding Pixie* was more effective compare to *Color For Kids*. The analysis of correct answers provided by the testers can proof that *Finding Pixie* was efficient in the effort of delivering tutorial of color. This is because *Finding Pixie* enables the users to interact with the real and virtual world at the same time. Beside this, *Finding Pixie* was an effective interactive color learning tool because interactions, games, and the tutorial was provided in the learning tool. Users can have fun while learning.

On the other hand, based on observation, *Finding Pixie* was more engaging compare to *Color For Kids*. *Finding Pixie* comparatively more attractive to *Color For Kids*.

An interview was made towards the teacher of Taska UTeM. According to the teacher of Taska UTeM, *Finding Pixie* able to deliver the knowledge effectively as the users can play while learning the colors.

As a conclusion of the analysis, *Finding Pixie* was effective in delivering a color learning tool on the Android platform. Users can be easily engaged with the tutorials or games in the application as the application was interactive.

Summary

The testing process is important to ensure the application was functioning as intended. This chapter had discussed each testing approach in details. The results of unit testing, integration testing and system testings show that *Finding Pixie* met all the requirement for an interactive color learning tool. On the other hand, the acceptance testing proved that *Finding Pixie* is effective in delivering an interactive color learning tool on the Android platform. As a conclusion, the application of *Finding Pixie* has fulfilled all the requirements and achieved the objective stated.

The strength and the weakness of the *Finding Pixie* as well as the proposition for improvement and future work will be discussed in the next chapter.

CHAPTER 7

CONCLUSION

This chapter will conclude this project. The application had passed the testing and it is well developed as an interactive learning tool. This chapter will cover the weakness and strength of the application. Beside this, it will also discuss the proposition for improvement and future work.

7.1 Observation of weakness and strength

Based on the testing and evaluation in the previous chapter, some weakness and strength of *Finding Pixie* has been discovered. Hence, this session will discussed about the discovered weakness and strength. Discovered weakness and strength is hoped to be improve in the future in order to increase the efficiency of *Finding Pixie*.

7.1.1 Weakness

There are some weakness comes along with *Finding Pixie*. The main weakness of *Finding Pixie* will be the detection of color. Detection of color may affected by several factors. If the detection of color was made in a place that insufficient light, the detection of color will fail. Beside this, the accuracy of RGB value was not reliable and make some of the color detection failed. Finding Pixie will treat the dark color as a wrong input even if the color should be the correct answer.

Next, due the limitation of the device, some of the animation may fail to play upon the launch of the application. The error message showing “can’t play the video” will be popping up if and only if the device was not compatible with the animation played.

7.1.2 Strength

Finding Pixie has provided an effective color learning tool with photorealistic augmented reality technology. The implementation of this technology enables *Finding Pixie* able to detect the color without marker. This method has brought the mobile learning tool to a new level as it implements virtual object in real time environment. *Finding Pixie* provides an interesting and fun learning environment towards the learning process. Last but not least, interactive elements that available in *Finding Pixie* makes the color learning process more effectively.

7.2 Proposition for improvement

There are some improvements that can be made towards *Finding Pixie* in order to increase the usability of the application. First of all, the detection of color was hoped to improve in order to make the detection of color smoother. Failure in the detection of correct answer will be affect the learning process as the users might have no idea on how to proceed with the application.

Next, the issue of failure in displaying the animation needed to be solve to make sure the application runs smoothly. Failure in displaying the animation may reduce the attraction of users to the *Finding Pixie*.

7.3 Contribution

This application is able to contribute to the educational field as well as the technology field. The combination of photorealistic technique with the augmented reality technology will provide an interesting and fun environment in the learning process. Since there is no similar product available in the market, the *Finding Pixie* will be the first interactive color learning tool with a photorealistic augmented reality technique that available in the Android platform.

7.4 Future Work

In future, *Finding Pixie* may improved with the accuracy of detection of the RGB value. Failure in the detection of color may irritate the users. Next, more functions may add to *Finding Pixie* in order to deliver the tutorial more effectively. Speech recognition may be added in order to ensure toddlers learn the pronunciation of the color as well as the name. Other than speech recognition, bilingual version of *Finding Pixie* was recommended to develop in order to help toddlers in learning color in other languages.

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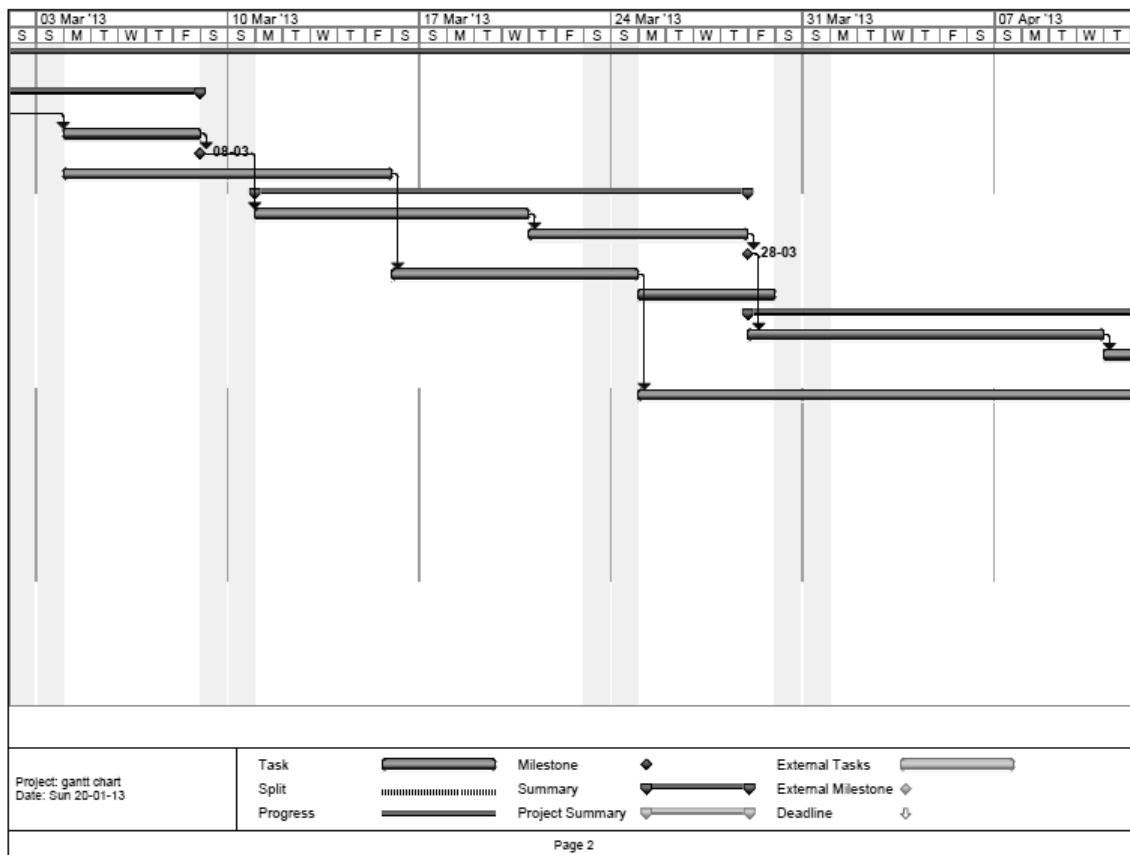
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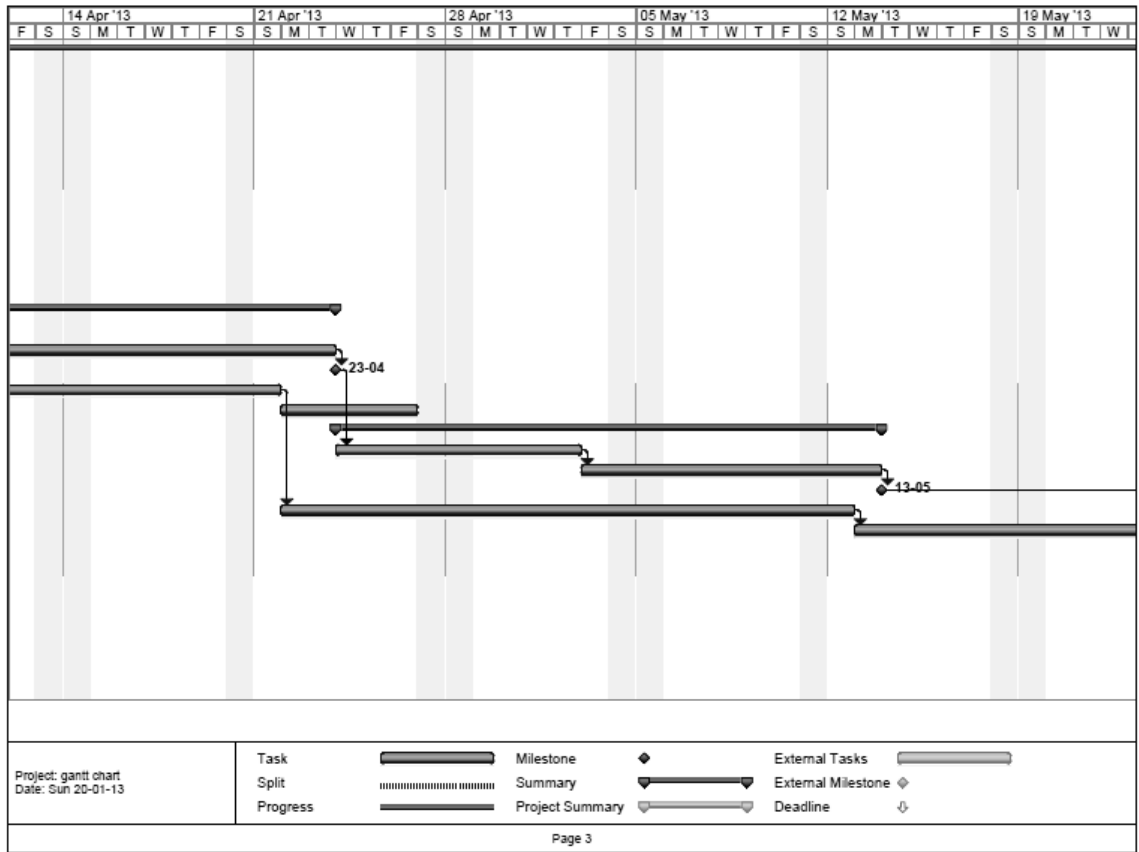
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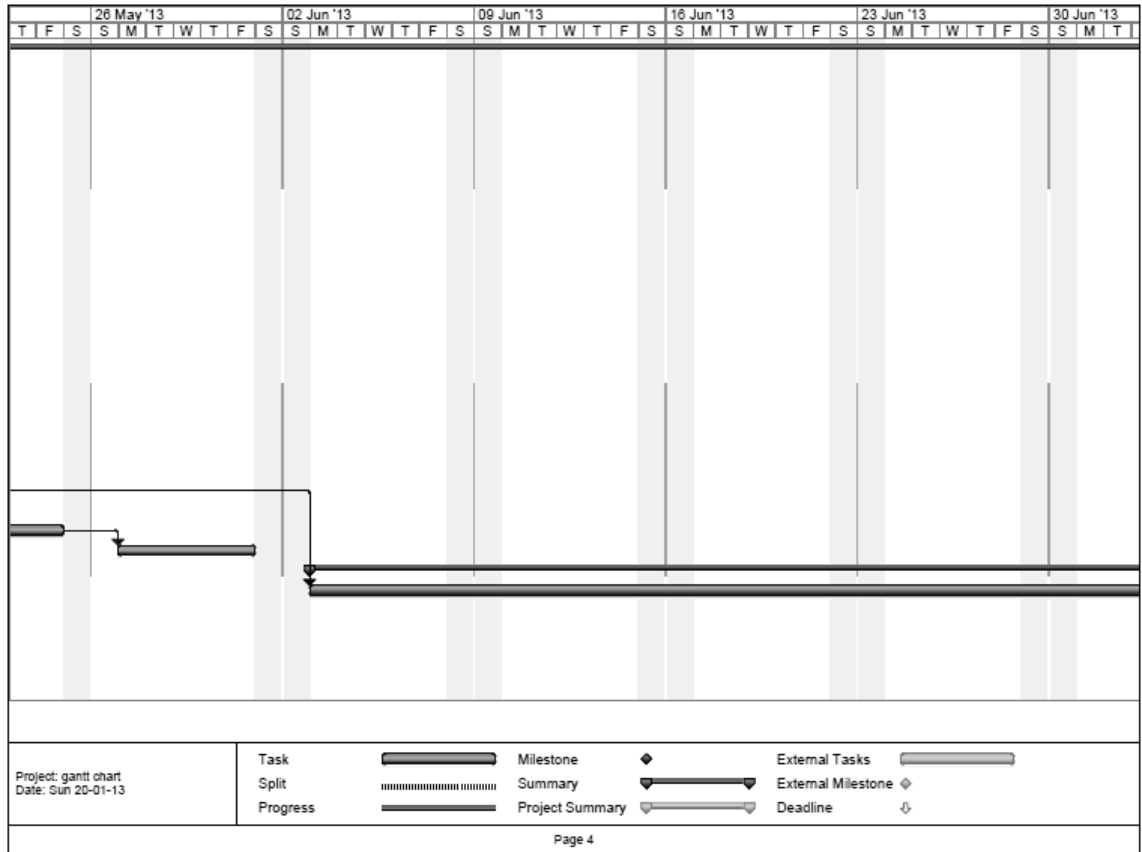
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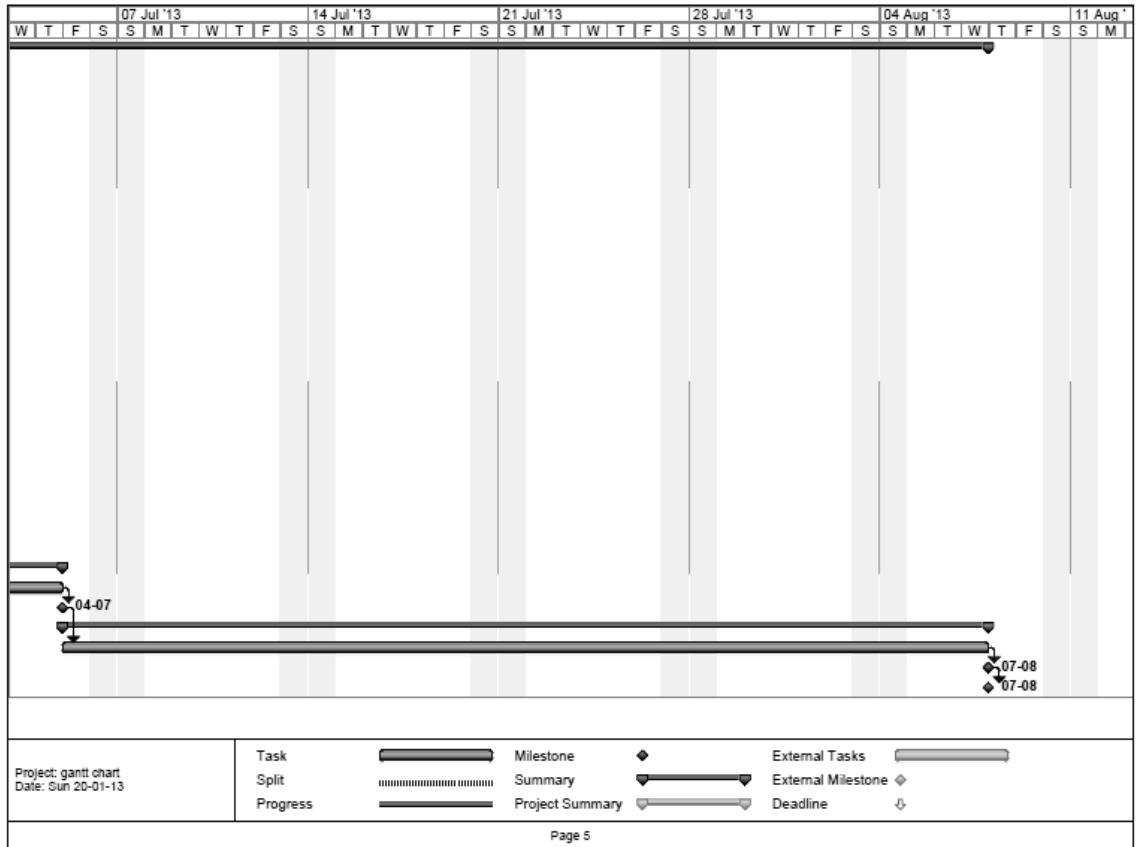
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Appendix B : Unit Test Case

No	Name	Procedure	Pre- condition	Expected Result	Result
1	Red_Tutorial	Click on the button of Rexie in the tutorial menu	None	Tutorial of red color delivered in the form of animation and audio	Pass
2	Orange_Tutorial	Click on the button of Oxie in the tutorial menu	None	Tutorial of orange color delivered in the form of animation and audio	Pass
3	Yellow_Tutorial	Click on the button of Yexie in the tutorial menu	None	Tutorial of yellow color delivered in the form of animation and audio	Pass
4	Green_Tutorial	Click on the button of Gixie in the tutorial menu	None	Tutorial of green color delivered in the form of animation and audio	Pass
5	Blieve_Tutorial	Click on the button of Blixie in the tutorial menu	None	Tutorial of blue color delivered in the form of animation and audio	Pass
6	Indigo_Tutorial	Click on the button of Inxie in the tutorial menu	None	Tutorial of indigo color delivered in the form of animation and audio	Pass
7	Purple_Tutorial	Click on the button of Purxie in the tutorial menu	None	Tutorial of purple color delivered in the form of animation and audio	Pass
8	Red_Game	Click on the button of Rexie in the game menu	Click "start" on previous interface	Instruction provides in the form of animation and audio.	Pass
9	Orange_Game	Click on the button of Oxie in the game menu	Game of red color completed	Instruction provides in the form of animation and audio.	Pass
10	Yellow_Game	Click on the button of Yexie in the game menu	Game of orange color completed	Instruction provides in the form of animation and audio.	Pass
11	Green_Game	Click on the button of Gixie in the game menu	Game of yellow color completed	Instruction provides in the form of animation and audio.	Pass
12	Blue_Game	Click on the button of Blixie in the game menu	Game of green color completed	Instruction provides in the form of animation and audio.	Pass
13	Indigo_Game	Click on the button of Inxie in the game menu	Game of blue color completed	Instruction provides in the form of animation and audio.	Pass
14	Purple_Game	Click on the button of Purxie in the game menu	Game of indigo color completed	Instruction provides in the form of animation and audio.	Pass

15	right_color	Click on the color that stated in the instruction	Click on the button of Pixie in any game	Proceed to next game.	Pass
16	wrong_color	Click on the color that not stated in the instruction	Click on the button of Pixie in any game	Display error message	Pass

Appendix C : Integration Test Case

No	Name	Procedure	Pre- condition	Expected Result	Result
1	Tutorial_Menu	Click on the button of tutorial in main menu	None	Menu of tutorial is displayed	Pass
2	Red_Tutorial	Click on the “Rexie” in the tutorial menu	None	Tutorial of red color shown	Pass
3	Orange_Tutorial	Click on the “Oxie” in the tutorial menu	None	Tutorial of orange color shown	Pass
4	Yellow_Tutorial	Click on the “Yexie” in the tutorial menu	None	Tutorial of yellow color shown	Pass
5	Green_Tutorial	Click on the “Gixie” in the tutorial menu	None	Tutorial of green color shown	Pass
6	Blue_Tutorial	Click on the “Blixie” in the tutorial menu	None	Tutorial of blue color shown	Pass
7	Indigo_Tutorial	Click on the “Inxie” in the tutorial menu	None	Tutorial of indigo color shown	Pass
8	Purple_Tutorial	Click on the “Purxie” in the tutorial menu	None	Tutorial of purple color shown.	Pass
9	Intro of Game	Click on the button of start in main menu	None	The story of Pixie is played in form of animation.	Pass
10	Menu of game	Click on the button of start in the intro page	Enter the intro page of game.	Instruction of game provided	Pass
11	Red_Game	Click on the button of Rexie in the game menu	Enter the menu page of game.	Camera view was display.	Pass
12	Orange_Game	Click on the button of Oxie in the game menu	Game of red color completed	Camera view was display.	Pass
13	Yellow_Game	Click on the button of Yexie in the game menu	Game of orange color completed	Camera view was display.	Pass
14	Green_Game	Click on the button of Gixie in the game menu	Game of yellow color completed	Camera view was display.	Pass
15	Blue_Game	Click on the button of Blixie in the game menu	Game of green color completed	Camera view was display.	Pass
16	Indigo_Game	Click on the button of Inxie in the game menu	Game of blue color completed	Camera view was display.	Pass

17	Purple_Game	Click on the button of Purxie in the game menu	Game of indigo color completed	Camera view was display.	Pass
18	Victory_page	Game of purple color completed	Complete all the game	Display the victory page of the game.	Pass
19	Right_color	Click on the color that stated in the instruction	Click on the button of Pixie in any game	Proceed to next game.	Pass
20	Wrong_color	Click on the color that not stated in the instruction	Click on the button of Pixie in any game	Display error message	Pass

Appendix D : System Test Case

No	Name	Procedure	Pre- condition	Expected Result	Result
1	Red_Game	Scan on red color	Enter the menu page of the game.	Proceed to the next game.	Pass
2	Orange_Game	Scan on orange color	Game of red color completed	Proceed to the next game.	Pass
3	Yellow_Game	Scan on yellow color	Game of orange color completed	Proceed to the next game.	Pass
4	Green_Game	Scan on green color	Game of yellow color completed	Proceed to the next game.	Pass
5	Blue_Game	Scan on blue color	Game of green color completed	Proceed to the next game.	Pass
6	Indigo_Game	Scan on indigo color	Game of blue color completed	Proceed to the next game.	Pass
7	Purple_Game	Scan on purple color	Game of indigo color completed	Display the victory page of the game.	Pass
8	Wrong_color	Scan the color that not stated in the instruction	Enter any game page	Display error message	Pass



Appendix E : Review Question

Review Question For Application of *Finding Pixie*








Name :
Year :

Please match the color with the correct name.

Example:

	•	•	Black
	•	•	White

Question:

	•	•	Red
	•	•	Yellow
	•	•	Indigo
	•	•	Orange
	•	•	Green
	•	•	Purple
	•	•	Blue