

SMART (SMART MATHEMATIC WITH
AUGMENTED REALITY TECHNOLOGY)
FOR PRESCHOOL

STUDENT'S NAME
KARTIKA IDAYU BINTI TAJUL ARIFIN

Bachelor of Computer Science
(Graphics & Multimedia Technology)

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : KARTIKA IDAYU BINTI TAJUL ARIFIN
Date of Birth : 23 AUGUST 1993
Title : SMART (SMART MATHEMATICS WITH AUGMENTED
REALITY TECHNOLOGY) APPLICATION FOR
PRESCHOOL
Academic Session : 2018/2019

I declare that this thesis is classified as:

- CONFIDENTIAL (Contains confidential information under the Official Secret Act 1997)*
 RESTRICTED (Contains restricted information as specified by the organization where research was done)*
 OPEN ACCESS I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

(Student's Signature)

(Supervisor's Signature)

930823-11-5740
New IC/Passport Number
Date: 9/1/2019

Name of Supervisor
Date:

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

THESIS DECLARATION LETTER (OPTIONAL)

Librarian,
Perpustakaan Universiti Malaysia Pahang,
Universiti Malaysia Pahang,
Lebuhraya Tun Razak,
26300, Gambang, Kuantan.

Dear Sir,

CLASSIFICATION OF THESIS AS RESTRICTED

Please be informed that the following thesis is classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are as listed below.

Author's Name
Thesis Title

Reasons (i)

 (ii)

 (iii)

Thank you.

Yours faithfully,

(Supervisor's Signature)

Date:

Stamp:

Note: This letter should be written by the supervisor, addressed to the Librarian, *Perpustakaan Universiti Malaysia Pahang* with its copy attached to the thesis.



SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Science Computer (Graphic and Multimedia Technology)

(Supervisor's Signature)

Full Name :

Position :

Date :



STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : KARTIKA IDAYU BINTI TAJUL ARIFIN

ID Number : CD15017

Date : 9 JANUARY 2019

SMART (SMART MATHEMATIC WITH AUGMENTED REALITY
TECHNOLOGY) APPLICATION FOR PRESCHOOL

KARTIKA IDAYU BINTI TAJUL ARIFIN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Degree

Faculty of Computer Systems and Software Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2019

ACKNOWLEDGEMENTS

Alhamdulillah, praise to the Almighty Allah for His blessings that I can finish this undergraduate final year project. A million thanks to Ms. Noraniza Samat. I am grateful to have such a great supervisor who gives lot of advice and patiently guide me until I'm finishing this thesis. Without her, I may not able to develop SMART Application project and this thesis very well.

An appreciation to Prasekolah SK Kuala Serupai especially to Ms. Hernani, the one who believe in me and gives lot of commitment in helping me to get all the information and data needed. Thank you to headmaster, teacher, parents and all pre-schoolers for their cooperation throughout the data collection process until the testing phase was carried out.

Special thanks to both of my evaluator, Dr. Taha Hussein and Dr. Suryanti Awang for evaluating my project. All positive comments and constructive criticism help me a lot to improve this thesis. A lot of thanks to Norathirah and Arifah who's never left me behind, help me in giving opinion, share the information and knowledge. Not forget to Syiffa, Anis, Nazreen, Syafiqah, Nik and all my friends for helping me in many ways. Other than that, thank you to lecturers, and all person who related directly or indirectly in finishing this project. I may not be able to complete this thesis without all these people.

Dedicate to both of my parents, Mr. Tajul Arifin Abd Rahman and Mrs. Siti Khatijah Yusof. I believe that I was able to get to this stage because of their prayers always accompanied me. The encouragements and support from my lovely siblings, Herawatie and Muhammad Fakruddin gives me passion. The one who I missed the most, late sister Norbaya. Her strong spirit always inspired me. Thankfully I do have a family who's always being my backbones. Finally, May Allah S.W.T repay all your kindness and each of our good deeds. Amin.

ABSTRAK

Fokus utama projek ini adalah mengenai Augmented Reality. Projek yang dibangunkan adalah sebuah aplikasi pendidikan matematik awal bagi kanak-kanak prasekolah dengan menggunakan pendekatan teknologi Augmented Reality. Buku bergambar 2D yang digunakan oleh guru di dalam kelas atau ibu bapa di rumah sebagai medium pembelajaran matematik awal bagi kanak-kanak prasekolah semakin membosankan dan tidak mengikuti perkembangan teknologi terkini. Kewujudan teknologi Augmented Reality yang membolehkan objek 3D timbul pada imej 2D mampu menarik minat kanak-kanak dengan lebih mendalam. Di samping itu, penyampaian kandungan pembelajaran juga dapat di sampaikan dengan lebih mudah tanpa memerlukan bimbingan orang dewasa sepenuhnya. Selari dengan fenomena masa kini iaitu kanak-kanak lebih gemar menggunakan gajet berbanding buku, aplikasi ini telah menggabungkan kedua-dua elemen tersebut iaitu buku dan gajet bagi meningkatkan lagi tahap interaktif dan keseronokan kanak-kanak prasekolah untuk menerokai isi pembelajaran matematik awal prasekolah. Pembangunan aplikasi SMART (Matematik Awal Prasekolah) ini adalah berdasarkan Kurikulum Standard Prasekolah (KSPK) dan telah dibangunkan menggunakan kaedah model ADDIE. Menerusi pembangunan aplikasi ini, pembelajaran matematik awal sama ada di prasekolah atau rumah pasti lebih menyeronokkan. Matlamat utama pembangunan aplikasi ini adalah supaya dapat membantu meningkatkan penguasaan konsep nombor dan kemahiran matematik dalam kalangan kanak-kanak prasekolah.

ABSTRACT

The focus of this project is on Augmented Reality. This study is about the development of early mathematics education applications for preschool children by using the Augmented Reality technology approach. 2D illustrated books used by teachers in the classroom or parents at home as a medium of early mathematic learning for preschoolers are getting boring and not following the latest technology developments. The traditional 2D picture book is now more attractive with the existence of augmented reality technology which is capable to bring 3D objects on the 2D image. In addition, the delivery of learning content can also be delivered more easily without the adult full guidance. In line with current phenomenon where children prefer to use gadgets instead of books, this application combines both elements which is book and gadget to enhance the interactive and fun levels among preschoolers to explore the contents of pre-school math learning. The development of SMART (Preschool Early Mathematic) is based on the Preschool Standard Curriculum (KSPK) and has been developed using the ADDIE model method. Through this application, early math learning whether at preschool or home is certainly more fun. With the existence of this application, it is hoped that it can help to increase the mastery of numerical concepts and math skills among preschoolers.

TABLE OF CONTENT

DECLARATION	
TITLE PAGE	
ACKNOWLEDGEMENTS	II
ABSTRAK	III
ABSTRACT	IV
TABLE OF CONTENT	V
LIST OF TABLES	IX
LIST OF FIGURES	X
LIST OF ABBREVIATIONS	XIII
CHAPTER 1 INTRODUCTION	1
1.1 INTRODUCTION	1
1.2 PROBLEM STATEMENT	3
1.3 AIM AND OBJECTIVE	4
1.3.1 AIM	4
1.3.2 OBJECTIVE	4
1.4 SCOPE	4
1.4.1 System	4
1.4.2 Target User	4
1.5 SIGNIFICANT	5
1.6 THESIS ORGANIZATION	5

CHAPTER 2 LITERATURE REVIEW	6
2.1 INTRODUCTION	6
2.3 PRESCHOOL EARLY MATH	7
2.4 AUGMENTED REALITY	8
2.5 ANALYSIS OF COMPARISON ON EXISTING SYSTEM	10
2.5.1 Teach me 123 English L1	10
2.5.2 Counting with Paula Augmented Reality	11
2.5.3 123 Addition Subtraction Augmented Reality	12
2.6 RELEVANCE OF COMPARISON ON EXISTING SYSTEM	14
2.7 SUMMARY	15
CHAPTER 3 METHODOLOGY	16
3.1 INTRODUCTION	16
3.2 ADDIE METHODOLOGY	17
3.2.1 Analysis Phase	18
3.2.2 Design Phase	22
3.2.3 Development Phase	37
3.2.4 Implement Phase	37
3.2.5 Evaluate Phase	37
3.3 HARDWARE AND SOFTWARE REQUIREMENT	38
3.4 GANTT CHART	39
CHAPTER 4 RESULTS AND DISCUSSION	40
4.1 INTRODUCTION	40
4.2 IMPLEMENTATION	41

4.2.1	Installing software	42
4.2.2	Creating Materials	42
4.2.3	Getting the Vuforia License Key	47
4.2.4	Upload Image Target	48
4.2.5	Build application project	51
4.2.5.1	Implementing Augmented Reality into the scene	53
4.2.5.2	Creating Interface	56
4.2.6	Build and Run in Mobile device	75
4.3	TESTING	77
4.3.1	User Acceptance Testing	77
4.3.2	Usability Testing	77
4.3.3	Pre-testing and Post Testing	78
4.4	RESULT AND DISCUSSION	78
4.4.1	Result of User Acceptance Test (UAT)	78
4.4.2	Result of Usability Test	86
4.4.3	Result of Pre-testing and Post Testing	90
4.5	SUMMARY	90
CHAPTER 5 CONCLUSION		91
5.1	INTRODUCTION	91
5.2	CONCLUSION	91
5.3	PROJECT CONSTRAINS	92
5.4	FUTURE WORK	93
REFERENCES		94

APPENDIX A	96
APPENDIX B INTERVIEW QUESTIONS	97
APPENDIX C	98
APPENDIX D USER ACCEPTANCE TESTING FORM	100
APPENDIX E USABILITY TESTING QUESTIONAIRES	105
APPENDIX F TEST RESULTS BEFORE AND AFTER USING THE SMART APPLICATION	106
APPENDIX G SAMPLE OF BOOK	107
APPENDIX H GANTT CHART	109
APPENDIX I PRASEKOLAH SK KUALA SERUPAI	110

LIST OF TABLES

Table 2.1	Comparison between Advantage and disadvantage of the existing system	13
Table 2.2	Relevance comparison between each existing system	14
Table 3.1	Main interface storyboard	31
Table 3.2	Main Menu interface storyboard	32
Table 3.3	Mengenal interface storyboard	33
Table 3.4	Menulis interface storyboard	34
Table 3.5	Mengira interface storyboard	35
Table 3.6	Latihan interface storyboard	36

LIST OF FIGURES

Figure 2.1	Teach me 123 English L1 Logo	10
Figure 2.2	AR object appeared when tablet camera directed to the book	10
Figure 2.3	Counting with Paula Augmented Reality Logo	11
Figure 2.4	Main GUI	11
Figure 2.5	AR object appeared on flashcard	11
Figure 2.6	123 Addition Subtraction Augmented Reality Logo	12
Figure 2.7	Counting AR object on marker	12
Figure 2.8	Able to change with different object	12
Figure 3.1	ADDIE Model	17
Figure 3.2	ADDIE Phase	18
Figure 3.3	The most understanding language	21
Figure 3.4	Books and Gadget	22
Figure 3.5	Context Diagram	23
Figure 3.6	Use Case Diagram	24
Figure 3.7	Flowchart Main Interface	25
Figure 3.8	Flowchart Menu Interface	26
Figure 3.9	Flowchart <i>Mengenal</i> Interface	27
Figure 3.10	Flowchart <i>Menulis</i> Interface	28
Figure 3.11	Flowchart <i>Mengira</i> Interface	29
Figure 3.12	Flowchart <i>Latihan</i> Interface	30
Figure 4.1	Flowchart of implement process	41
Figure 4.2	Logo of software has been installed	42
Figure 4.3	Logo designed using Adobe Photoshop	43
Figure 4.4	Materials created using Adobe Photoshop	43
Figure 4.5	Creating book using Adobe Illustrator software	44
Figure 4.6	Materials created using Adobe Illustrator	44
Figure 4.7	Audio editing using Audacity software	45
Figure 4.8	Editing 3D Object using Blender software	45
Figure 4.9	Creating video using Adobe Premiere software	46
Figure 4.10	Login using registered account	47
Figure 4.11	License Manager interface	47
Figure 4.12	Click on “Confirm” button	47

Figure 4.13	Copy License Key	48
Figure 4.14	Target Manager	48
Figure 4.15	Create Database	49
Figure 4.16	Add target image	49
Figure 4.17	upload the image	50
Figure 4.18	Download database	50
Figure 4.19	Open Unity 3D	51
Figure 4.20	Create New Project in Unity 3D	51
Figure 4.21	Save Scene	52
Figure 4.22	Save Scene window	52
Figure 4.23	Delete Main Camera	53
Figure 4.24	Insert AR Camera	53
Figure 4.25	Insert image target	54
Figure 4.26	Open downloaded image target database	54
Figure 4.27	Import image target database	54
Figure 4.28	Insert 3D model	55
Figure 4.29	Image target and 3D model in <i>Mengira</i> scene	55
Figure 4.30	<i>Mengira</i> scene	56
Figure 4.31	<i>Mula</i> (Start) scene	61
Figure 4.32	Menu scene	63
Figure 4.33	<i>Mengenal</i> scene	65
Figure 4.34	<i>Menulis</i> scene	66
Figure 4.35	<i>Latihan</i> scene	70
Figure 4.36	Open Build Setting window	75
Figure 4.37	Build Setting window	75
Figure 4.38	Save file as “.apk” format	76
Figure 4.39	Transferred “.apk” file to mobile device	76
Figure 4.40	Result for question 1	86
Figure 4.41	Result for question 2	87
Figure 4.42	Result for question 3	87
Figure 4.43	Result for question 4	88
Figure 4.44	Result for question 5	88
Figure 4.45	Result for question 6	89

Figure 4.46	Result for question 7	89
Figure 4.47	Comparison between pre-testing and post testing	90

LIST OF ABBREVIATIONS

2D	2 Dimension
3D	3 Dimension
AR	Augmented Reality
BBM	<i>Bahan Bantu Mengajar</i>
KPM	<i>Kementerian Pendidikan Malaysia</i>
KSPK	<i>Kurikulum Standard Prasekolah Kebangsaan</i>
P & P	<i>Pengajaran dan Pembelajaran</i>
PPM	<i>Pembantu Pengurusan Murid</i>
PPPM	<i>Pelan Pembangunan Pendidikan Malaysia</i>
SMART	Smart Mathematic with Augmented Reality Technology
TMK	<i>Telekomunikasi Maklumat dan Komunikasi</i>

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The Education Act (1996) that already approved make a significant change in preschool education, which is preschool education policy has been implement into the National Education System. The change of this policy are clearly shows that the Ministry of Education (*Kementerian Pendidikan Malaysia* (KPM)) is constantly working to maintain and improve the quality of preschool education. Even so, preschool teachers need to have extensive knowledge of preschool education which includes some main aspects such as the development of kid's cognition and teaching and learning process (*Pengajaran dan Pembelajaran* (P&P)) strategies (*Pendidikan Dan Pembangunan Manusia*, 2016).

Starting in 2002, all the children's learning centres are managed by the Ministry of Education or organized by the private sector must follow the prescribed syllabus provided by KPM. Therefore, the implemented Preschool Education Program can be said able to provide knowledge exposure, basic skills and values to kids. All these aspects are applied practically and informally as well as in a fun atmosphere through a learning while playing approach.

Due to the rapid development of technology, preschool teachers should introduce more sophisticated learning methods in line with latest technological developments. In this way, cognitive development and technology knowledge in every pre-schooler can be improved. Kids need to have early exposure on technology usage so that they can use the internet application towards a positive and help them in the learning process.

Attractive activities are able to provide a more effective understanding of Math to normal kids. For example, number-related learning usually occurs through experience, social interaction, time, language and understanding. In preschool education, teachers play an important role in planning attractive and meaningful activities for preschoolers. The Use of Teaching Materials (*Bahan Bantu Mengajar* (BBM)) in the teaching and learning processes is very important for teachers to ensure the information is delivered clearly to their students.

However, it seems the traditional teaching materials that been used by the teachers in Malaysia such as books and flashcard is less interesting and not enough to attract the preschoolers to give their attention during the learning session. This can cause children failed to have a solid mathematical development experience. Children should be given a good pre-numerical basis and experience as a solid preparation for Mathematics learning at a higher level. Additionally, in this present technology, these materials seem like has been far outdated.

Augmented Reality is one of the emerging technologies that can be integrated in teaching and learning. The use of Augmented Reality can make learning process to be more fun, through which preschoolers interest towards learning can be boosted. In other countries, Augmented reality technology is now often used in learning process at this 21st century. However, in Malaysia this technology has not yet been widely applied in schools. This project is aimed to upgrading the 2D teaching materials (BBM) of Counting numbers in Concept Number syllabus. To increase attention from preschoolers during the learning session, Augmented Reality technology are proposed to be integrated into teaching materials such as flashcards and books that used by the teachers in the preschool.

1.2 PROBLEM STATEMENT

Current learning method at preschool are fully guided by teacher. While at home, they need to be guided by their parents to complete ununderstood homework. Indirectly, this current method becomes not attractive, interactive and sometimes not effective. There are many countries that already introduced self-learning by using latest technology to preschool kids. Now it's time for our country to introduce self-learning to preschoolers by using more sophisticated technology such as self-learning application using augmented reality.

Kids are more attracted to gadget. The power of gadget over the kids which hit at this moment is not only a phenomenon in Malaysia, but also kids around the world when most of parents express their anxiety for the same issue. However, the existence of gadgets should not be blamed because gadgets also have their own benefits. Studies that conducted by independent researchers found that the use of technology was able to support the tendency of children to learn (Prof Dr M. Swamenathan, 2014). Hence, the gadgets given to kids can be filled with more beneficial applications such as edutainment games for early math.

There is no existing application that follow the exact National Preschool Standard Curriculum of early math by Kementerian Pendidikan Malaysia in market. Although there are many flashcards and books with augmented reality (AR) technology in the market, most of them are about learning ABC than numbers. In fact, there is still no early math augmented reality (AR) book for preschoolers that comes with Malay language. This shows that our preschools educational levels are not competitive and not following the current technologies.

1.3 AIM AND OBJECTIVE

1.3.1 AIM

The aim of this project is to improve the levels of preschools education in Malaysia to become more competitive and follow the trend. To improve the teaching and learning materials with the use of Augmented reality (AR) technology and to provide a new learning experience and encourage preschoolers to explore the math subject with more interesting, interactive and effective way.

1.3.2 OBJECTIVE

- i. To study the used of augmented reality (AR) technology for preschool's Early math teaching materials
- ii. To design and develop an augmented reality (AR) application with early mathematic content based on National Preschool Standard Curriculum by Kementerian Pendidikan Malaysia.
- iii. To evaluate the effectiveness of integrating an augmented reality (AR) technology into the preschool teaching materials for early mathematic education.

1.4 SCOPE

1.4.1 System

- i. Mobile AR app for android
- ii. Malay Language content

1.4.2 Target User

- i. Preschooler with age four to six
- ii. Teachers as teaching materials

- iii. Parents as encouragement of learning early mathematic to their children

1.5 SIGNIFICANT

- i. Help teachers improve their teaching materials in attractive and interactive way by replacing traditional teaching methods with a technology-based teaching and learning tools and facilities which followed the growth of current technologies.
- ii. Benefit for parents that involve in SMART application whose allowing their children to engage with AR at home. At the same time, parents do encourage their children to explore early mathematic by themselves using this learning application.
- iii. To apply the latest AR technology in preschool education system to produce highly IT iterate future generation.

1.6 THESIS ORGANIZATION

This thesis consists of five chapters. Chapter one discusses on the introduction to the project, problem statement, aim and objective, scope and significant. Introduction part describes briefly about the project and related issues. Problem statement part is concise description of the issues that need to be addressed before trying to solve the problem. At the aim and objective part will evaluate what want to do and what will get from this project. Objectives are the specific actions that are intended to be achieved which is associated with goal of the project. The discussion on the boundary of the project and users will be done in scope part. The significance part will explain the important and its benefit to society of this project.

Chapter 2 will conduct the literature review. This chapter will introduce about the preschool and early math in Preschool Early Math part. While the Augmented Reality part will introduce about the augmented reality technology. Describing about the existing work or solution that have been done by other work on Existing System part. The comparison of exiting system will be done in Comparison of Existing System part.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter consists of a literature review about the augmented reality (AR) technology in early math education system. In Preschool Early Math part gives review on Malaysian Education Development Plan, the important of early mathematical and support with the theories of preschool early mathematic learning. The Augmented Reality part will discuss about augmented reality (AR) technology and its benefit on learning process. Existing System part gives argument on three of existing system that has been publish on market. While in Comparing the Existing Technology, part will be comparing that three of reviewed system.

2.3 PRESCHOOL EARLY MATH

Preschool education is a program that provides learning experience for 4 to 6 years old children within a year or more before going to standard one in formal primary schools. Preschool education is included in the Malaysian Education Development Plan (*Pelan Pembangunan Pendidikan Malaysia* (PPPM)). To improve the quality of education at the preschool level, Ministry has reviewed the National Preschool Standard Curriculum (*Kurikulum Standard Prasekolah Kebangsaan* (KSPK)) and producing the review of KSPK 2017. This review has fully implemented in 2017. The focus on empowering preschool education focuses on the 4M basic mastery of Reading, Writing, Counting and Reasoning (Razlan & Khalid 2017).

Early Mathematics provides early math experience will be introduced to the preschoolers which is covers one of 4M basic which is counting. Early mathematical experience is important as it was a basic to help students live their daily lives with more systematic and facilitate preschoolers to understand higher mathematical concepts. According to Nani and Rohani, the sequence of development in Mathematics learning through three levels, which is concrete, picture and symbol level. This is in line with Bruner's Cognitive Development Theory which has three stages, enactive, iconic and symbolic. However, most kindergarten teachers are more likely to teach children direct to the third level which is symbolic without giving experience at both levels (Nani Menon & Rohani Abdullah 2003). This causes children to not have a strong Mathematical development experience. Children should be given a good early math basis and experience as a solid preparation for Mathematics learning at a higher level.

Jean Piaget give opinion that every normal child is able to understand mathematics well when the activities and methods given are interesting. Mathematics is an example of logical thinking that forms the concept of a child's number that requires knowledge, social interaction, time, language and understanding of childish thinking. At the stage of the child, they should be given experience with objects when studying the concept of numbers (Prof. Madya Dr.Rohani Abdullah, Nani Menon, & Mohd. Sharani Ahmad, 2007). According to Rohani Abdullah, cognitive refers to intellectual or individual. Cognitive development refers to the way children learn and process the information. In other words, it is a process of developing the children

knowledge. Skills development is based on the changing mental structure of children. It involves language, imagination, mentality, mind, reasoning, problem solving and memory (Menon Nani & Abdullah Rohani, 2003).

2.4 AUGMENTED REALITY

Augmented reality (AR) is a variation of a Virtual Reality (VR). Virtual reality technologies completely immerse a user inside a synthetic environment and while immersed, the user cannot see the real world around them. In contrast, Augmented reality is taking digital or computer-generated information, whether it be images, audio, video, and touch or haptic sensation and overlaying them over in a real-time environment. Augmented reality technically can be used to enhance all five senses, but its most common present-day use is visual. Unlike virtual reality, augmented reality allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it. Augmented reality can be thought of as the blend, or the “middle ground”, between the completely synthetic and the completely real.

Augmented reality is interactive, so it doesn't make sense to watch it or listen to it. We must engage with it to gain experience that it provides. Augmented reality can support many different application areas. It can be applied in education, entertainment, medicine and many more areas. Each of these different application areas and specific application constitute an experience.

There are various types of technologies that forming augmented reality which is marker based or also known as recognition based augmented reality, marker less augmented reality, location-based augmented reality, projection-based augmented reality, outlining augmented reality and superimposition based augmented reality. However, in this chapter we will focus more on two primary types of AR implementations which is marker based and marker less augmented reality. Marker based is when the tracked object is black-white square marker such as QR (Quick Response) code. While marker less is when the tracked object can be anything else such an image or human body.

For education, it is possible to use marker less or marker-based technologies marker based and marker less augmented reality technologies are presented to show how we can create learning activities to visualize augmented information that help students to understand the educational content (Constatine Stephanidis & Margherita Antona, 2014).

Traditional methods of learning spatially-related content by viewing 2D diagrams create a sort of resistance to learning at cognitive level. This resistance exists even when working with 3D objects on a computer screen because the manipulation of the objects in space is made through mouse clicks (Vincent Alevan, Judy Kay, & Jack Mostow, 2010). Augmented reality application combines images, 2D or 3D virtual objects with a 3D real environment in real time. Virtual computer generated and real objects appear together in a real-time system in a way that the user sees the real world and the virtual objects superimposed with the real objects. The user's perception of the real world is enhanced and the user is interacting in a more natural way. The virtual object can be used to display additional information about the real world that are not directly perceived.

A number of earlier studies found a positive effect of using AR in the educational process. (Cascales, Pérez-López, & Contero, 2013) claim that AR as an advanced ICT which allows the user to interact with virtual and real world in a real-time application. In an interviewed, Najibah conclude that AR technology in children's pictorial books enhance student experiences and assisting teachers' teaching task. For example, children can see the object that the teacher tells in three dimensions and manipulate this virtual picture with natural motion (Najibah Abu Bakar, n.d.).

Alisa state that Radu who aimed on finding a comprehensive understanding of how augmented reality medium differs from other educational mediums, analysed 26 studies providing a comparison of learning with AR opposed to non-AR applications, and states that it is shown by many studies that augmented reality makes the performance better in many ways in learning tasks as well as improves book's functional features. The author also claims that a high number of research studies investigated the ways AR can potentially benefit learning (Alisa, 2016).

2.5 ANALYSIS OF COMPARISON ON EXISTING SYSTEM

In this section, the existing application is being compared to ensure that the new application build is better than the existing application. The advantage and disadvantage of each reviewed application will be compared.

2.5.1 Teach me 123 English L1



Figure 2.1 Teach me 123 English L1 Logo

The Figure 2.1 shows Teach me 123 English L1 Logo application. This application is developed by Child Academy Company for curriculum series with Augmented Reality features. A modern technique was combine to this educational book based on AR technology. For this on purchasing book series, developer was enhancing set of content characteristic such letters, words, numbers and animal sounds pronunciation and moving images as shows in Figure 2.2. This book characteristic will be function when directed to cameras Phone and mobile devices tablet subsidized system (Android). Disadvantage of this application is, it used 2D model for the augmented reality which make it does not attractive at all.



Figure 2.2 AR object appeared when tablet camera directed to the book

2.5.2 Counting with Paula Augmented Reality



Figure 2.3 Counting with Paula Augmented Reality Logo

Figure 2.3 shows the Counting with Paula Augmented Reality Logo. Counting with Paula Augmented Reality is the latest application create by Omens Studios where is from Singapore. This application is available for both smartphones and tablets. Figure 2.4 show example the main GUI of this application on smartphones screen. By implement Augmented Reality technology into the physical flash cards, the Numbers come to live onscreen to challenge and guide kids through basic mathematics equations. Figure 2.5, shows the AR object appeared on flashcard. Clearly, we can see that this is one of interactive application. However, there is no approach for introduction of numbers and develop for general kids without mention the age with more specific suitability to use this application.

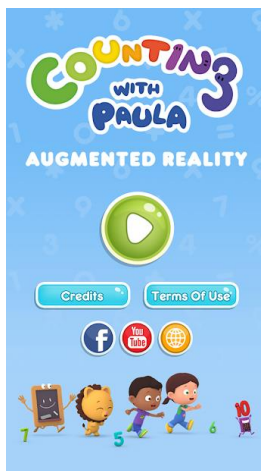


Figure 2.4 Main GUI

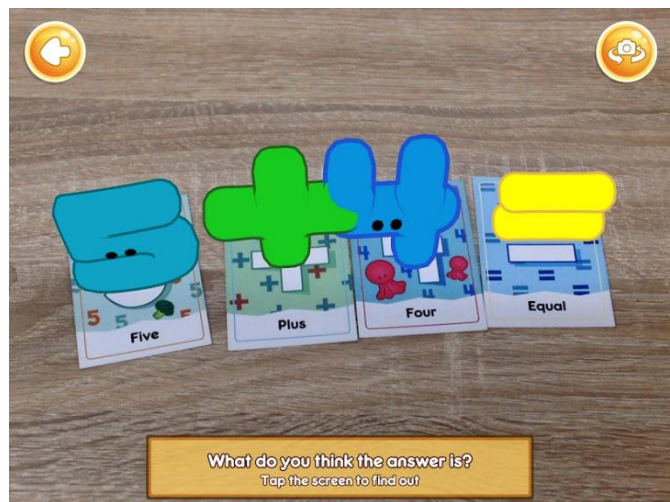


Figure 2.5 AR object appeared on flashcard

2.5.3 123 Addition Subtraction Augmented Reality



Figure 2.6 123 Addition Subtraction Augmented Reality Logo

The Figure 2.6 shows the logo of the 123 Addition Subtraction Augmented Reality application. This application was developed by IGY (Interactive Graphics for You) company where the company was come from Giza, Egypt. This free download application also provides the flashcard marker which can be downloaded via the provided link.

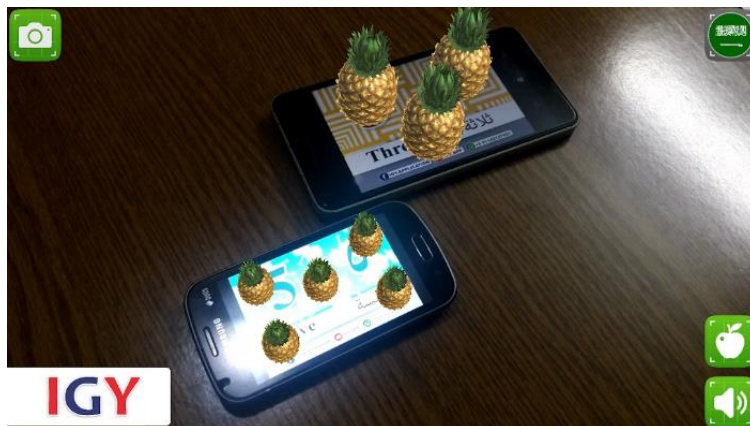


Figure 2.7 Counting AR object on marker



Figure 2.8 Able to change with different object

Based on Figure 2.7, we can see that this application allows users to count the number of objects generated from the flashcard marker. It can be zoom in and zoom out. Figure 2.8 shows the different object appeared on screen which means the application can change the object to another object. However, this application emphasizes the lessons more for Egyptian children where the symbol of numbers, text and Audio are in Arabic and English only. Furthermore, the colour of flashcards provided are less interesting.

Table 2.1 Comparison between Advantage and disadvantage of the existing system

	<i>Teach me 123 English L1</i>	<i>Counting with Paula Augmented Reality</i>	<i>123 Addition Subtraction Augmented Reality</i>
Advantage	Using a book as markers. With the content of introduction to numbers	Interactive application Augmented Reality with 3D Numbers	Able to change the 3D object to another object The 3D object are able to be zoom in/out
Disadvantage	Does not attractive since the augmented reality using 2D object model Not specify the age of user	No introduction of numbers. Not suitable for beginners Not specify the age of user	Not specify the age of user Basic mathematic learning which focus in Arabic language

Table 2.1 shows the Comparison between Advantage and disadvantage of the existing system. From three of above existing application, we can summarize that most of mathematic educational apps found in market are not specific and not following the sequence of development in Mathematics learning level for pre-schoolers which is child within 4 to 6 years old. These applications also not specific the age level.

2.6 RELEVANCE OF COMPARISON ON EXISTING SYSTEM

Each existing system is compared with platform, language and Marker used for each application. The comparison that have been made will be used to improve the new system that will be build.

Table 2.2 Relevance comparison between each existing system

Criteria	<i>Teach me 123 English LI</i>	<i>Counting with Paula Augmented Reality</i>	<i>123 Addition Subtraction Augmented Reality</i>
Platform	<i>Android</i>	<i>Android</i>	<i>Android</i>
Language	English	English	English & Arabic
Marker Use	Book	Flashcard	Flashcard

From table 2.2, we can compare the platform, language and marker use. The relevance of this comparison with this application project is as we compare in Table 2.1, all of three reviewed application are using android platform. Since android platform are dominant used in global smartphone operating system, this application is relevance to be built with android platform. Most of appropriate application in market are using English language, including all reviewed application. But one of them which is 123 Addition Subtraction Augmented Reality application are using multi-language which is English and Arabic. The relevance comparison here is, this application also should be built with understanding language which is Malay. The reason of using

Malay language is based on target user which is Malaysian people whose mostly understand and prefer with Malay language. The used of book as marker is more systematic. However, the used of flashcard as marker is more interactive. From the comparison, no application that used both type of marker. In order to make this application more interesting, both type of marker which is book that include flashcard inside it will be used to be markers for this application.

2.7 SUMMARY

Many theories have been proposed to explain the advantage of using augmented reality in education. Augmented reality can be thought of as the blend, or the “middle ground”, between the completely synthetic and the completely real. The augmented reality seems like as a bridge of connecting books, as classical tools of education, and media technologies, the use of which has proved to have a positive impact on learners’ performance. Books with implemented augmented reality technology can be used both at home with parents and as well in the classroom at school, which makes these books be a universal learning means and will satisfy the learners demand to integrate the technologies used at home into the classroom as well. Based on that comparison, the new system can improve the efficiency of the early mathematic learning. The system also improves the traditional methods of learning into interactive and attractive learning method with Augmented Reality for preschoolers learn numbers concept. By using mobile devices (Android), the traditionally silent book in the hands of the pre-schoolers finally will turns into an interactive math book with sound and moving image.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The methodology covers the methods and approaches that used to achieve the objectives of the project. The methodology leads the study to be more systematic and the flow of study is more focused on achieving the objectives. This chapter consists of discussion about the flow of method for developing the augmented reality (AR) technology in early math education application. The explanation about the type of methodology used in the project, its advantage and disadvantage will be in ADDIE methodology part. The flow of using the methodology will be discuss phase by phase. This chapter also will be determined all the hardware and software used in this project on hardware and software requirement. Lastly, the scheduling of this project is included in Gantt chart part. The Gantt chart is used to show project timetables with the tasks and timelines, such as the start of the task and the time limit used to accomplish the relevant task.

3.2 ADDIE METHODOLOGY

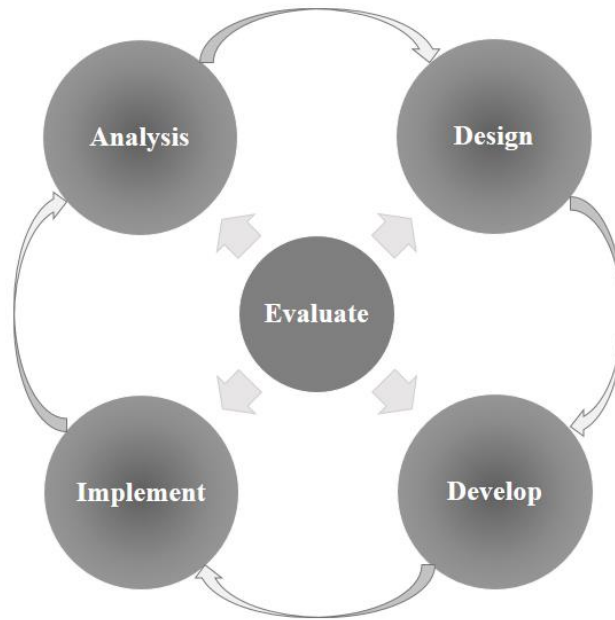


Figure 3.1 ADDIE Model

The methodology that has been chosen for this project is ADDIE model which is shown in Figure 3.1. ADDIE model is used by many professional instructional designers for technology-based teaching. One reason for the widespread use of this model is that it is extremely valuable for large and complex teaching designs. There are five phases in ADDIE model which is Analysis, Design, Development, Implement and Evaluate. In the analysis phase, all the variables that need to be in the application will be analysed. Design phase will focus on identifying learning objectives for the application and how the materials will be created and designed. It may include a storyboard. Even at this phase, the selection and use of technology will be decided. While development phase is the stage to create all content and components of application based on design phase. The actual delivery of the application into a real-world environment will be on Implement phase. It is including any prior training or briefing and provide support to users. All feedback and data are collected to evaluate which parts that require improvement and this contributes to the design, development and implementation of next application iterations.



Figure 3.2 ADDIE Phase

Figure 3.2 shows the description of ADDIE phase by phase. The advantages of the ADDIE model are it is a basic model that can be used for any kind of learning and allows the design principles to be implemented systematically and thoroughly. It provides a step-by-step process to help in planning and creating training programs. By using ADDIE model, the opportunity to re-evaluate goals and learning outcomes is provided. However, the disadvantage of ADDIE is it is not iterative which makes it incompetent. The needs of the users must be identified before developing the application. All phases are related. Any changes that occur during a single phase of the model, affect all other phases then leading to re-work. Finally, it's a very time-consuming model.

3.2.1 Analysis Phase

The target users of this application are being analysed. The main target user of this application is pre-schoolers with age four to six, teachers as their teaching materials and also parents as encouragement of learning early mathematic to their children are identified for this project. At analysis stage, the review of syllabus, interview, observation and questionnaire session has been conducted to obtain the information about user requirements for the application. In the sessions, the users were asked about the application available and interest level on current teaching method of preschool early math. The learning environment that chosen to evaluate this application is at Preschool which is Prasekolah SK Tatau with pre-schoolers and teacher are the testers.

i. Data requirement

The requirements from users are gathered to be investigated and identified what the interest of pre-schoolers, what parent's needs, what the preschool teachers' needs and their teaching materials requirement. From requirement analysis, problem and objective of the project can be identified.

a) Interviews

To get information about the current problems faced by preschoolers, an interviews and discussions was conducted with preschool teacher. The interview session has been done via phone call.

(Interview questions in **Appendix B**)

b) Review

A review on the National Preschool Standard Curriculum (*Kurikulum Standard Prasekolah Kebangsaan (KSPK)*) of Early Mathematics are done first then follow with literature review to get more information about which syllabus that should be prioritize.

c) Observations

Observation technique are done by observing several things throughout mathematics learning session which is includes the teacher's teaching and learning method, the use of teaching materials in class, the focus of pre-schooler during learning session, how the pre-schoolers completing their worksheet which is whether the pre-schooler was able to do it by their own or imitate from friends.

d) Questionnaire

A questionnaire that require a selection of predefined responses from parents individually has been done through google form. 30 respondent taking part in this questionnaire. The aim of this questionnaire is to investigate what the best approach that

can be done on preschoolers based on their own home environment. This questionnaires at the same time can reveal about the preschooler's level of interest on current early math learning. The distributed questionnaire is divided into three sections which section A is question about personal details. Section B consist of questions regarding the preschooler's level of interest on current early math learning. While section C consist of questions regarding parent's encouragement between book and gadget on preschooler.

(Questionnaire questions in **Appendix C**)

ii. User Requirement Analysis

a) Interviews

Based on interviews and discussions, the researcher found that the ability of preschoolers in mastering the concept of numbers is uneven and there is a large gap between pre-schoolers. This is because there are a few preschoolers who have not mastered the concept of numbers 1 to 10. Preschool teacher claimed that current teaching materials is less attractive and interactive. Teacher suggest that researchers produce an application that can help weak preschoolers to master the concepts of numbers better. Teacher also give opinion that the application should came with latest technology based National Preschool Standard Curriculum (*Kurikulum Standard Prasekolah Kebangsaan (KSPK)*) as new teaching materials. The application must be more attractive which may able to gain the attention from pre-schoolers and at the same time help the teacher to control the class.

b) Review

From the review analysis on the National Preschool Standard Curriculum (*Kurikulum Standard Prasekolah Kebangsaan (KSPK)*) of Early Mathematics and literature review, the syllabus that should be prioritize are determined. This application will focus on number concept (*konsep nombor*) which required the understanding of number 1 to 10. It will cover on the introduction of number 1 to 10, writing number 1 to 10 and counting number 1 to 10.

c) *Observations*

From the observation, the focus level of pre-schoolers during mathematic learning session is low especially 5 preschoolers that mentioned by their teacher. The observation is also carried out during the pre-schoolers completing their worksheet. Teacher seems have difficulties to control the pre-schoolers when they are assigned to do the worksheet. It was found that pre-schoolers who do not know number 1 to 10 emulate their friends to complete their worksheet. Clearly it shows that the pre-schooler does not understand the concept of numbers taught by their teacher and rely on friend to completing the worksheet. However, researcher found that the pre-schooler was very interested when their teachers used information and communication technology (*Telekomunikasi Maklumat dan Komunikasi* (TMK)) in teaching and learning compared to learning using the whiteboard.

d) *Questionnaire*

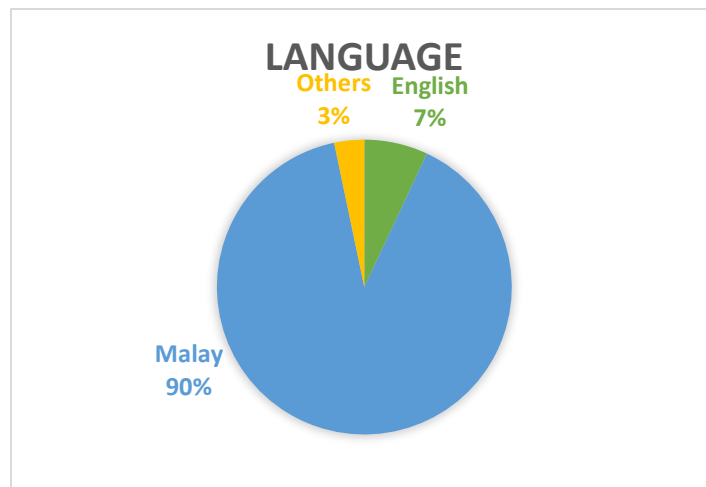


Figure 3.3 The most understanding language

The Figure 3.3 shows the analysis that 90% parents using Malay language at home. This means that the understanding of Malay language is higher among the preschoolers. However, most of existing application are using English language. Language play important role to ensure the high level of preschoolers understanding against early math learning. From this analysis, Malay language will be the main language in this application.

Most of parents disagree if their children can do mathematic exercise by their own. More of them quite agree that their children need their help to do the math exercise. However, it is not easy to help their children to complete math exercise. This analysis shows that current mathematic learning is fully guided.

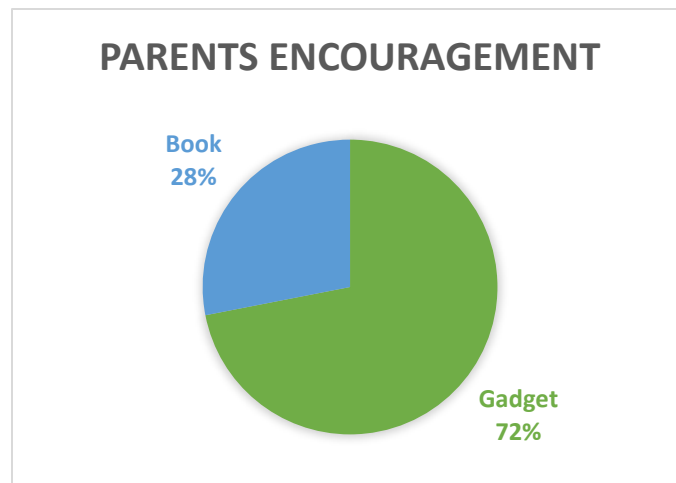


Figure 3.4 Books and Gadget

From figure 3.4, there are comparison the parents' encouragement between book and gadget on their child. The graph shows that parents whose allow their children using the gadget to play game is in high percentages than giving math exercise book to their children. From this analysis, this project came out with the combination the used of book and gadget which is mobile device. Furthermore, lack of parents downloads the math learning application for their children. That is because hard to find the appropriate math application for their children.

3.2.2 Design Phase

Once the design requirements are gathered, initial prototyping and modelling is done. Feedback from user experiences help in designing the prototype and the overall architecture of the application. There can be multiple iterations.

i. *Context Diagram*

The context diagram will show the movement of data that through the system. Figure 3.5 shows the context diagram for SMART application. This application will interact with User by exchange the information. The application receives selection Mengenal (Introduction), Selection Menulis (Writing), Selection Mengira (Counting) and Selection Latihan (Exercise) as input, then it will forward video about introduction to numbers, video how to write numbers, 3D animation model for counting learning and 2D model as exercise activity to the User.

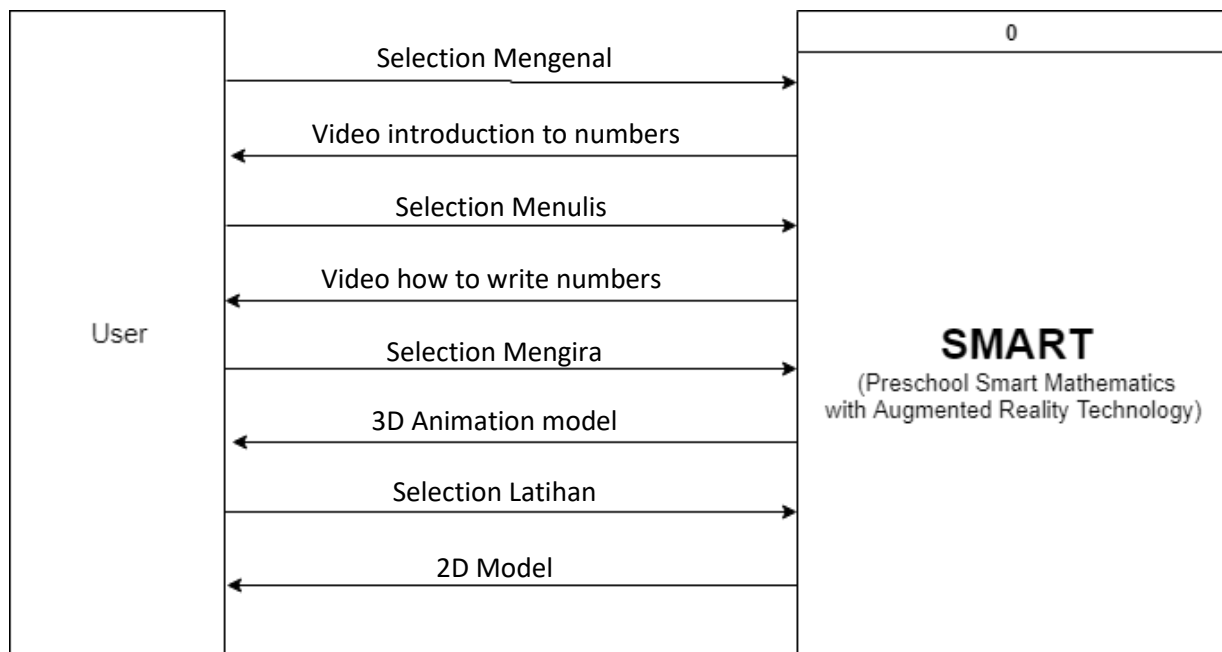


Figure 3.5 Context Diagram

ii. *Use Case Diagram*

Use case diagrams are used to visualizing the functional requirements of a system. The use case diagram in figure 3.6 specify how the application interacts with user. SMART application allows the user to view video, view 3D animation and view 2D model.

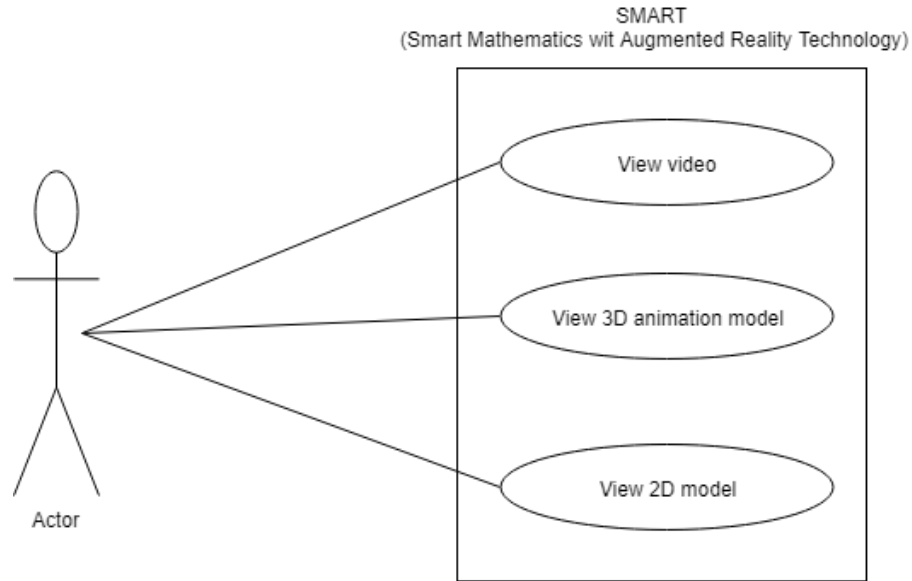


Figure 3.6 Use Case Diagram

iii. Flowchart

A flowchart represents a visualization of the sequence steps and decisions needed to perform a process. Figure 3.7 shows flowchart of this application. The application will start by displaying Main interface which is provide MULA (Start) button. When user select Mula, Menu scene would be open. User able to select four types of Menu. If user select Mengenal, the application will open Mengenal interface and show the video of introduction to numbers. If the application selects Menulis, the application will open Menulis interface and show the video of writing numbers. If application selects Mengira the application will open Mengira scan marker interface. If the application detect marker, then it displays 3D animation. If no, the application will scan the marker again. If user select Latihan, it will open Latihan scan marker interface. If the application detect marker, the application will show question and choice of answer panel. If no, the application will scan the marker again. If user select correct answer, the application will display correct answer panel. If user select wrong answer, the application will display wrong answer panel. If user select Kembali, then the application will back to Menu interface. Finally, if user select Keluar, then the application end and the user will be exit from the application.

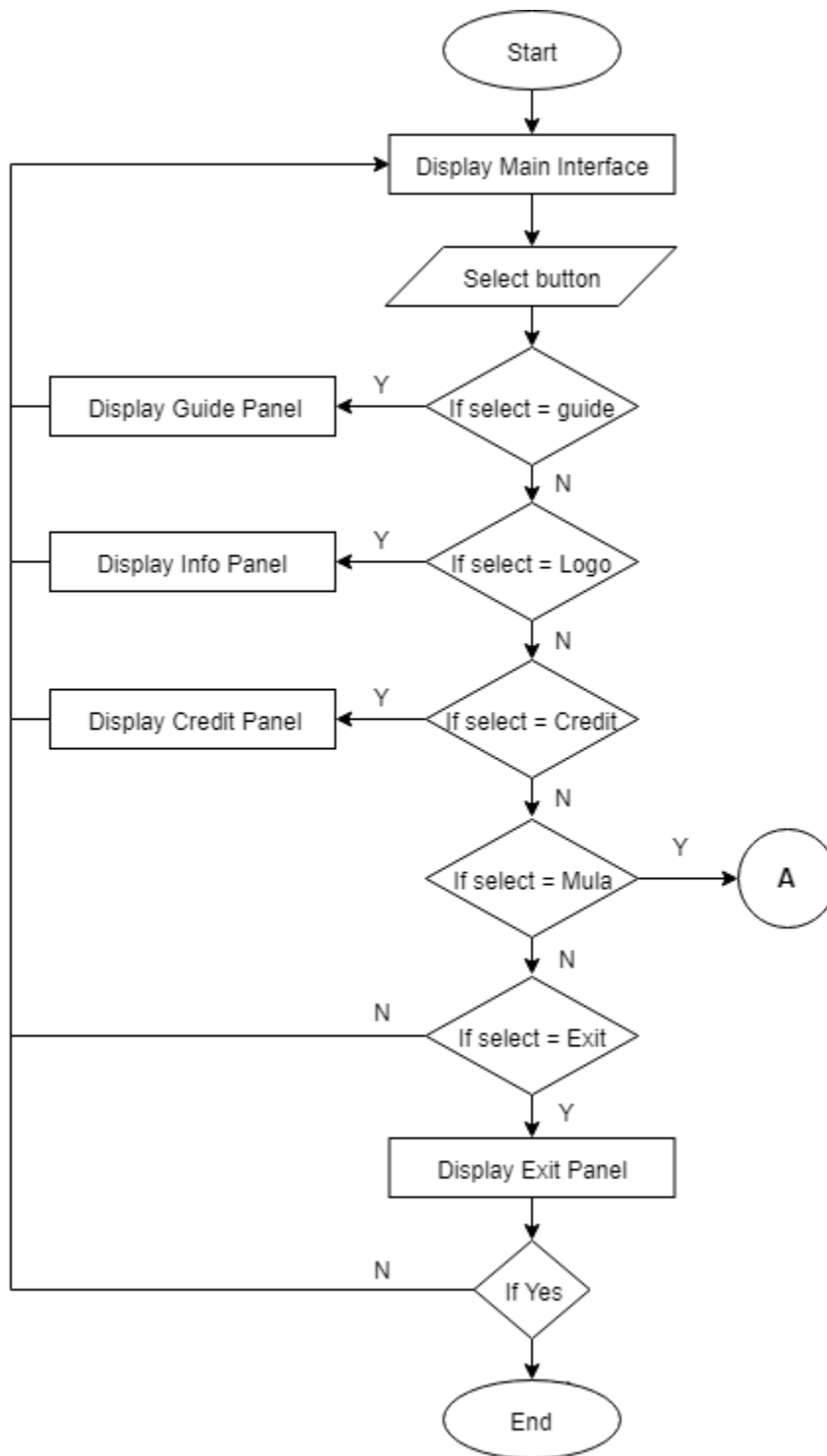


Figure 3.7 Flowchart Main Interface

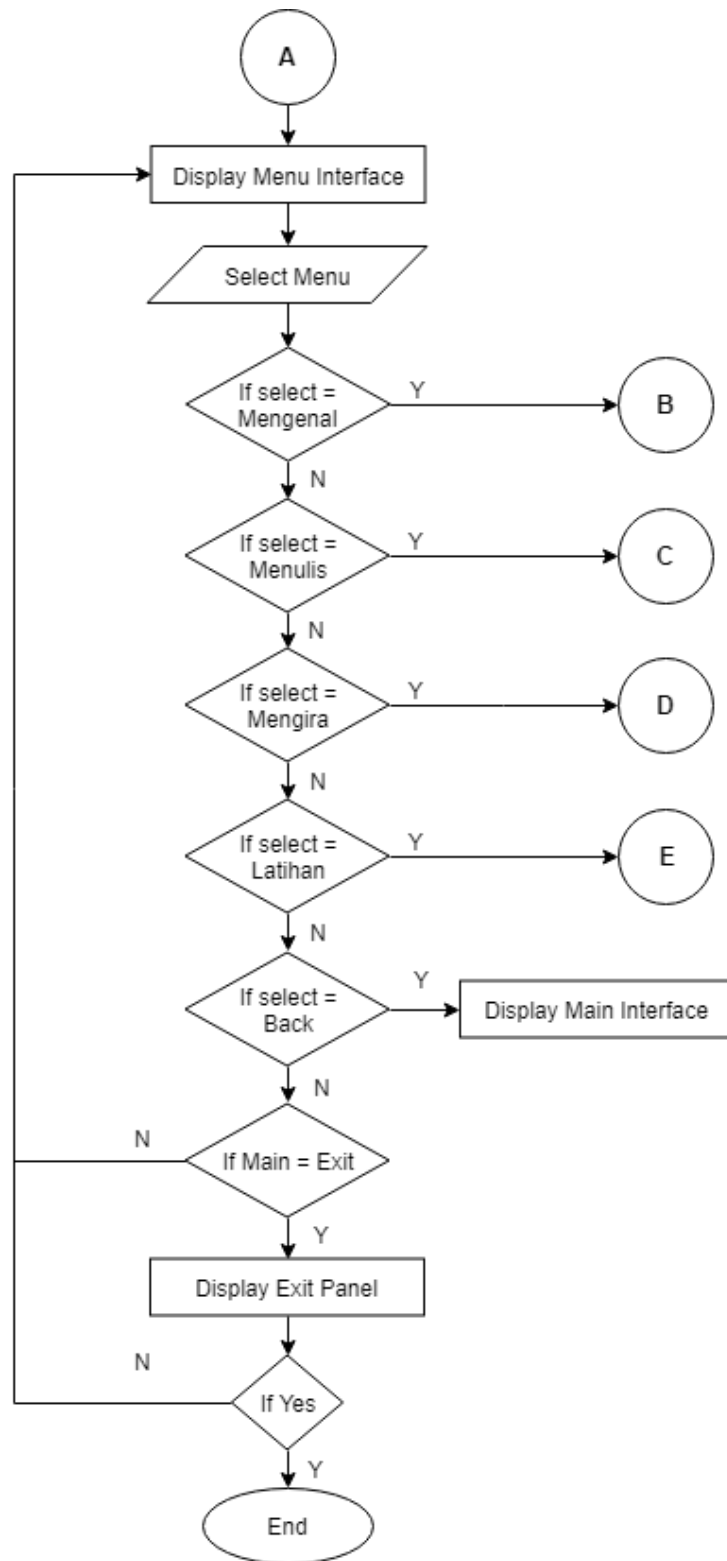


Figure 3.8 Flowchart Menu Interface

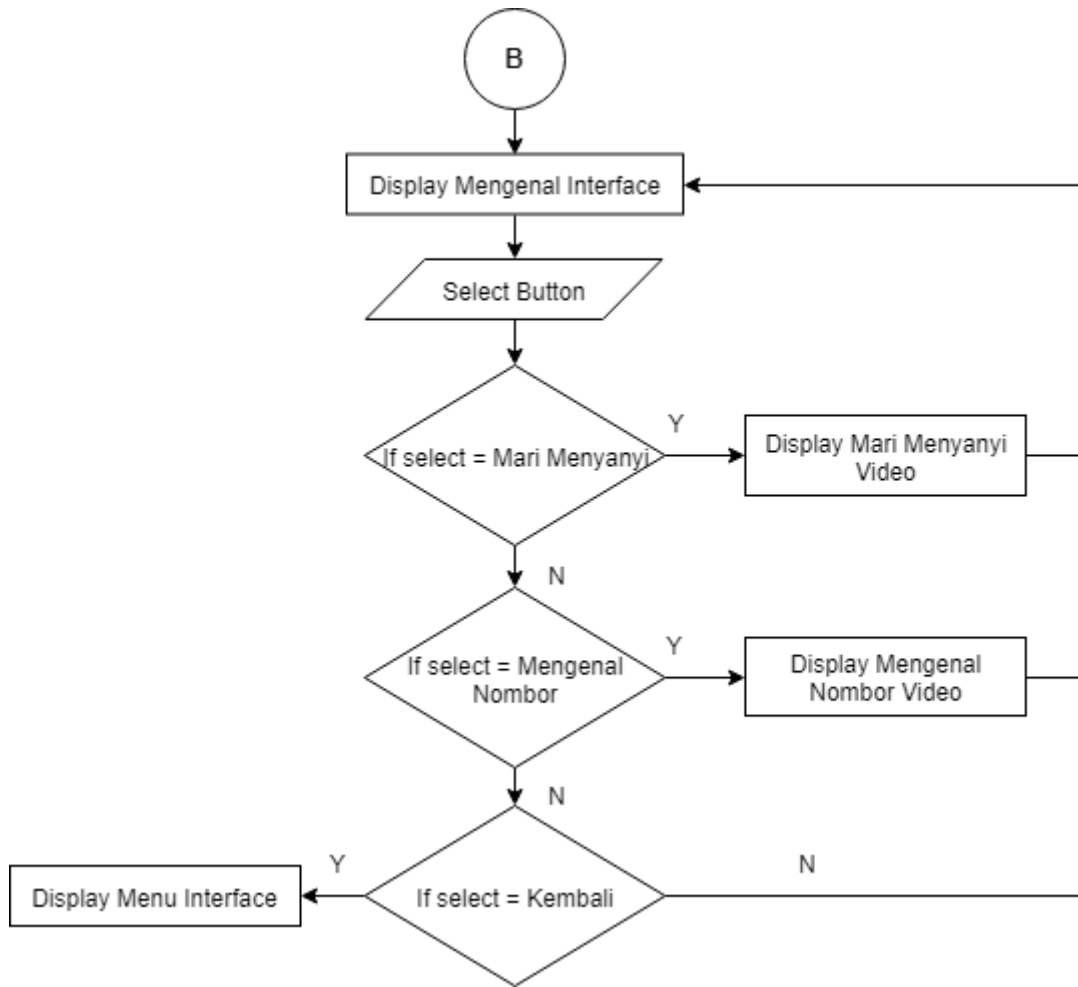


Figure 3.9 Flowchart *Mengenal* Interface

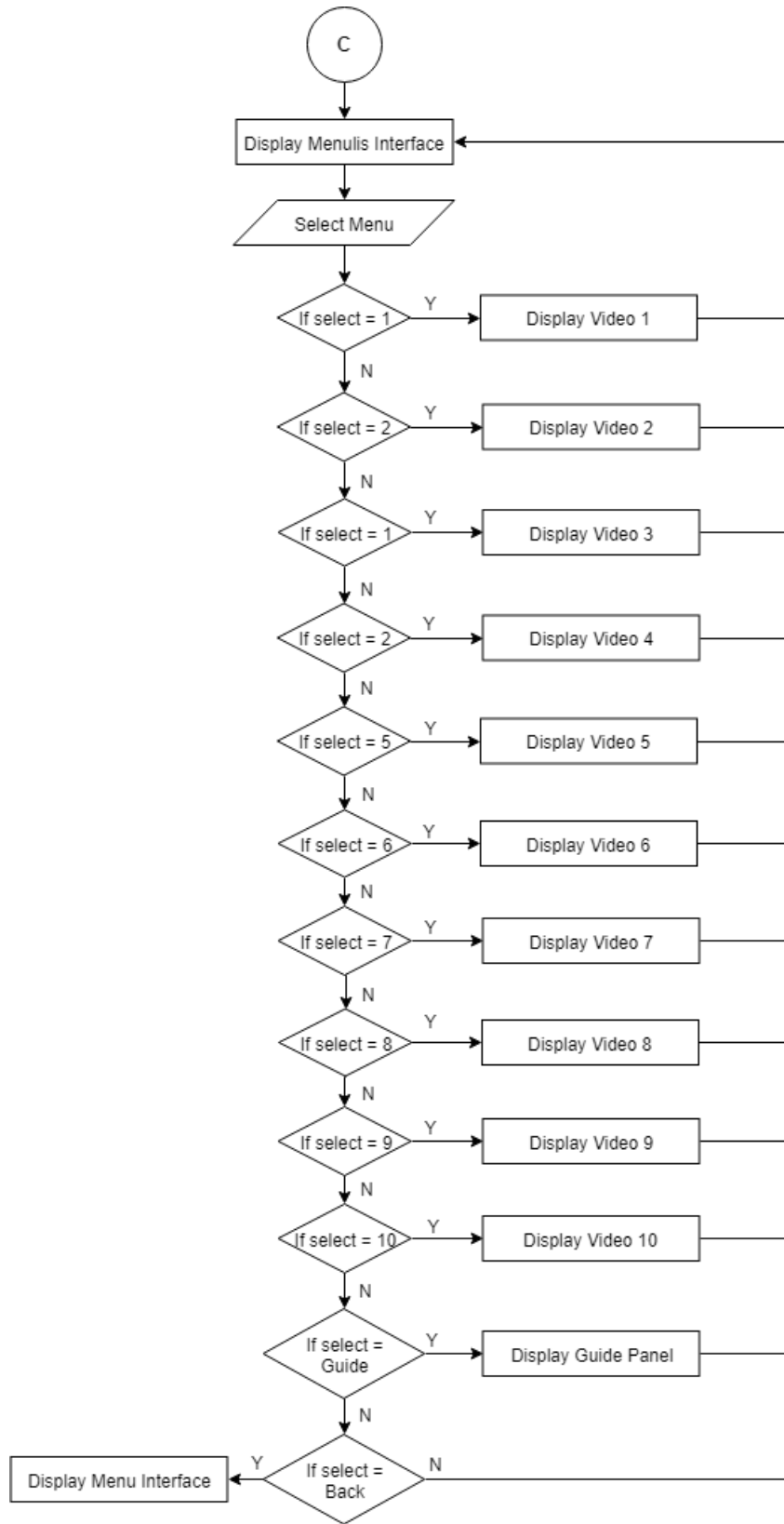


Figure 3.10 Flowchart *Menulis* Interface

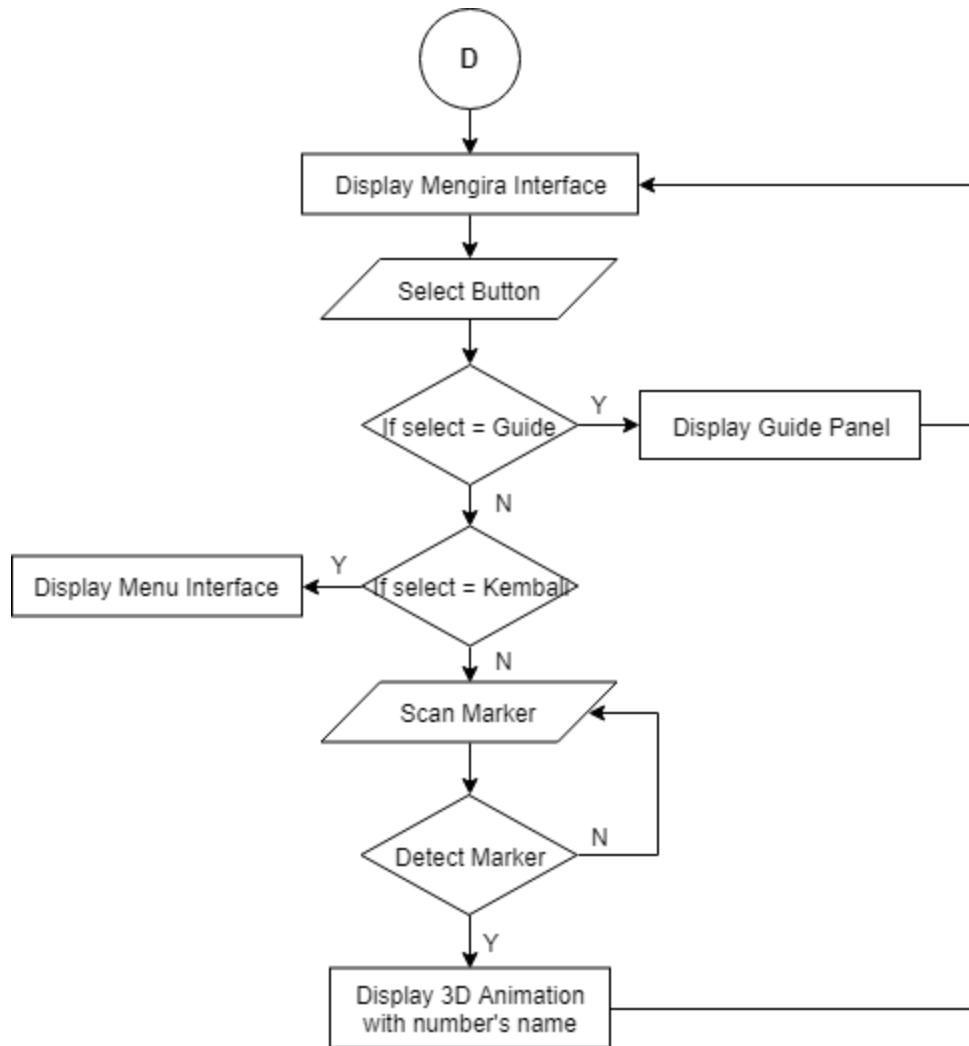


Figure 3.11 Flowchart *Mengira* Interface

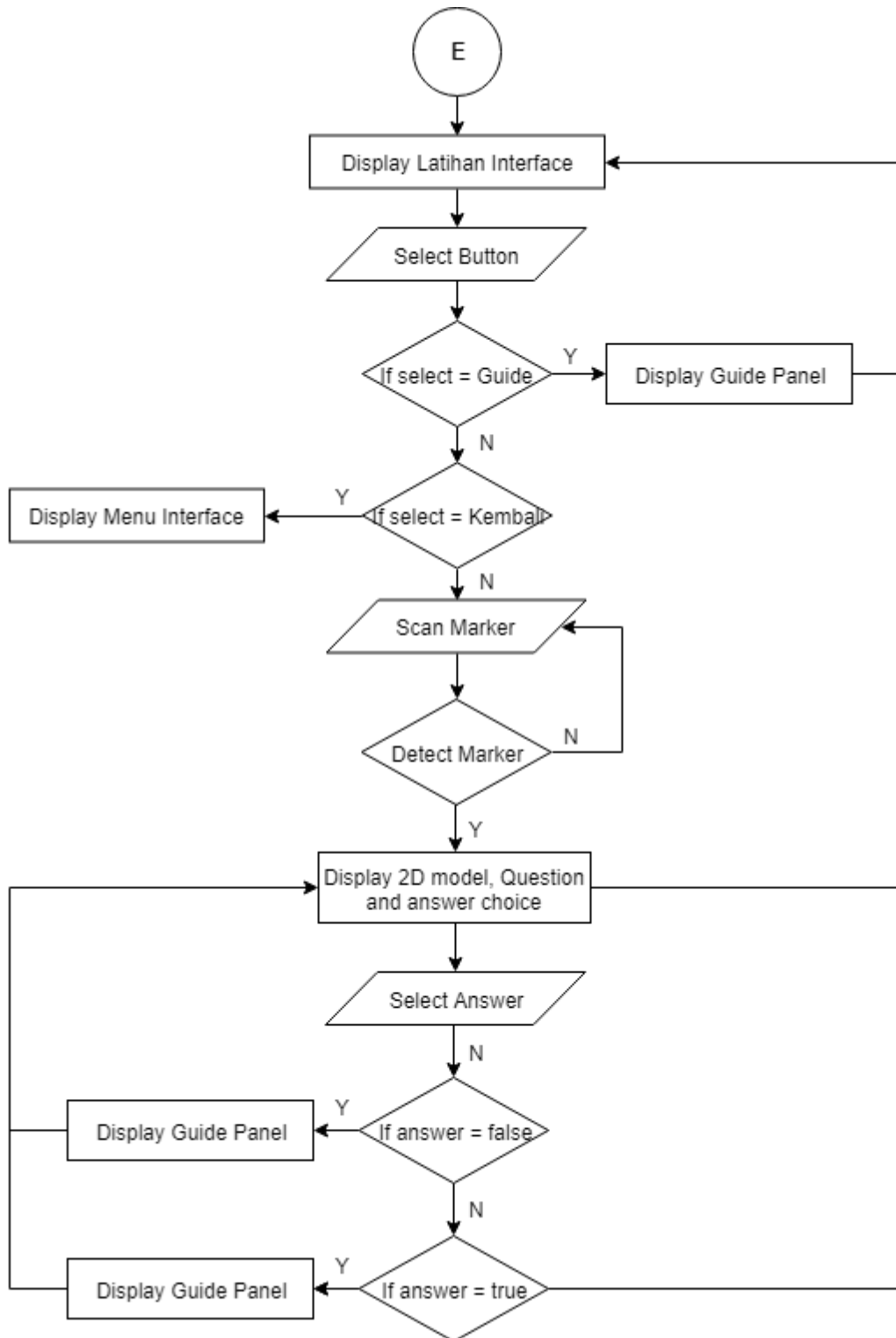


Figure 3.12 Flowchart *Latihan* Interface

iv. Storyboard

Table 3.1 Main interface storyboard

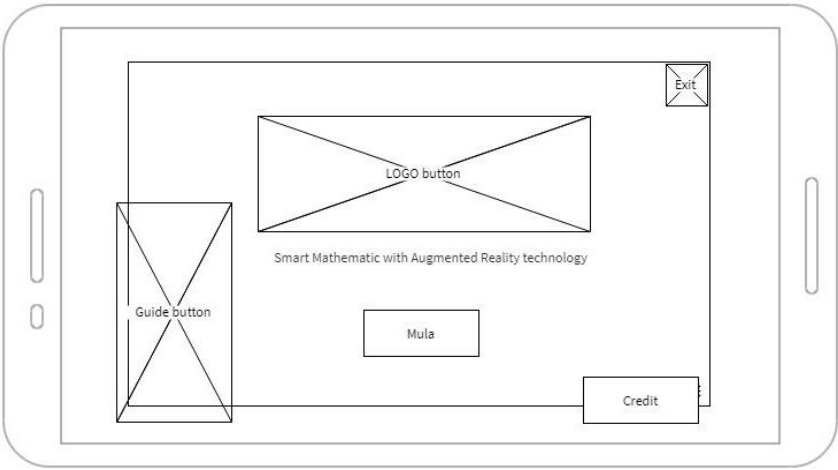
	
<p>Scene: Main interface</p>	<p>Description: This Main interface is the first interface that will appear after the user clicks to open SMART application.</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Background 2. Image Guide Character 3. Image Credit Button 4. Image Exit Button 5. Image SMART Logo 6. Image Guide Panel 7. Image Credit Panel 8. Image Apps Info Panel 9. Image Exit Panel 10. Image Yes Button 11. Image No Button 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. <i>Mula</i>: Navigate to Menu interface 2. Guide: Display guide panel 3. Credit: Display credit panel 4. Logo: Display application information panel 5. Exit: Display exit panel 6. Yes: Exit from application 7. No: Display Main Interface

Table 3.2 Main Menu interface storyboard

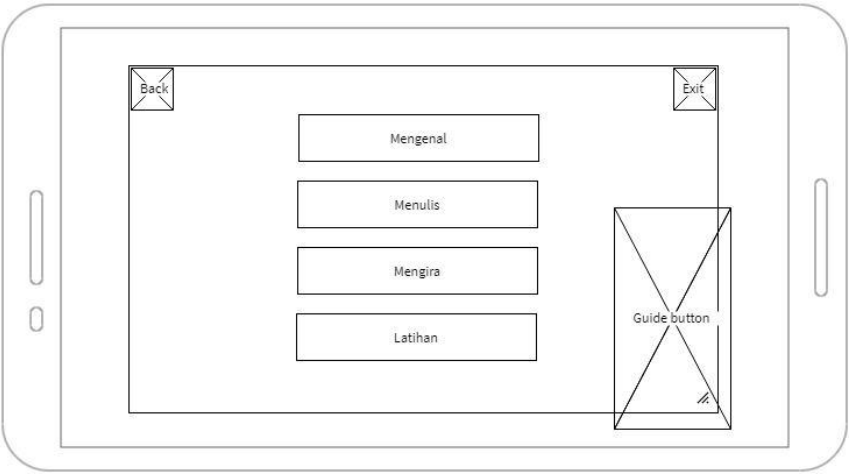
	
<p>Scene: Main Menu interface</p>	<p>Description: Main Menu interface will allow the user to choose the activities in SMART application</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Background 2. Image Guide Character 3. Image Guide Panel 4. Image Back Button 5. Image Exit Button 6. Image Exit Panel 7. Image Yes Button 8. Image No Button 9. Image Mengenal Button 10. Image Menulis Button 11. Image Mengira Button 12. Image Latihan Button <p>Audio:</p> <ol style="list-style-type: none"> 1. Background music 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. Back: Navigate to Main interface 2. <i>Mengenal</i>: Navigate to <i>Mengenal</i> interface 3. <i>Menulis</i>: Navigate to <i>Menulis</i> interface 4. <i>Mengira</i>: Navigate to <i>Mengira</i> interface 5. <i>Latihan</i>: Navigate to <i>Latihan</i> interface 6. Guide: Display guide panel 8. Exit: Display exit panel 9. Yes: Exit from application 7. No: Display Main Interface

Table 3.3 Mengenal interface storyboard

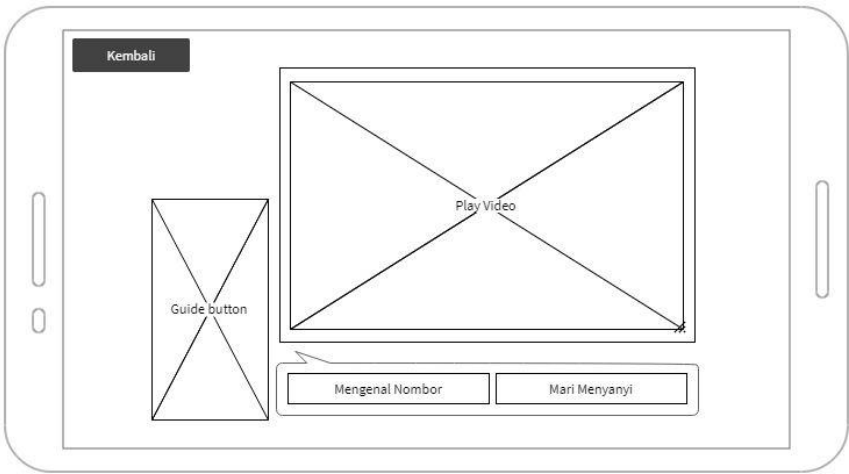
	
<p>Scene: <i>Mengenal</i> interface</p>	<p>Description: Mengenal interface will allow the user to choose and play Mengenal Nombor video or Mari Menyanyi video</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Guide Character 2. Image Guide Panel 3. Image Kembali Button <p>Video:</p> <ol style="list-style-type: none"> 4. Video Mengenal Nombor 5. Video Mari Menyanyi 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. <i>Kembali</i>: Navigate to Menu interface 2. <i>Mengenal Nombor</i>: Display Mengenal Nombor Video 3. <i>Mari Menyanyi</i>:: Display Mari Menyanyi Video 4. Guide: Display guide panel

Table 3.4 Menulis interface storyboard

<p>Scene: <i>Menulis</i> interface</p>	<p>Description: Menulis interface will allow the user to choose and play video of writing numbers 1 to 10</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Guide Character 2. Image Guide Panel 3. Image Kembali Button 4. Image Number 1 5. Image Number 2 6. Image Number 3 7. Image Number 4 8. Image Number 5 9. Image Number 6 10. Image Number 7 11. Image Number 8 12. Image Number 9 13. Image Number 10 <p>Video:</p> <ol style="list-style-type: none"> 1. writing number 1 2. writing number 2 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. <i>Kembali</i>: Navigate to Menu interface 2. Guide: Display guide panel 3. Number 1: Display writing number 1 video and text 'satu' 4. Number 2: Display writing number 2 video and text 'dua' 5. Number 3: Display writing number 3 video and text 'tiga' 6. Number 4: Display writing number 4 video and text 'empat' 7. Number 5: Display writing number 5 video and text 'lima' 8. Number 6: Display writing number 6 video and text 'enam' 9. Number 7: Display writing number 7 video and text 'tujuh'

<p>3. writing number 3 4. writing number 4 5. writing number 5 6. writing number 6 7. writing number 7 8. writing number 8 9. writing number 9 10. writing number 10</p> <p>Audio:</p> <p>1. Background music</p>	<p>10. Number 8: Display writing number 8 video and text 'lapan'</p> <p>11. Number 9: Display writing number 9 video and text 'sembilan'</p> <p>12. Number 10: Display writing number 10 video and text 'sepuluh'</p>
---	---

Table 3.5 Mengira interface storyboard

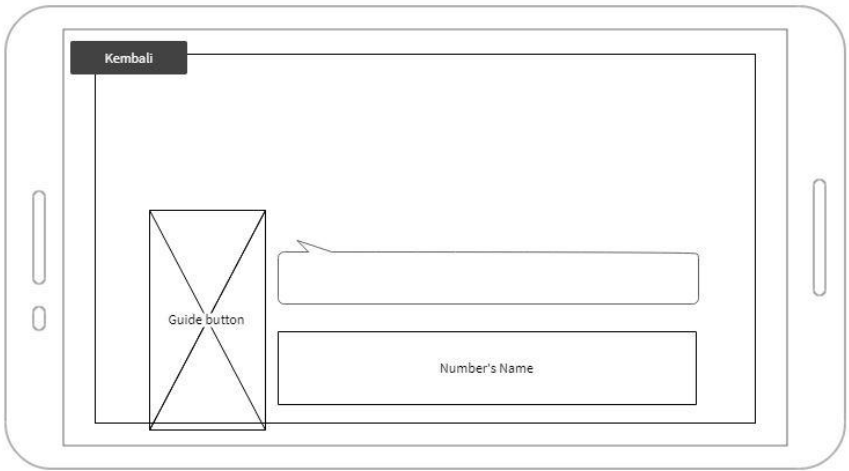
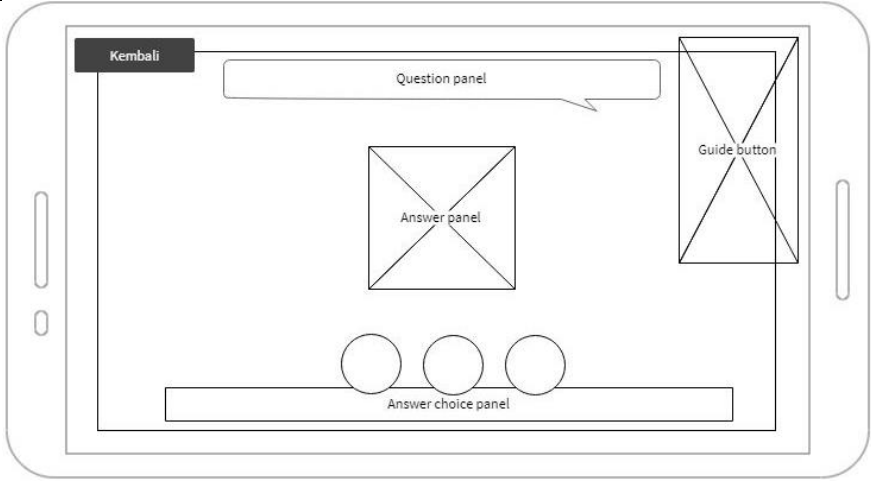
	
<p>Scene:</p> <p><i>Mengira</i> interface</p>	<p>Description:</p> <p><i>Mengira</i> interface contain AR camera where the 3D model and the number's name will appear on screen when user scan the marker to the camera</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Guide Character 2. Image <i>Kembali</i> Button 3. Image Question Panel 4. Image Guide Panel 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. <i>Kembali</i>: Navigate to Menu interface 2. Guide: Display guide panel

Table 3.6 Latihan interface storyboard

	
<p>Scene: <i>Latihan</i> interface</p>	<p>Description:</p> <p><i>Latihan</i> interface contain AR camera where the 2D model and the choice of answer will appear on screen when user scan the marker to the camera</p>
<p>Graphics:</p> <ol style="list-style-type: none"> 1. Image Guide Character 2. Image <i>Kembali</i> Button 3. Image button 1 4. Image button 2 5. Image button 3 6. Image button 4 7. Image button 5 8. Image button 6 9. Image button 7 10. Image button 8 11. Image button 9 12. Image button 10 13. Image Question Panel <p>Audio:</p> <ol style="list-style-type: none"> 1. Background music 	<p>Buttons:</p> <ol style="list-style-type: none"> 1. <i>Kembali</i>: Navigate to Menu interface 2. Guide: Display guide panel

3.2.3 Development Phase

After design phase, it is time to develop the application. At this phase, the development of the application will be done based on the design that have been created in design phase. The development will start by creating the markers, logo, blueprint and any 2D image using software Adobe Photoshop and Adobe Illustrator. The creation of 3D animation model and environment will be done using Blender and Unity3D software. Other than that, Unity3D also will used to develop the exercises. Finally, Vuforia software will be used to create image target which need collaboration with unity3D.

During the project development, the hardware that mostly used is computer or laptop which is installed with appropriate software to build the application from the beginning. Since this application may use high polygon 3D model, computer or laptop and mobile device with high specification are suggested to be use. This is to prevent incident such application lag and crashing of the hardware during the implementation of this application. Rendering are included in the development process. 3D models and animations that have higher details to be rendered. To avoid any problems occur during rendering process, the computer must have higher specification. The smartphone or tablet will be used to test and scan the marker from the book and flashcard.

3.2.4 Implement Phase

In the implementation phase, the application is first will be deploy in a test environment, and then in the teaching environment. The application then can be installed by teachers on their android mobile device such as smartphone or tablet, at which an evaluation of the application performed.

3.2.5 Evaluate Phase

The application will be used by preschoolers, teachers or parents. Then teacher and parents will evaluate this application by fill out a formative questionnaire about the application. While the observation will be held on preschoolers to evaluate the effectiveness of the application. All the feedback will be collected to identify any improvement needed in future.

3.3 HARDWARE AND SOFTWARE REQUIREMENT

This section describes all requirements to build SMART application which include the hardware and software.

3.3.1 Hardware Requirement

This part will list all hardware tools needed for the construction of the SMART application. The listed hardware was required for being used from the beginning of the development until the development is complete.

- i. Personal Computer
 - Used as medium for project development. Intel Core i5-3337U 1.8GHz
- ii. Android mobile device
 - To display the output. Smartphone or tablet

3.3.2 Software Requirement

This part will list the all software that required to develop SMART application. Each software has their own function and will be used to create different materials for the application with different format file.

- i. Adobe Photoshop and Adobe illustrator
 - To create the logo and blueprint image
 - To create Early Math AR book as a marker
- ii. Blender
 - To create the 3D object

- iii. Unity
 - To implement the model into augmented reality
 - To develop the interface of SMART application

- iv. Vuforia
 - To supports application development for Android-based devices

- v. Audacity
 - To edit the audio

3.4 GANTT CHART

This project is planning to be conducted in two phase of time which is PSM1 in semester 2 of 2018/2019 and PSM2 in semester 1 of 2018/2019. The distribution of work was using ADDIE methodologies which is Analysis, Design, Develop, Implement and Evaluate phase. PSM1 covered on Analysis phase and Design phase. Duration time to complete Analysis phase require 25 days, while Design phase require 22 days. Total duration required to complete PSM1 is 47 days not include weekend which is start from 5 March 2018 and finish on 3 May 2018. PSM2 covered on Development phase, Implement phase and Evaluation phase. Total duration required to complete PSM2 is 66 days not include weekend where Development phase require 48 days, Implement phase require 10 days and Evaluation phase require 8 days. PSM2 is starting from 5 September 2018 and finish on 5 December 2018.

(Gantt Chart in **Appendix H**)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter consists of the details about the implementation, testing, result and discussion of SMART Application. In implementation part gives explanation about the development process of this project. Testing part discussing on how this application been tested. The result of testing this project will be discussed in result and discussion part.

4.2 IMPLEMENTATION

This part describes the specific process in implementing the requirement into the application. All process involved in this project development has been recorded step by step.

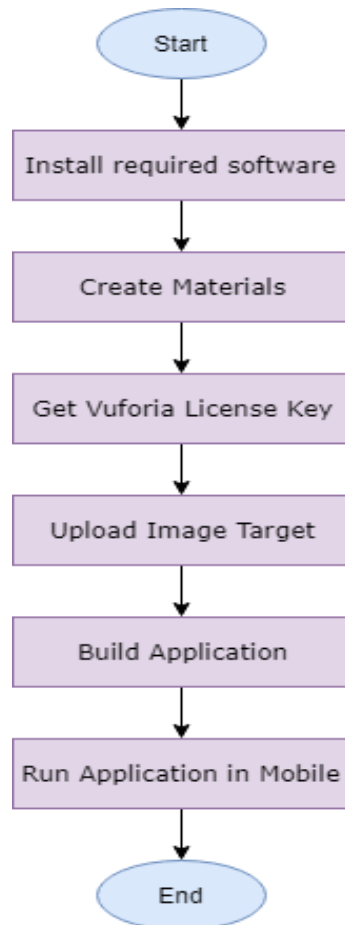


Figure 4.1 Flowchart of implement process

Figure 4.1 shows the flowchart of implementation process. The process starts with installing all required software that need to be used along this project. The process followed by creating all the materials used in application. When all the materials are ready, then continue with getting license key from Vuforia Portal. This license key is important as to allow the development of augmented reality been done in Unity 3D software later. Next, upload the image target which will act as marker. Followed with the process of build the application. Once the process of build is done, the application finally can be run in mobile device.

4.2.1 Installing software



Figure 4.2 Logo of software has been installed

The first process of implementation is installing all required software. There are four most important software that being used which is Adobe Photoshop, Adobe Illustrator, Adobe Premiere, Audacity, Blender and Unity. Figure 4.2 show the logo of software that has been installed into developer laptop.

4.2.2 Creating Materials

This area will explain about the process of designing or modelling all materials that being used in this project. The materials that been mention are including the logo, marker (image target) which is book and flashcard, video, audio, 2D images (sprite) and 3D objects. All this material been create using different software which are Adobe Illustrator, Adobe Photoshop, Adobe Premiere, Audacity and Blender.

i. Designing 2D object

Logo of this application are created as 2D image. Logo are intended to visually communicate the identity of an application. The process of designing SMART logo and background for application interface being complete by using Adobe Photoshop software. Figure 4.3 shows the process of creating logo in Adobe Photoshop software. While Figure 4.4 shows another material that being create using same software.

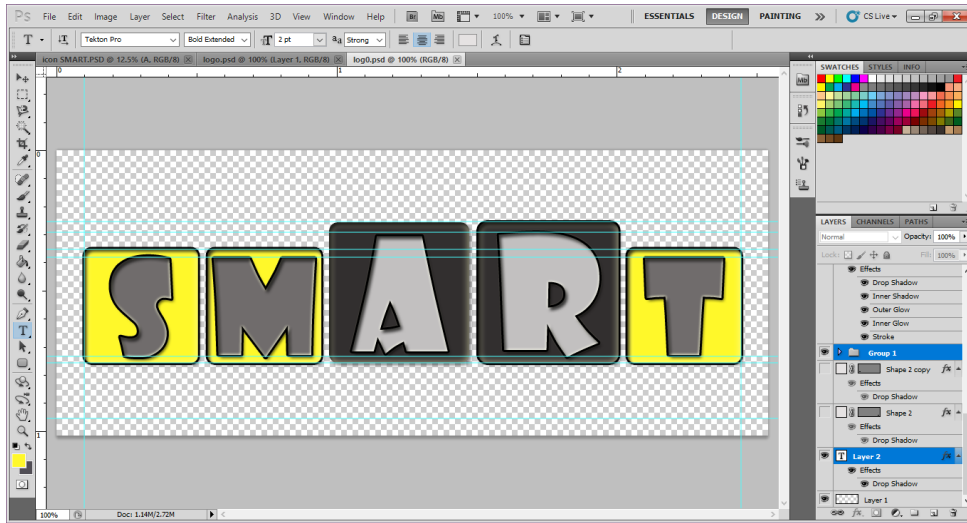


Figure 4.3 Logo designed using Adobe Photoshop

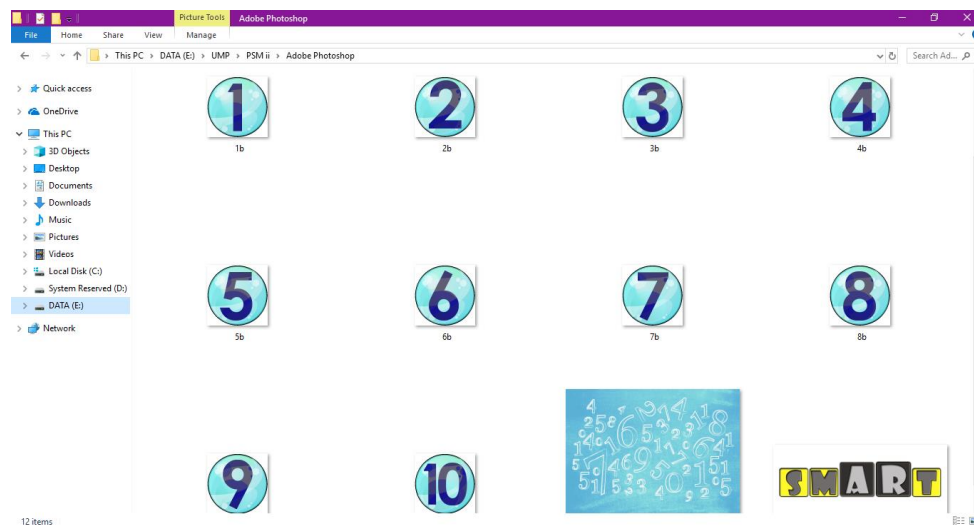


Figure 4.4 Materials created using Adobe Photoshop

ii. Designing Marker

Markers or image target play an important role in an augmented reality application. The augmented reality camera will scan the image with the help of tracking points to show augmented 3D objects or any assigned contents

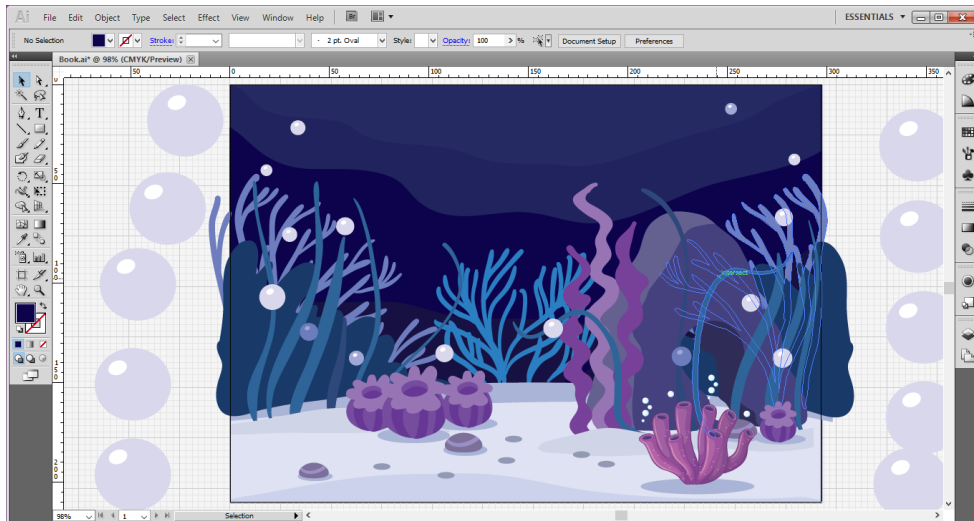


Figure 4.5 Creating book using Adobe Illustrator software

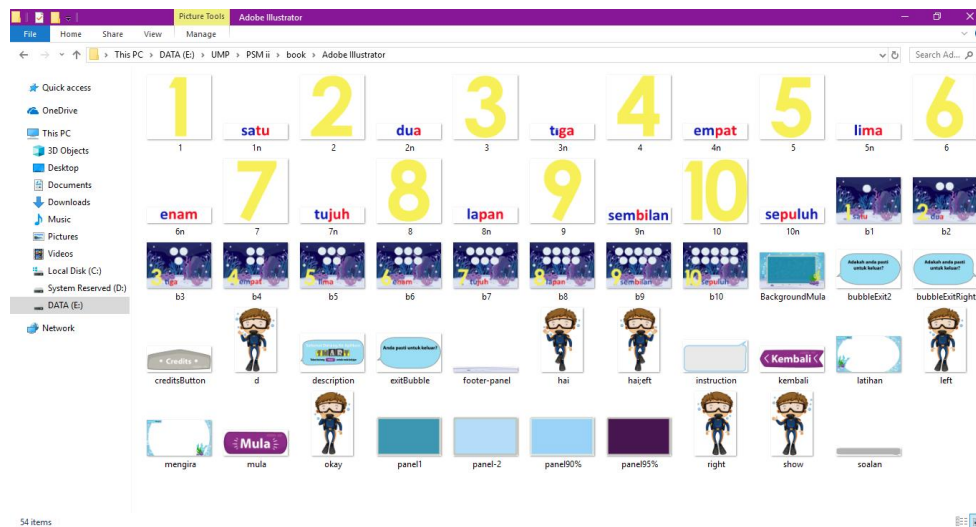


Figure 4.6 Materials created using Adobe Illustrator

As shown in Figure 4.5, the markers have specifically design using Adobe Illustrator software. There are two different size of marker used for this project which is A4 size for book and A7 size for flashcard. Figure 4.6 show other materials that also been created using Adobe Illustrator.

iii. Audio Editing

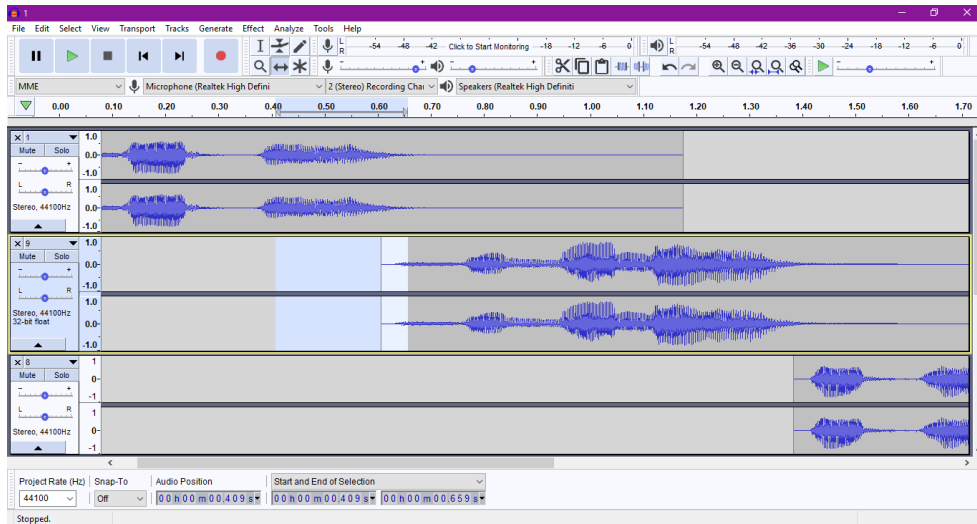


Figure 4.7 Audio editing using Audacity software

iv. Modelling 3D object

Before starting on the development of the Augmented Reality application, the 3D models must be modelled first. This process will be done by using 3D modelling tools which are Blender software.



Figure 4.8 Editing 3D Object using Blender software

v. Texturing of 3D Assets

Texturing can be done via two ways:

- i. Basic texturing – applying basic shaders or colors on the 3D model.
- ii. UV texturing – applying and tuning pre-saved textures on the 3D model by “wrapping” the texture neatly around the model. This requires the 3D model to be mapped on to the texture, which is usually an image, in a process called “UV mapping”.

vi. Creating video

In several decades of research, the use of video in education may lead to many benefits. Video can be as good as an instructor in communicating facts or demonstrating procedures to assist in mastery learning. The aim of producing *Mengenal Nombor* video is to introduce number one to ten to the users. This video was created using Adobe Premiere. This video contains number one to ten shapes that been create in Adobe Illustrator and save as .png format, background that create using Adobe Photoshop and Audio that has been manipulated from Audacity software. Figure 4.9 shows the process of creating video using Adobe Premiere.

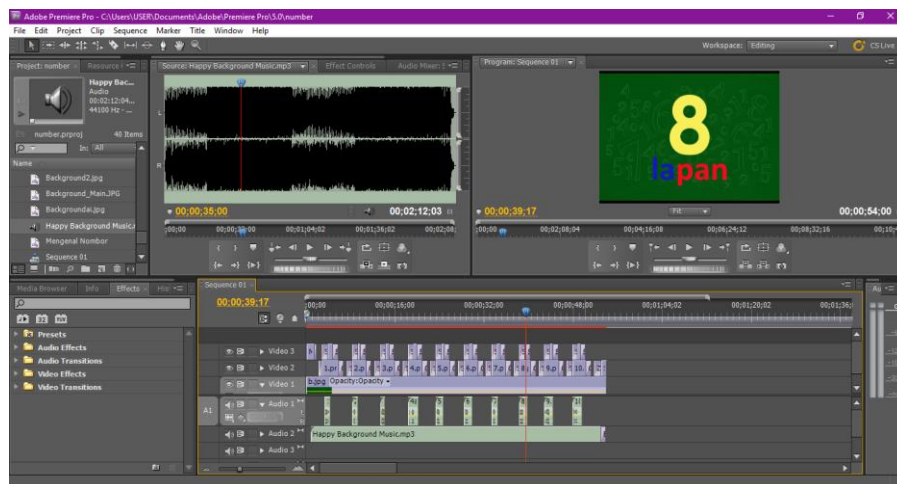


Figure 4.9 Creating video using Adobe Premiere software

4.2.3 Getting the Vuforia License Key

To enable the creation of augmented reality applications on mobile device, an augmented reality software development kit (SDK) which is Vuforia are needed.

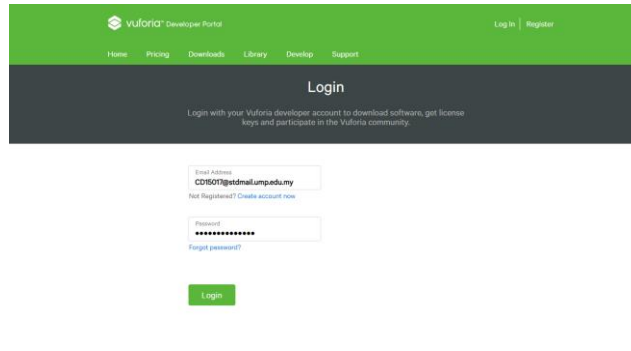


Figure 4.10 Login using registered account

First, click on Vuforia developer portal using this link <https://developer.vuforia.com>. Login using registered account as shown in Figure 4.10 to allow the developer to get the license key. After login, developer now can start creating the License Key through License Manager.

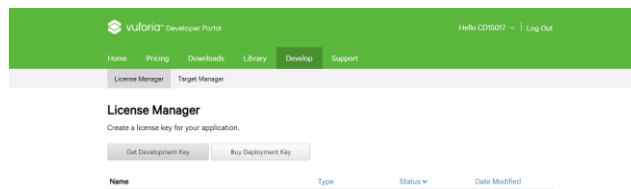


Figure 4.11 License Manager interface

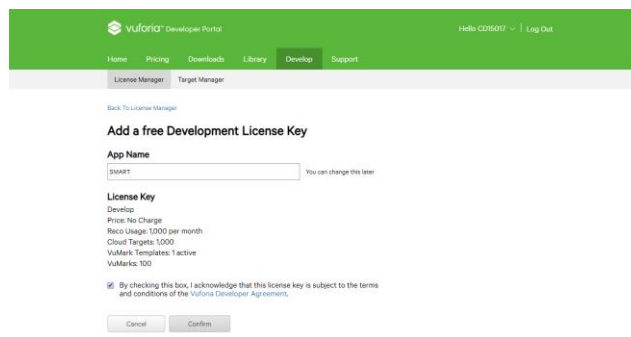


Figure 4.12 Click on “Confirm” button

License Key are used to activate the AR Camera which allow AR scene to be built on mobile device. Figure 4.11 shows License Manager interface. Click on “Get Development Key” and fill up the App Name as “SMART” then click on “Confirm” button as shown in Figure 4.12. The license key will be automatically added in the License Manager.

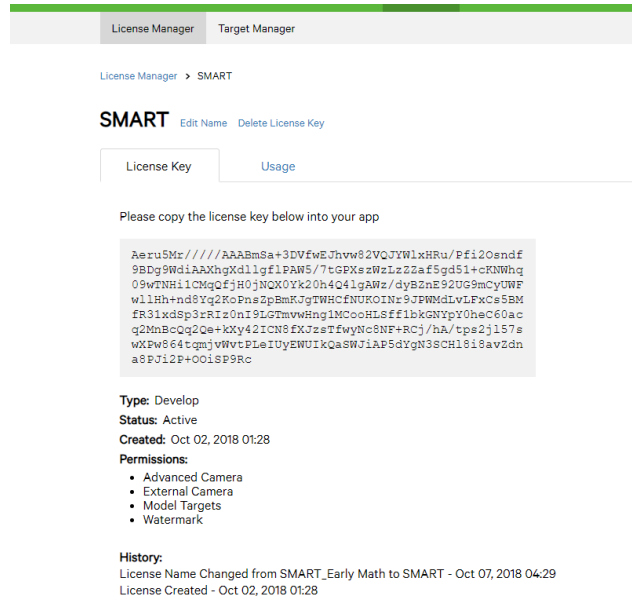


Figure 4.13 Copy License Key

Back to License Manager and click on the SMART to get the License Key. License Key will be appear as shown as in Figure 4.13. The License Key now can be copy into the Unity.

4.2.4 Upload Image Target

Beside license key, creating image target also need to be done through Vuforia Developer Portal.

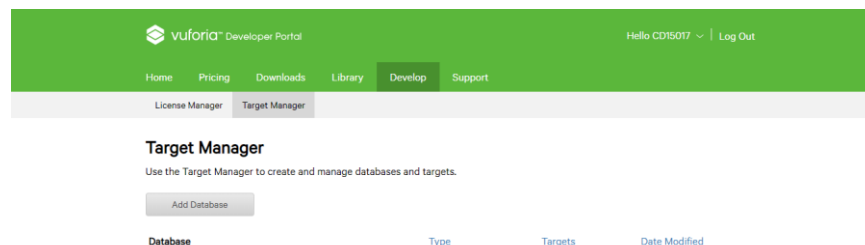
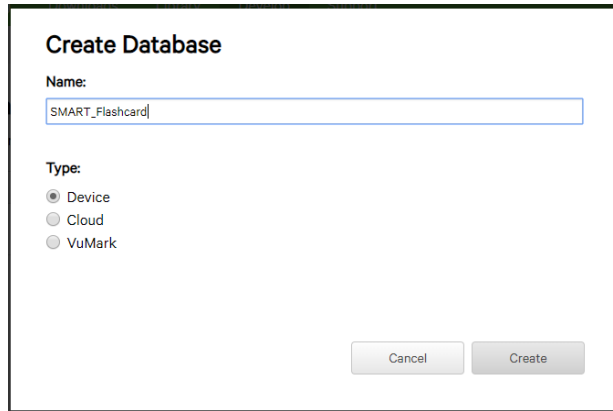


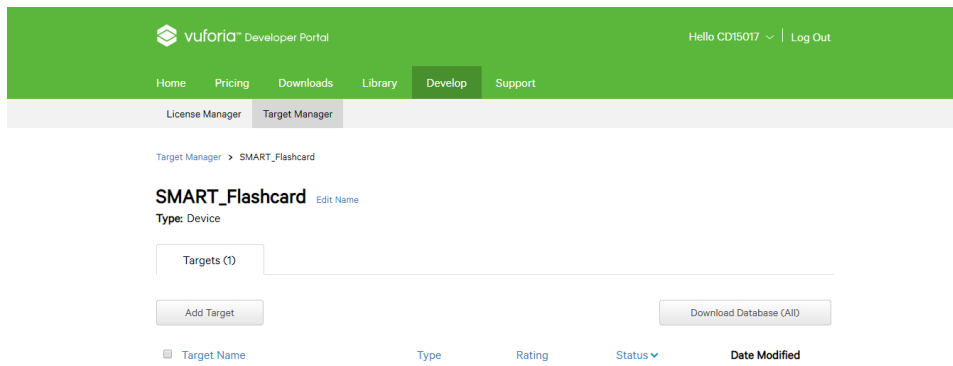
Figure 4.14 Target Manager



The image shows a 'Create Database' dialog box. It has a title bar 'Create Database'. Below the title, there is a 'Name:' label followed by a text input field containing 'SMART_Flashcard'. Below that, there is a 'Type:' label followed by three radio button options: 'Device' (which is selected), 'Cloud', and 'VuMark'. At the bottom right of the dialog, there are two buttons: 'Cancel' and 'Create'.

Figure 4.15 Create Database

As shown in Figure 4.14, to create the image target, click on Target Manager and add database by clicking Add Database. Key in the name of that database and choose Device as the type of this project would like to be displayed. Then click "Create" button as shown in Figure 4.15.



The image shows a screenshot of the Vuforia Developer Portal. The top navigation bar is green and contains the Vuforia logo, 'Developer Portal', and a user profile 'Hello CD15017 | Log Out'. Below the navigation bar, there are tabs for 'Home', 'Pricing', 'Downloads', 'Library', 'Develop', and 'Support'. The 'Target Manager' tab is active. Below the tabs, there is a breadcrumb 'Target Manager > SMART_Flashcard'. The main content area shows the details for 'SMART_Flashcard' with an 'Edit Name' link. Below the name, it says 'Type: Device'. There is a 'Targets (1)' section with an 'Add Target' button and a 'Download Database (AID)' button. At the bottom, there is a table header with columns: 'Target Name', 'Type', 'Rating', 'Status', and 'Date Modified'.

Figure 4.16 Add target image

Finish creating the Database, now add the target image. Click on the name of image target that have been created to open the database file. Then click on the “Add Target” button as shown in Figure 4.16 to add the image which will be the project marker.

Add Target

Type:

Single Image Cuboid Cylinder 3D Object

File:

Flash1.JPG Browse...

.jpg or .png (max file 2mb)

Width:

50

Enter the width of your target in scene units. The size of the target should be on the same scale as your augmented virtual content. Vuforia uses meters as the default unit scale. The target's height will be calculated when you upload your image.

Name:

Flash1

Name must be unique to a database. When a target is detected in your application, this will be reported in the API.

Cancel Add

Figure 4.17 upload the image

At Add Target, choose the type as Single Image, width 50. Browse the file to select the image. When all required field are complete, click on "Add" button to upload the image. Image that been rate with 5 stars is a very good image target, while image with 1 star is consider not suitable to be chosen as image target.

vuforia™ Developer Portal Hello CD15017 Log Out

Home Pricing Downloads Library Develop Support

License Manager Target Manager

Target Manager > SMART_Flashcard

SMART_Flashcard Edit Name

Type: Device

Targets (0)

Add Target Download Database (AJD)

Target Name	Type	Rating	Status	Date Modified
-------------	------	--------	--------	---------------

Figure 4.18 Download database

4.2.5 Build application project

Now, all materials are ready, License Key and image target also available. Next, create Project in Unity 3D software.



Figure 4.19 Open Unity 3D

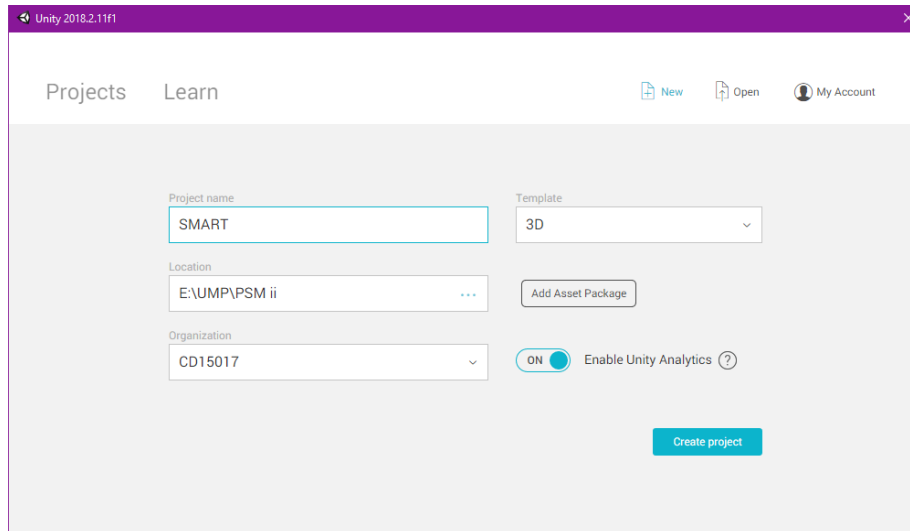


Figure 4.20 Create New Project in Unity 3D

Figure 4.17 shows the Unity 3D loading to open. Fill up the project name, location to save and organization as shown in Figure 4.18 above. Click on “Create project” button.

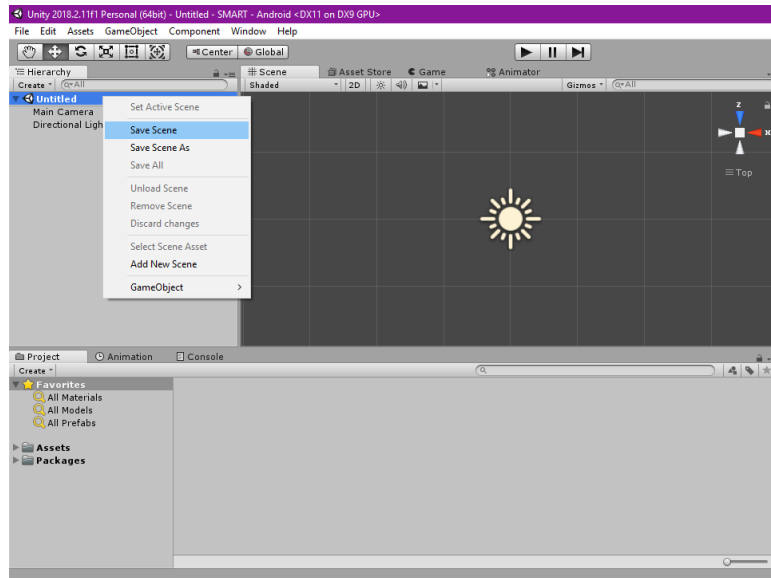


Figure 4.21 Save Scene

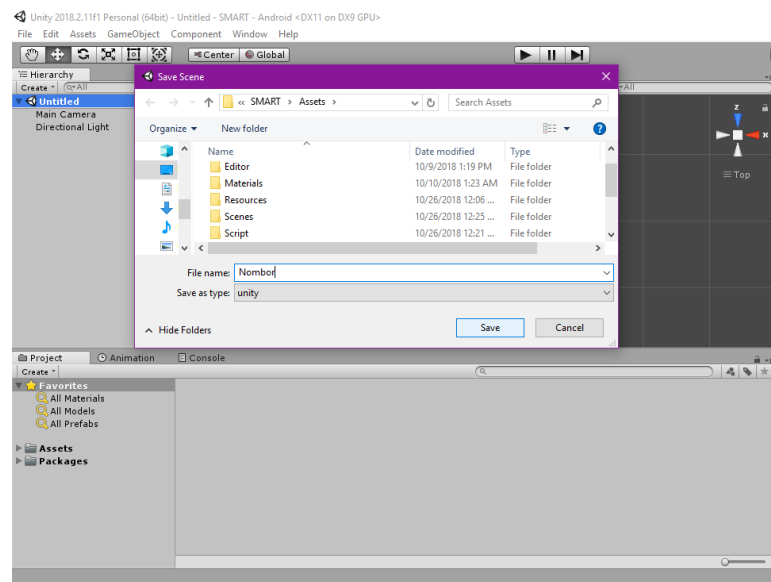


Figure 4.22 Save Scene window

Save scene by right click as shown in Figure 4.21 then select save scene. Save scene window such in Figure 4.22 will appear. Write file name then save file.

4.2.5.1 Implementing Augmented Reality into the scene

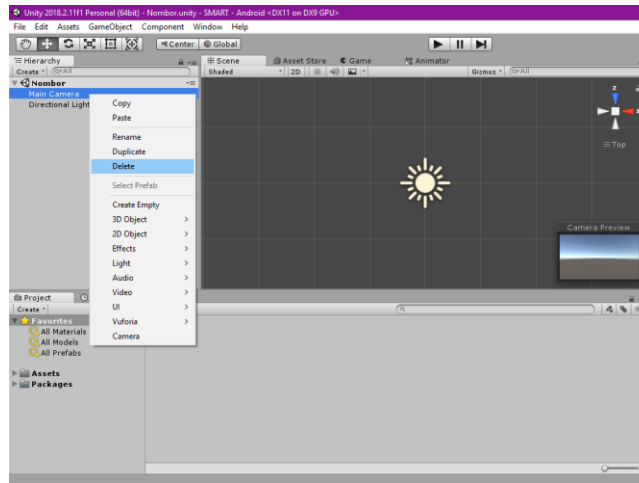


Figure 4.23 Delete Main Camera

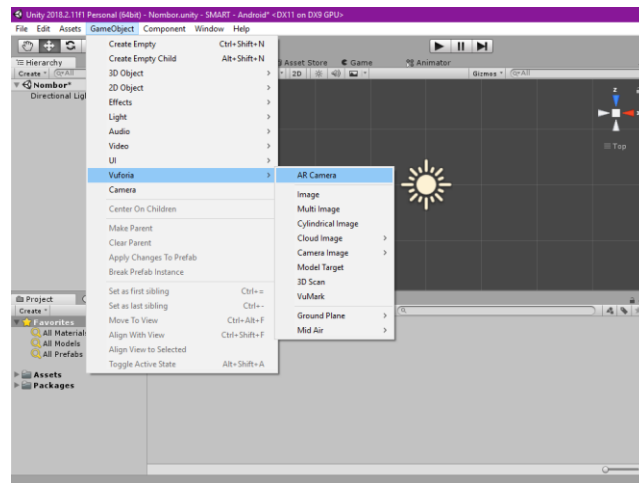


Figure 4.24 Insert AR Camera

Firstly, delete the main camera as shown in figure 4.23. Then insert AR Camera by click on GameObject, choose Vuforia and select AR Camera as shown in Figure 4.24.

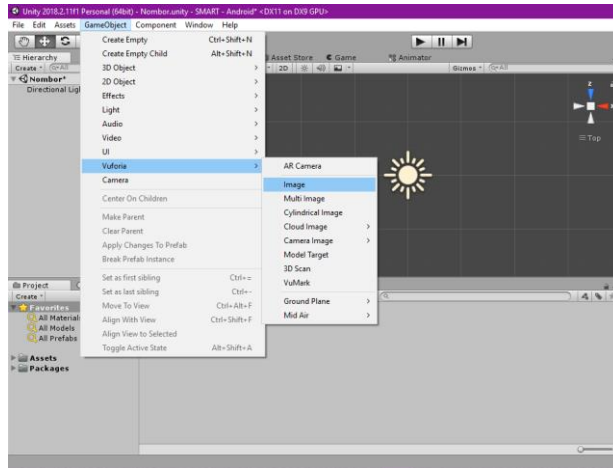


Figure 4.25 Insert image target

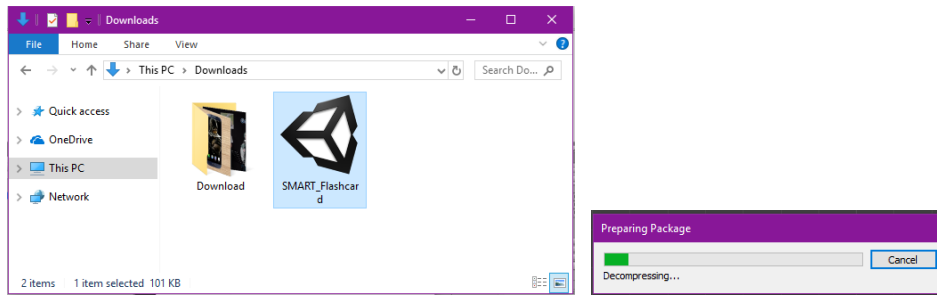


Figure 4.26 Open downloaded image target database

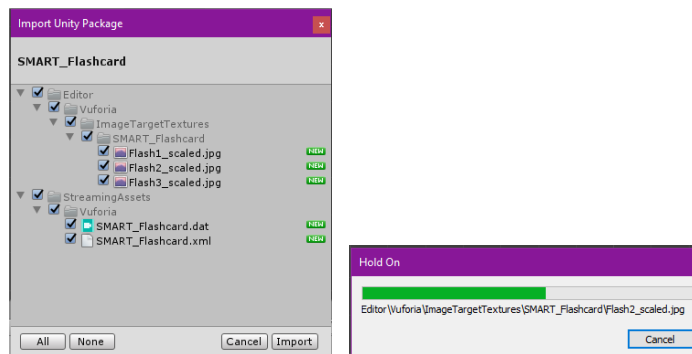


Figure 4.27 Import image target database

Next, insert image target by click on GameObject, go to Vuforia and select image as shown in Figure 4.25. Open downloaded image target database to import the image from Vuforia into unity such in Figure 4.26. Back to Unity, then click on import button as shown in figure 4.27 to proceed with importing image target database. Wait until the process finish.

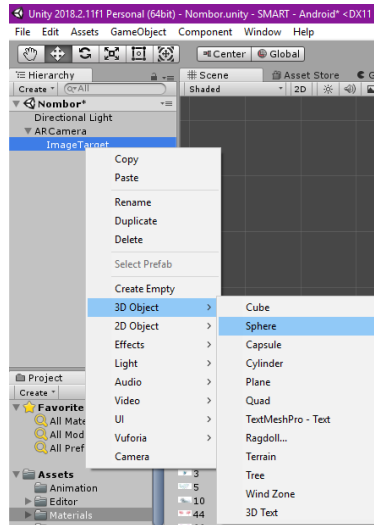


Figure 4.28 Insert 3D model

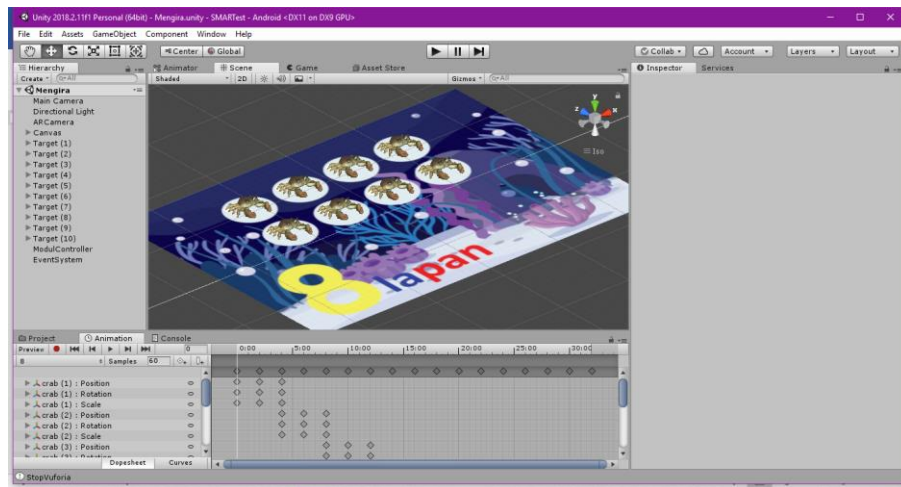


Figure 4.29 Image target and 3D model in *Mengira* scene

Then insert 3D model by right click on image target and select 3D object as shown in Figure 4.28 or drag the 3D model into the image target directly. Figure 4.29 shows the image target and 3D model with animation.

There are two scene that implementing AR camera

4.2.5.2 Creating Interface

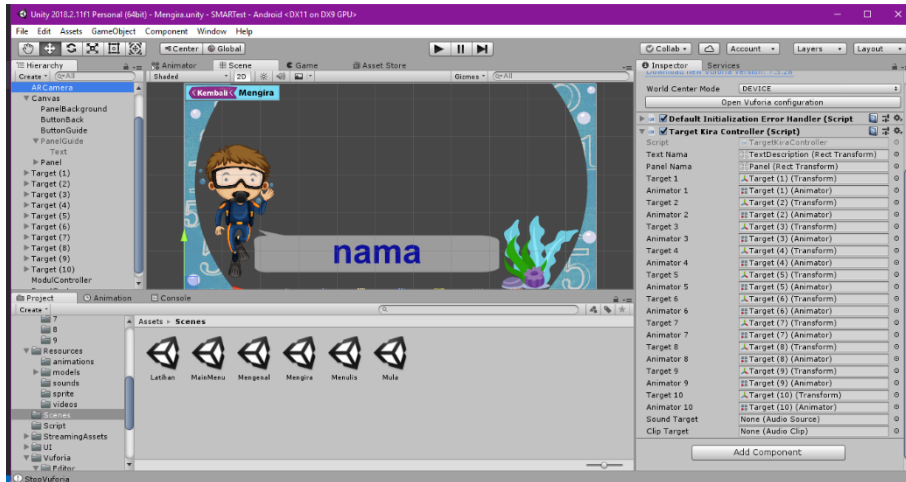


Figure 4.30 Mengira scene

Beside implementing AR camera, *Mengira* scene contain a canvas with three panels inside it. These panels are Background panel, Guide panel and name of numbers panel. Background image (sprite) are drag into the Background panel which will act as camera frames. There are two buttons inside background panel which is back and guide. All buttons are designed with different shape which is done by drag 2D image (sprite) into Source image box. When AR camera detect the marker, the name of number panels will be active and text name will be change according to markers. The code mention was written as TargetKiraController code script and drag it into AR camera. DefaultEventTrackableHandler code script are used to activate the panels when it detect markers or lost.

TargetKiraController code script

```
using UnityEngine;
using UnityEngine.UI;
using System.Collections;
using System.Collections.Generic;

namespace Vuforia
{
    public class TargetKiraController : MonoBehaviour
    {
        public Transform TextNama;
        public Transform PanelNama;

        public Transform target1;
        public Animator animator1;

        public Transform target2;
        public Animator animator2;

        public Transform target3;
        public Animator animator3;

        public Transform target4;
        public Animator animator4;

        public Transform target5;
        public Animator animator5;

        public Transform target6;
        public Animator animator6;

        public Transform target7;
        public Animator animator7;

        public Transform target8;
        public Animator animator8;

        public Transform target9;
        public Animator animator9;

        public Transform target10;
        public Animator animator10;

        //-----Begin Sound-----
        public AudioSource soundTarget;
        public AudioClip clipTarget;
        private AudioSource[] allAudioSources;
    }
}
```

```

    void PauseAllAudio()
    {
        allAudioSources = FindObjectsOfType(typeof(AudioSource)) as
AudioSource[];
        foreach (AudioSource audioS in allAudioSources)
        {
            audioS.Pause();
        }
    }

    void playSound(string ss)
    {
        clipTarget = (AudioClip)Resources.Load(ss);
        soundTarget.clip = clipTarget;
        soundTarget.loop = false;
        soundTarget.playOnAwake = false;
        soundTarget.Play();
    }

    // Use this for initialization
    void Start()
    {
        soundTarget = (AudioSource)gameObject.AddComponent<AudioSource>();

        animator1 = target1.GetComponent<Animator>();
        animator1.speed = -1;

        animator2 = target2.GetComponent<Animator>();
        animator2.speed = -1;

        animator3 = target3.GetComponent<Animator>();
        animator3.speed = -1;

        animator4 = target4.GetComponent<Animator>();
        animator4.speed = -1;

        animator5 = target5.GetComponent<Animator>();
        animator5.speed = -1;

        animator6 = target6.GetComponent<Animator>();
        animator6.speed = -1;

        animator7 = target7.GetComponent<Animator>();
        animator7.speed = -1;

        animator8 = target8.GetComponent<Animator>();
        animator8.speed = -1;

        animator9 = target9.GetComponent<Animator>();
        animator9.speed = -1;

        animator10 = target10.GetComponent<Animator>();
        animator10.speed = -1;
    }

```

```

// Update is called once per frame
void Update()
{
    StateManager sm = TrackerManager.Instance.GetStateManager();
    IEnumerable<TrackableBehaviour> tbs = sm.GetActiveTrackableBehaviours();

    foreach (TrackableBehaviour tb in tbs)
    {
        string name = tb.TrackableName;
        ImageTarget it = tb.Trackable as ImageTarget;
        Vector2 size = it.GetSize();

        Debug.Log("Active image target:" + name + " -size: " + size.x + ", "
+ size.y);

        PauseAllAudio();

        if (name == "b1")
        {
            playSound("sounds/1");
            animator1.speed = 1; ;
            TextNama.GetComponent<Text>().text = "satu";
        }

        if (name == "b2")
        {
            playSound("sounds/2");
            animator2.speed = 1;
            TextNama.GetComponent<Text>().text = "dua";
        }

        if (name == "b3")
        {
            playSound("sounds/3");
            animator3.speed = 1;
            TextNama.GetComponent<Text>().text = "tiga";
        }

        if (name == "b4")
        {
            playSound("sounds/4");
            animator4.speed = 1;
            TextNama.GetComponent<Text>().text = "empat";
        }

        if (name == "b5")
        {
            playSound("sounds/5");
            animator5.speed = 1;
            TextNama.GetComponent<Text>().text = "lima";
        }

        TextNama.GetComponent<Text>().text = "enam";
    }
}

```




Figure 4.31 *Mula* (Start) scene

Mula interface is the very first scene that will be displayed when the user opens the application. This main scene contains a canvas with six panel inside it. These panels are Background panel, Main panel, Guide panel, Credit panel, Info panel and exit panel. Background image (sprite) are drag into the Background panel which will act as interface background. There are five buttons inside Panel Main which is start, guide, credit, info and exit buttons. All buttons are built with different shape which is done by dragging 2D image (sprite) into Source image box. Panel Guide, Credit, info and exit has been set inactive by untick the box inside inspector panel. The panels have been code as active by clicking the buttons. StartController code script are used to activate the panels.

StartController code script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class StartController : MonoBehaviour {

    public string MainMenu;
    public GameObject MulaPanel;
    public GameObject KeluarPanel;
    public GameObject creditPanel;
    public GameObject infoPanel;
    public GameObject howtoPanel;
```

```

public void mula()
{
    creditPanel.SetActive(false);
    infoPanel.SetActive(false);
    KeluarPanel.SetActive(false);
    howtoPanel.SetActive(false);
}

public void credit()
{
    creditPanel.SetActive(true);
    infoPanel.SetActive(false);
    howtoPanel.SetActive(false);
}

public void info()
{
    creditPanel.SetActive(false);
    infoPanel.SetActive(true);
    howtoPanel.SetActive(false);
}

public void howto()
{
    creditPanel.SetActive(false);
    infoPanel.SetActive(false);
    howtoPanel.SetActive(true);
}

public void keluar()
{
    MulaPanel.SetActive(true);
    KeluarPanel.SetActive(true);
}

public void MainMenuScene()
{
    SceneManager.LoadScene(MainMenu);
}

public void KeluarScene()
{
    Application.Quit();
}
}

```

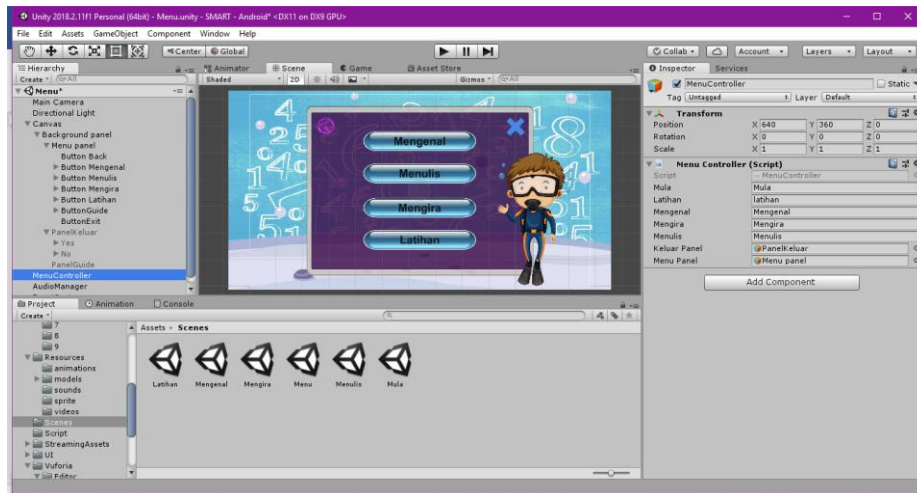



Figure 4.32 Menu scene

Menu interface prepare list of activity that can be navigate by users. In development, Menu scene contains a canvas with four panel inside it. These panels are Background panel, Menu panel, Guide panel and exit panel. Background image (sprite) are drag into the Background panel which will act as interface background. There are seven buttons inside Menu panel which is *Mengenal*, *Menulis*, *Mengira*, *Latihan*, back and exit buttons. All buttons are built with different shape which is done by drag 2D image (sprite) into Source image box. Panel Guide and exit has been set inactive by untick the box inside inspector panel. The code to activate the panel and navigate to each activity scene are written as MenuController code script.

MenuController code script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MenuController : MonoBehaviour {

    public string Mula;
    public string Latihan;
    public string Mengenal;
    public string Mengira;
    public string Menulis;
```

```

public GameObject KeluarPanel;
public GameObject MenuPanel;

public void MainMenuScene()
{
    SceneManager.LoadScene("MainMenu");
}

public void MulaScene()
{
    SceneManager.LoadScene(Mula);
}

public void LatihanScene()
{
    SceneManager.LoadScene(Latihan);
}

public void MengenalScene()
{
    SceneManager.LoadScene(Mengenal);
}

public void MengiraScene()
{
    SceneManager.LoadScene(Mengira);
}

public void MenulisScene()
{
    SceneManager.LoadScene(Menulis);
}

public void menu()
{
    MenuPanel.SetActive(true);
    KeluarPanel.SetActive(false);
}

public void keluar()
{
    MenuPanel.SetActive(true);
    KeluarPanel.SetActive(true);
}

public void KeluarScene()
{
    Application.Quit();
}
}

```

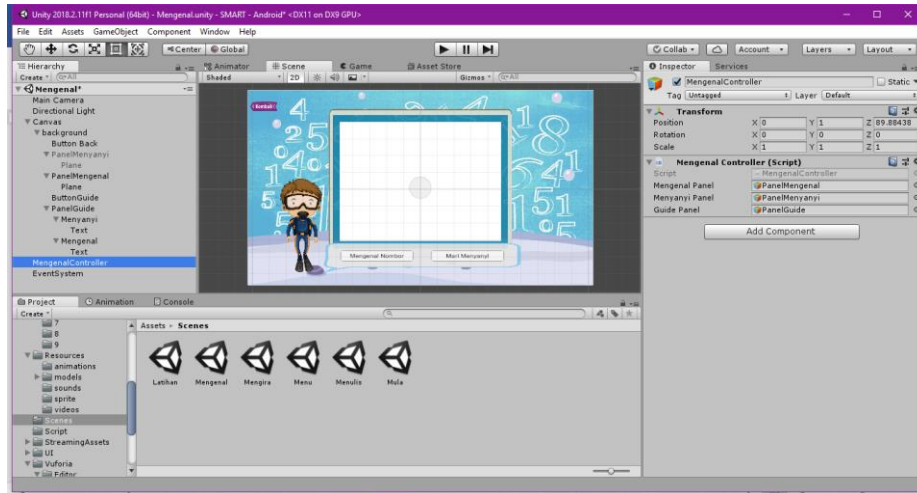


Figure 4.33 *Mengenal* scene

Mengenal scene contains a canvas with four panel inside it. These panels are Background panel, *Mengenal* panel, *Menyanyi* panel and Guide panel. Background image (sprite) are drag into the Background panel which will act as interface background. *Mengenal* and *Menyanyi* panel both are contained plane 3D object. The video of *Mengenal* and *Menyanyi* was drag into the plane 3D object. There are three buttons inside Panel Main which is *Mengenal*, *Menyanyi* and back buttons. All buttons are built with different shape which is done by drag 2D image (sprite) into Source image box. Panel Guide and *Menyanyi* has been set inactive by untick the box inside inspector panel. The code for this scene was write as *MengenalController* code script.

MengenalController code script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MengenalController : MonoBehaviour {

    public GameObject mengenalPanel;
    public GameObject menyanyiPanel;
    public GameObject GuidePanel;

    public void MainMenuScene()
    {
        SceneManager.LoadScene("MainMenu");
    }
}
```

```

public void guide()
{
    GuidePanel.SetActive(true);
}

public void mengenal()
{
    mengenalPanel.SetActive(true);
    menyanyiPanel.SetActive(false);
}

public void menyanyi()
{
    mengenalPanel.SetActive(false);
    menyanyiPanel.SetActive(true);
}
}

```

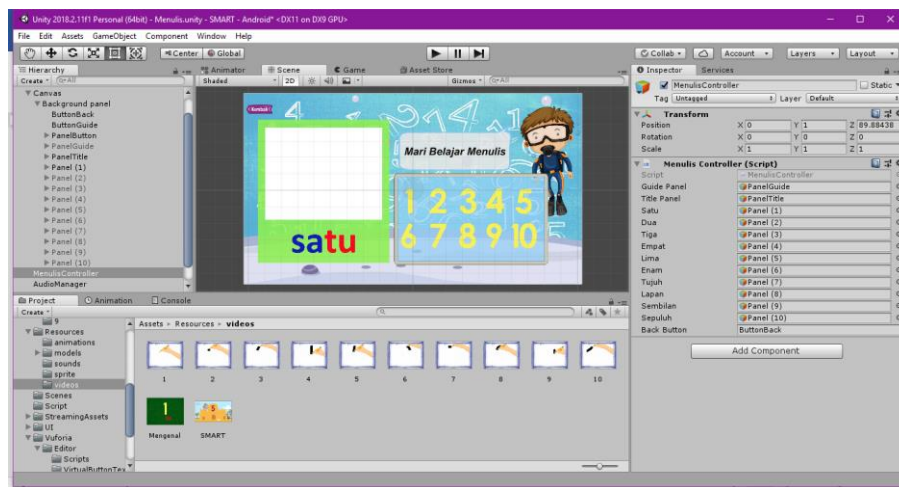


Figure 4.34 *Menulis* scene

Menulis scene contains a canvas with fourteen panel inside it. These panels are Background panel, button panel, Guide panel, tittle panel, and ten numbers panel. Background image (sprite) are drag into the Background panel which will act as interface background. There are two buttons inside background panel which is back and guide. While button panel contain ten numbers buttons inside it. All buttons are built with different shape which is done by drag 2D image (sprite) into Source image box. The numbers panels have been code as active one by one by clicking the each numbers buttons. *MenulisController* code script are used for each button to activate the panels or for button navigate to Menu scene.

MenulisController code script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class MenulisController : MonoBehaviour
{
    public GameObject GuidePanel;
    public GameObject titlePanel;
    public GameObject satu;
    public GameObject dua;
    public GameObject tiga;
    public GameObject empat;
    public GameObject lima;
    public GameObject enam;
    public GameObject tujuh;
    public GameObject lapan;
    public GameObject sembilan;
    public GameObject sepuluh;
    public string BackButton;

    public void MainMenuScene()
    {
        SceneManager.LoadScene("MainMenu");
    }

    public void guide()
    {
        GuidePanel.SetActive(true);
        titlePanel.SetActive(false);
    }

    public void Satu()
    {
        titlePanel.SetActive(true);
        satu.SetActive(true);
        dua.SetActive(false);
        tiga.SetActive(false);
        empat.SetActive(false);
        lima.SetActive(false);
        enam.SetActive(false);
        tujuh.SetActive(false);
        lapan.SetActive(false);
        sembilan.SetActive(false);
        sepuluh.SetActive(false);
    }

    public void Dua()
    {
        titlePanel.SetActive(true);
        satu.SetActive(false);
        dua.SetActive(true);
        tiga.SetActive(false);
        empat.SetActive(false);
        lima.SetActive(false);
    }
}
```

```

enam.SetActive(false);
tujuh.SetActive(false);
lapan.SetActive(false);
sembilan.SetActive(false);
sepuluh.SetActive(false);
}

public void Tiga()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(true);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Empat()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(true);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Lima()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(true);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Enam()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);

```

```

    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(true);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Tujuh()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(true);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Lapan()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(true);
    sembilan.SetActive(false);
    sepuluh.SetActive(false);
}

public void Sembilan()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(true);
    sepuluh.SetActive(false);
}

```

```

public void Sepuluh()
{
    titlePanel.SetActive(true);
    satu.SetActive(false);
    dua.SetActive(false);
    tiga.SetActive(false);
    empat.SetActive(false);
    lima.SetActive(false);
    enam.SetActive(false);
    tujuh.SetActive(false);
    lapan.SetActive(false);
    sembilan.SetActive(false);
    sepuluh.SetActive(true);
}
}

```

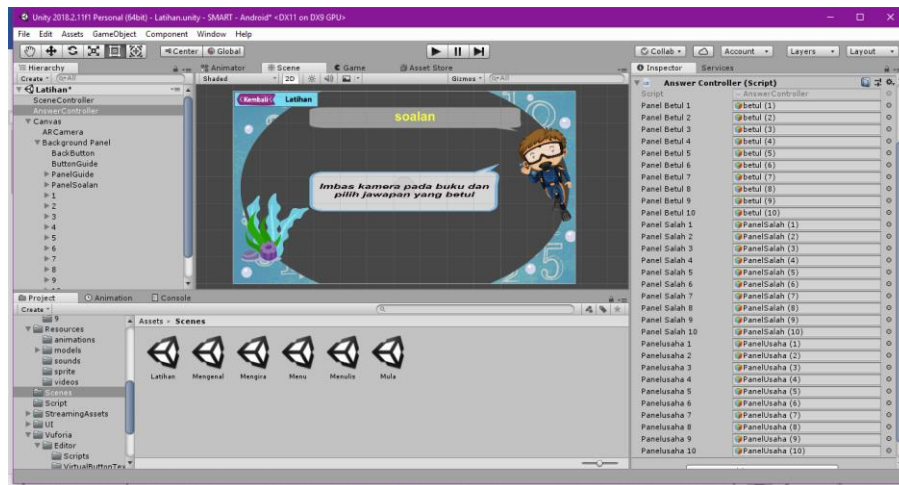


Figure 4.35 *Latihan scene*

Latihan scene was another activity that contain AR camera inside the scene. There are three other panel inside the canvas. These panels are Background panel, Guide panel, question panel with choice of answer panel and true of false answer panel. Background image (sprite) are drag into the Background panel which will act as interface background. There are two buttons inside background panel which is back and guide. All buttons are designed with different shape which is done by drag 2D image (sprite) into Source image box. The question panel with choice of answer panels have been code as active when its detect the marker. The code mention was written as LatihanController code script and drag it into AR camera. AnswerController code script are used for each button to activate the answer panels.

LatihanController code script

```
using UnityEngine;
using UnityEngine.UI;
using System.Collections;
using System.Collections.Generic;

namespace Vuforia
{
    public class LatihanController : MonoBehaviour
    {
        public Transform TextSoalan;
        public Transform Panel1;
        public Transform Panel2;
        public Transform Panel3;
        public Transform Panel4;
        public Transform Panel5;
        public Transform Panel6;
        public Transform Panel7;
        public Transform Panel8;
        public Transform Panel9;
        public Transform Panel10;

        // Update is called once per frame
        void Update()
        {
            StateManager sm = TrackerManager.Instance.GetStateManager();
            IEnumerable<TrackableBehaviour> tbs = sm.GetActiveTrackableBehaviours();

            foreach (TrackableBehaviour tb in tbs)
            {
                string name = tb.TrackableName;
                ImageTarget it = tb.Trackable as ImageTarget;
                Vector2 size = it.GetSize();

                Debug.Log("Active image target:" + name + " -size: " + size.x + ", "
+ size.y);

                TextSoalan.gameObject.SetActive(true);

                if (name == "b1")
                {
                    Panel1.gameObject.SetActive(true);
                    Panel2.gameObject.SetActive(false);
                    Panel3.gameObject.SetActive(false);
                    Panel4.gameObject.SetActive(false);
                    Panel5.gameObject.SetActive(false);
                    Panel6.gameObject.SetActive(false);
                    Panel7.gameObject.SetActive(false);
                    Panel8.gameObject.SetActive(false);
                    Panel9.gameObject.SetActive(false);
                    Panel10.gameObject.SetActive(false);

                    TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
```

```

    }

    if (name == "b10")
    {
        Panel10.gameObject.SetActive(true);
        Panel2.gameObject.SetActive(false);
        Panel3.gameObject.SetActive(false);
        Panel4.gameObject.SetActive(false);
        Panel5.gameObject.SetActive(false);
        Panel6.gameObject.SetActive(false);
        Panel7.gameObject.SetActive(false);
        Panel8.gameObject.SetActive(false);
        Panel9.gameObject.SetActive(false);
        Panel11.gameObject.SetActive(false);

        TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
ketam?";
    }

    if (name == "b2")
    {
        Panel2.gameObject.SetActive(true);
        Panel1.gameObject.SetActive(false);
        Panel3.gameObject.SetActive(false);
        Panel4.gameObject.SetActive(false);
        Panel5.gameObject.SetActive(false);
        Panel6.gameObject.SetActive(false);
        Panel7.gameObject.SetActive(false);
        Panel8.gameObject.SetActive(false);
        Panel9.gameObject.SetActive(false);
        Panel10.gameObject.SetActive(false);

        TextSoalan.GetComponent<Text>().text = "Berapakah bilangan singa
laut?";
    }

    if (name == "b3")
    {
        Panel3.gameObject.SetActive(true);
        Panel2.gameObject.SetActive(false);
        Panel1.gameObject.SetActive(false);
        Panel4.gameObject.SetActive(false);
        Panel5.gameObject.SetActive(false);
        Panel6.gameObject.SetActive(false);
        Panel7.gameObject.SetActive(false);
        Panel8.gameObject.SetActive(false);
        Panel9.gameObject.SetActive(false);
        Panel10.gameObject.SetActive(false);

        TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
udang?";
    }

```

```

        if (name == "b4")
        {
            Panel14.gameObject.SetActive(true);
            Panel12.gameObject.SetActive(false);
            Panel13.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel15.gameObject.SetActive(false);
            Panel16.gameObject.SetActive(false);
            Panel17.gameObject.SetActive(false);
            Panel18.gameObject.SetActive(false);
            Panel19.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
penyu?";
        }

        if (name == "b5")
        {
            Panel15.gameObject.SetActive(true);
            Panel12.gameObject.SetActive(false);
            Panel13.gameObject.SetActive(false);
            Panel14.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel16.gameObject.SetActive(false);
            Panel17.gameObject.SetActive(false);
            Panel18.gameObject.SetActive(false);
            Panel19.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan ikan
paus?";
        }

        if (name == "b6")
        {
            Panel16.gameObject.SetActive(true);
            Panel12.gameObject.SetActive(false);
            Panel13.gameObject.SetActive(false);
            Panel14.gameObject.SetActive(false);
            Panel15.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel17.gameObject.SetActive(false);
            Panel18.gameObject.SetActive(false);
            Panel19.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
kerang?";
        }

```

```

        if (name == "b7")
        {
            Panel7.gameObject.SetActive(true);
            Panel2.gameObject.SetActive(false);
            Panel3.gameObject.SetActive(false);
            Panel4.gameObject.SetActive(false);
            Panel5.gameObject.SetActive(false);
            Panel6.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel18.gameObject.SetActive(false);
            Panel19.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan
sotong?";
        }

        if (name == "b8")
        {
            Panel8.gameObject.SetActive(true);
            Panel2.gameObject.SetActive(false);
            Panel3.gameObject.SetActive(false);
            Panel4.gameObject.SetActive(false);
            Panel5.gameObject.SetActive(false);
            Panel6.gameObject.SetActive(false);
            Panel7.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel19.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan kuda
laut?";
        }

        if (name == "b9")
        {
            Panel19.gameObject.SetActive(true);
            Panel2.gameObject.SetActive(false);
            Panel3.gameObject.SetActive(false);
            Panel4.gameObject.SetActive(false);
            Panel5.gameObject.SetActive(false);
            Panel6.gameObject.SetActive(false);
            Panel7.gameObject.SetActive(false);
            Panel8.gameObject.SetActive(false);
            Panel11.gameObject.SetActive(false);
            Panel110.gameObject.SetActive(false);

            TextSoalan.GetComponent<Text>().text = "Berapakah bilangan obor-
obor?";
        }
    }
}
}
}

```

4.2.6 Build and Run in Mobile device

Compile & Build Unity player setting

Once the application completely created in Unity 3D, now it's ready to be run into mobile device. To build all the player setting, open Build Setting window by click File > Build Setting (hit "Ctrl + Shift + B" as a shortcut) as shown in Figure 4.30 below.



Figure 4.36 Open Build Setting window

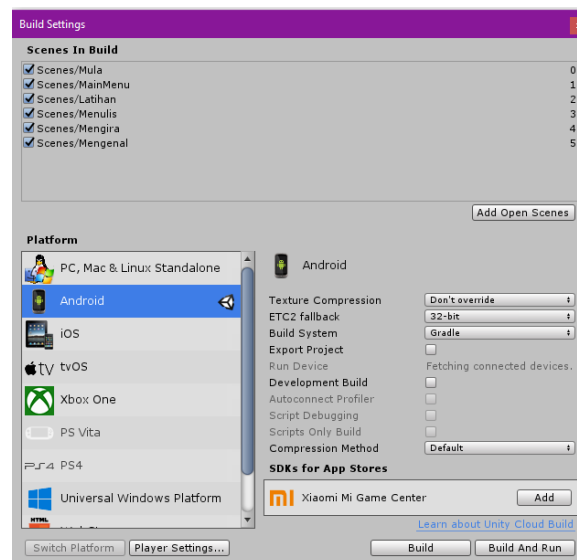


Figure 4.37 Build Setting window

Figure 4.31 show Build Setting window. Click "Add Open Scene" button to add the current scene that build into the player setting. Click the button for each current scene. The scene will be automatically added. Next, on Platform box, choose "Android" and click on "Switch Platform" button. Wait until the Asset to be reimported. The "Hold On" window will be shown such in figure.

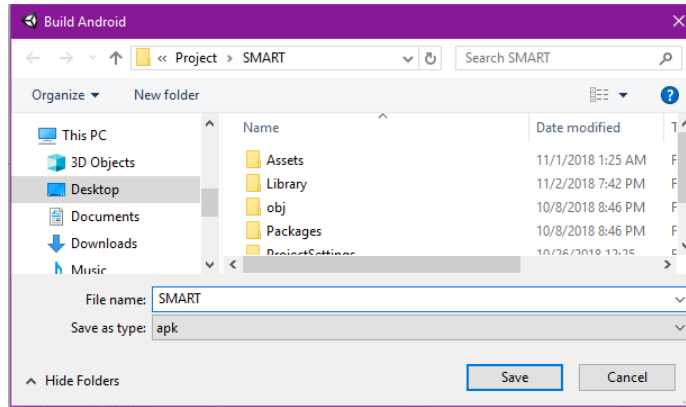


Figure 4.38 Save file as “.apk” format

Compile the project that has been created by click on “Build and Run” button. Since this project build as Android platform, the file will be stored as ".apk"(Android Package Kit) folder . This file format is used in distribute and installation of Android mobile apps. Save the file as shown in Figure 4.33

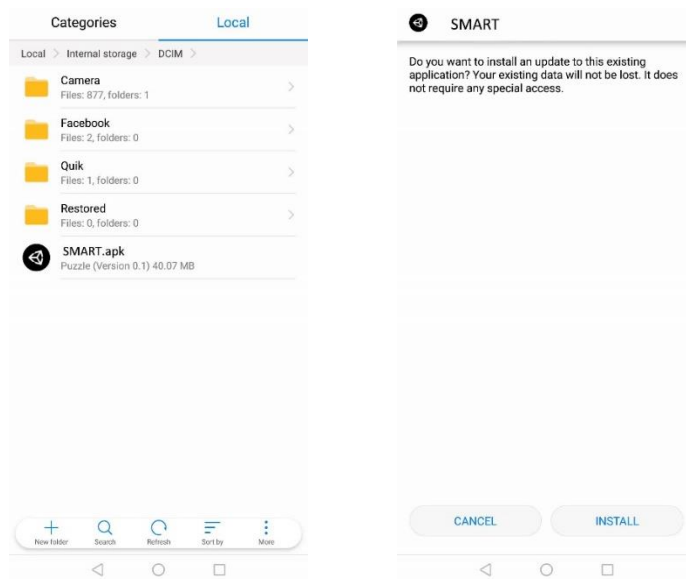


Figure 4.39 Transferred “.apk” file to mobile device

When the file are completely build as “.apk” format, transfer the file to the mobile device. As shown in Figure 4.34, hit on install button on mobile device to install the application.

4.3 TESTING

The testing phase was carried out to verify the compliance against a specific requirement. There are few types of testing strategy that been conducted to ensure that the product is fully tested. First, this application is tested by tester on the function of application to avoid any error occur before the application are released to real users. This functionality test was conducted using user acceptance test (UAT). Once it's been confirmed that all the function passed, the application will be tested on real users to evaluate whether the function on the application suitable according to objective or not. To evaluate the application, three basic criteria been emphasized. These criteria are satisfaction, efficiency and effectiveness of this application. At this stage, developer able to collect the information in order to achieve the objectives.

4.3.1 User Acceptance Testing

User Acceptance Testing (UAT) is a phase of beta testing which the application is tested in the "real world" by the intended users. Three people which is tester, assistant management of preschool (*Pembantu Pengurusan Murid (PPM)*) and preschool teacher take part in User acceptance test to test the functionality. The application then been installed on the android mobile device at which an evaluation of the application performed. The respondents will answer the UAT form and write comments if necessary.

(The UAT form fill by teacher are provided in **Appendix D.**)

4.3.2 Usability Testing

Usability testing is the best method to evaluate user's opinions about the application. There are total of 10 respondents who were involved in this usability test which was conducted among 7 parents, an assistant management of preschool (*pembantu pengurusan murid (PPM)*) and preschool teacher from SK Kuala Serupai. Set of questionnaires are given to the respondents to test the usability of this application.

(The questionnaire of usability test are provided in **Appendix E.**)

4.3.3 Pre-testing and Post Testing

The main point of this test is to evaluate the effectiveness of this application for preschoolers. Besides, this test also to evaluate if the application may help teachers to improve their teaching and learning materials or not. Pre-testing was conduct by the teacher after completing the teaching and learning sessions on preschoolers to test their understanding level. Five preschoolers who are still weak in concept numbers learning was choose by their teacher as respondent. The respondent for pre-testing and post testing will be the same person. For pre-testing, the respondent required to count the number of objects that has been draw by teacher on whiteboard. While, Post testing was conduct when the respondent using SMART application. The result was recorded by researcher during the test. The purpose of recording the result from this test is to compare the result before and after using the SMART application to the preschoolers.

(Result of the test before and after using SMART Application in **Appendix F**)

4.4 RESULT AND DISCUSSION

After the project have been successfully developed, the application is then tested to ensure that every item and description is working well. Below are the screenshots of result of the actual project that is being tested.

4.4.1 Result of User Acceptance Test (UAT)

Based on result from User Acceptance Test, all respondents have completely fill in the UAT form. All test data is pass which is means that all elements in the SMART Application works as expected result.

Event	Test Case	Expected Result	Actual Result	Pass/Fail	Comment
	Click <i>Mula</i> (start) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	<i>Pass</i>	

Main Interface	Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	<i>Pass</i>	
	Click info button	- Display info panel - Hide info panel when click any place	- <i>Display info panel</i> - <i>Hide info panel when click any place</i>	<i>Pass</i>	
	Click credit button	- Display credit panel - Hide credit panel when click any place	- <i>Display credit panel</i> - <i>Hide credit panel when click any place</i>	<i>Pass</i>	
	Click exit button	- Display exit panel - Hide exit panel when click no - Exit when click yes	- <i>Display exit panel</i> - <i>Hide exit panel when click no</i> - <i>Exit when click yes</i>	<i>Pass</i>	
Menu Interface	Click <i>Mengenal</i> button	Navigate to <i>Mengenal</i> interface	<i>Navigate to Mengenal interface</i>	<i>Pass</i>	
	Click <i>Menulis</i> button	Navigate to <i>Menulis</i> interface	<i>Navigate to Menulis interface</i>	<i>Pass</i>	
	Click <i>Mengira</i> button	Navigate to <i>Mengira</i> interface	<i>Navigate to Mengira interface</i>	<i>Pass</i>	
	Click <i>Latihan</i> button	Navigate to <i>Latihan</i> interface	<i>Navigate to Latihan interface</i>	<i>Pass</i>	

	Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	<i>Pass</i>	
	Click back button	Display Main interface	<i>Display Main interface</i>	<i>Pass</i>	
	Click exit button	- Display exit panel - Hide exit panel when click no - Exit when click yes	- <i>Display exit panel</i> - <i>Hide exit panel when click no</i> - <i>Exit when click yes</i>	<i>Pass</i>	
Mengenal Interface	Click <i>Mengenal Nombor</i> button	Play <i>Mengenal Nombor</i> video	<i>Play Mengenal Nombor video</i>	<i>Pass</i>	
	Click <i>Mari Menyanyi</i> button	Play <i>Mari Menyanyi</i> video	<i>Play Mari Menyanyi video</i>	<i>Pass</i>	
	Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	<i>Pass</i>	
Menulis Interface	Click button 1	Play write number 1 video	<i>Play write number 1 video</i>	<i>Pass</i>	
	Click button 2	Play write number 2 video	<i>Play write number 2 video</i>	<i>Pass</i>	
	Click button 3	Play write number 3 video	<i>Play write number 3 video</i>	<i>Pass</i>	
	Click button 4	Play write number 4 video	<i>Play write number 4 video</i>	<i>Pass</i>	

	Click button 5	Play write number 5 video	<i>Play write number 5 video</i>	<i>Pass</i>	
	Click button 6	Play write number 6 video	<i>Play write number 6 video</i>	<i>Pass</i>	
	Click button 7	Play write number 7 video	<i>Play write number 7 video</i>	<i>Pass</i>	
	Click button 8	Play write number 8 video	<i>Play write number 8 video</i>	<i>Pass</i>	
	Click button 9	Play write number 9 video	<i>Play write number 9 video</i>	<i>Pass</i>	
	Click button 10	Play write number 10 video	<i>Play write number 10 video</i>	<i>Pass</i>	
	Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	<i>Pass</i>	
	Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	<i>Pass</i>	
Mengira Interface	Scan book 1	- Display one 3D object with animation and audio - Display text panel = “ <i>satu</i> ”	- <i>Display one 3D object with animation and audio</i> - <i>Display text panel = “satu”</i>	<i>Pass</i>	
	Scan book 2	- Display two 3D object with animation and audio	- <i>Display two 3D object with animation and audio</i>	<i>Pass</i>	

		- Display text panel = “dua”	- <i>Display text panel = “dua”</i>		
Scan book 3		- Display three 3D object with animation and audio - Display text panel = “tiga”	- <i>Display three 3D object with animation and audio</i> - <i>Display text panel = “tiga”</i>	<i>Pass</i>	
Scan book 4		- Display four 3D object with animation and audio - Display text panel = “empat”	- <i>Display four 3D object with animation and audio</i> - <i>Display text panel = “empat”</i>	<i>Pass</i>	
Scan book 5		- Display five 3D object with animation and audio - Display text panel = “lima”	- <i>Display five 3D object with animation and audio</i> - <i>Display text panel = “lima”</i>	<i>Pass</i>	
Scan book 6		- Display six 3D object with animation and audio - Display text panel = “enam”	- <i>Display six 3D object with animation and audio</i> - <i>Display text panel = “enam”</i>	<i>Pass</i>	

	Scan book 7	- Display one 3D object with animation and audio - Display text panel = “ <i>tujuh</i> ”	- <i>Display one 3D object with animation and audio</i> - <i>Display text panel = “tujuh”</i>	<i>Pass</i>	
	Scan book 8	- Display eight 3D object with animation and audio - Display text panel = “ <i>lapan</i> ”	- <i>Display eight 3D object with animation and audio</i> - <i>Display text panel = “lapan”</i>	<i>Pass</i>	
	Scan book 9	- Display nine 3D object with animation and audio - Display text panel = “ <i>sembilan</i> ”	- <i>Display nine 3D object with animation and audio</i> - <i>Display text panel = “sembilan”</i>	<i>Pass</i>	
	Scan book 10	- Display ten 3D object with animation and audio - Display text panel = “ <i>sepuluh</i> ”	- <i>Display ten 3D object with animation and audio</i> - <i>Display text panel = “sepuluh”</i>	<i>Pass</i>	
	Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	<i>Pass</i>	

	Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	<i>Pass</i>	
Latihan Interface	Scan flashcard 1	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
	Scan flashcard 2	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
	Scan flashcard 3	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
	Scan flashcard 4	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	

Scan flashcard 5	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
Scan flashcard 6	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
Scan flashcard 7	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
Scan flashcard 8	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
Scan flashcard 9	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	

Scan flashcard 10	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	<i>Pass</i>	
Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	<i>Pass</i>	
Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	<i>Pass</i>	

4.4.2 Result of Usability Test

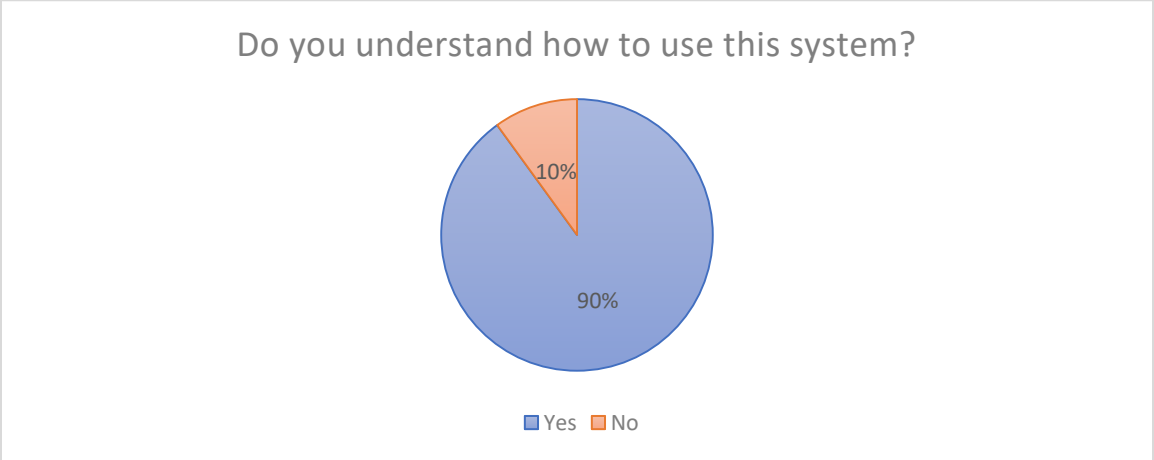


Figure 4.40 Result for question 1

Question 1 is asking the respondents about their understanding on how to use the application. From this question, it can evaluate that the application is easy to use or not. Based on result in Figure 4.40, 90% of respondents agree that they understand how to use this application.

However, one respondent not agree that she understand how to use this application. This is because the respondent never used the smartphone before.

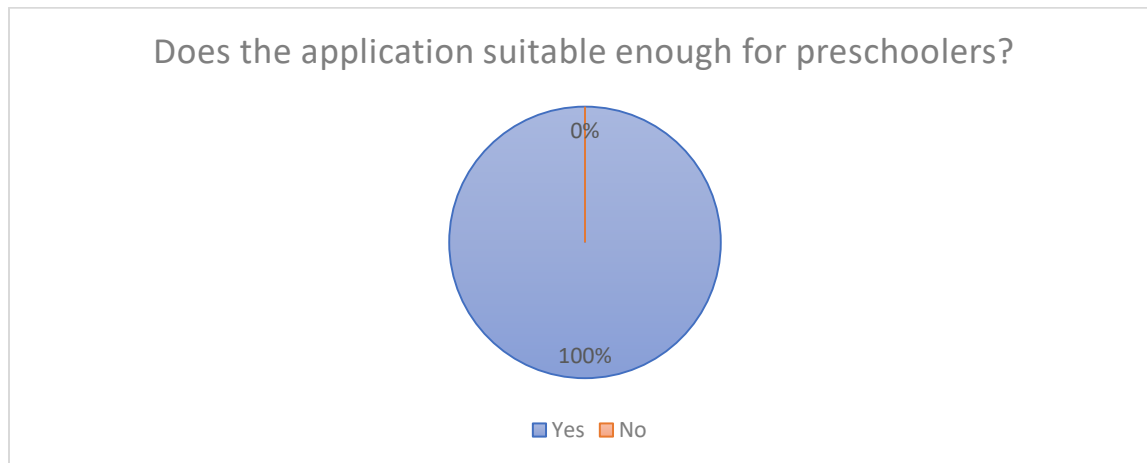


Figure 4.41 Result for question 2

This question asks respondent's view if this application is suitable for being used by preschoolers. The result from Figure 4.41 shows that 100% respondent agreed that SMART Application is suitable for preschoolers.

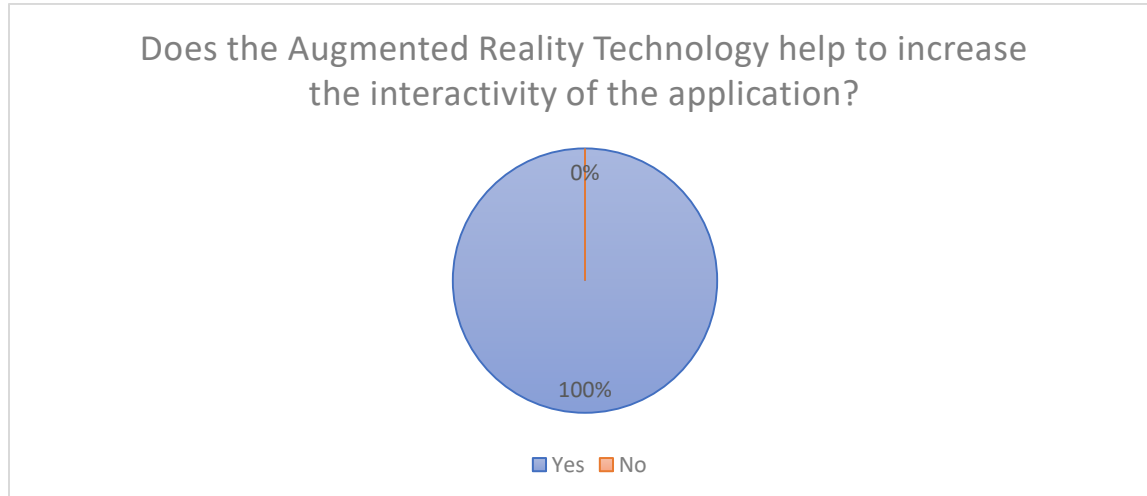


Figure 4.42 Result for question 3

As shown in Figure 4.42, all respondent was agreed that the Augmented Reality technology can help to increase the interactivity of the application.

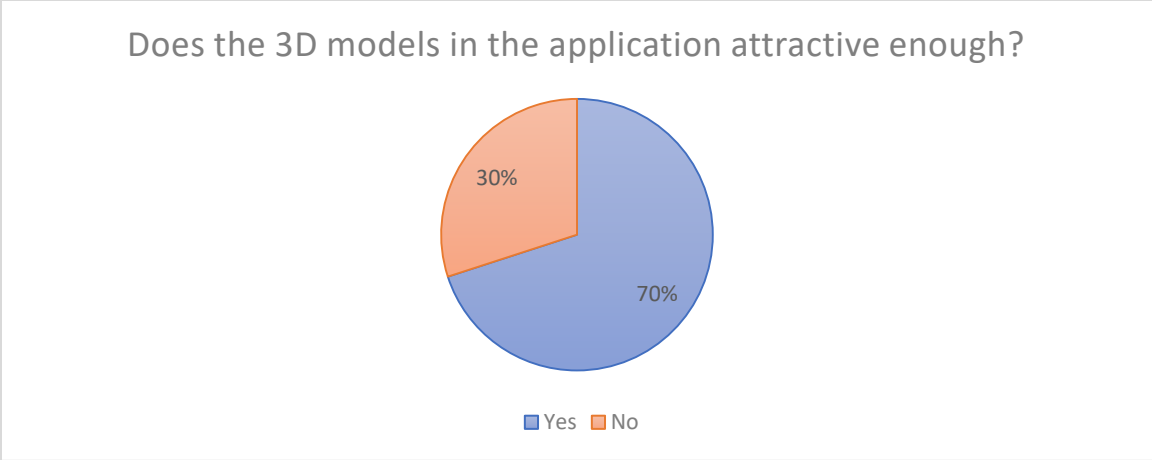


Figure 4.43 Result for question 4

From Figure 4.43, result from question 4 shows that 70% respondent agreed that the 3D models in SMART application was attractive. However, 30% respondent does not agree with that. 2 respondent claims that the animation movements of 3D model are rather boring. While 1 of them claims that the colour of some of 3D models is less attractive.

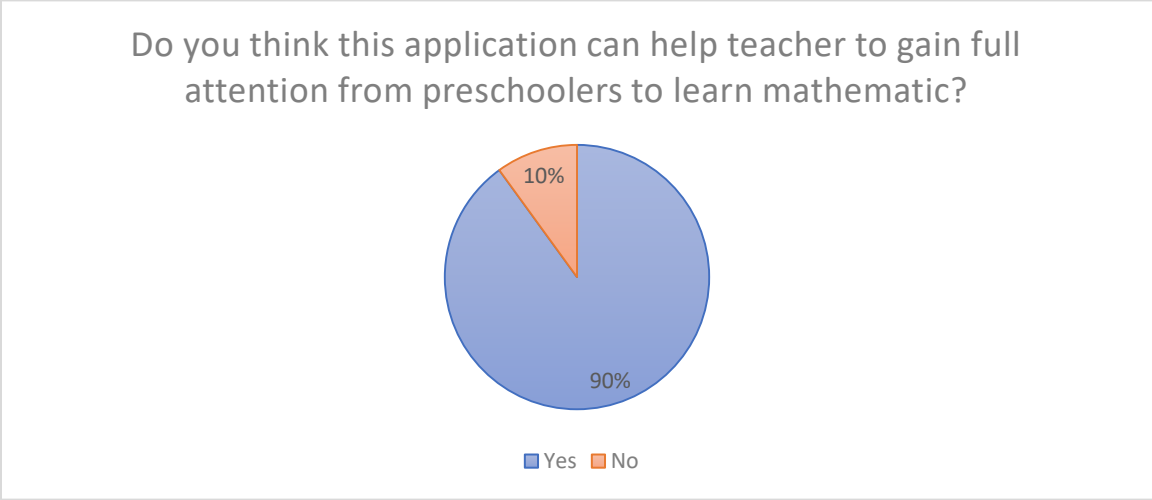


Figure 4.44 Result for question 5

There is 90% respondents was agreed that SMART application can help teacher to gain full attention from preschoolers to learn mathematic. From the Figure 4.4, result shows that 1 person disagree if the SMART application can help teacher to gain full attention from all preschoolers to learn mathematic. He gives opinion that this application must being more attractive to attract full attention from preschoolers because some of pre-schooler may already be accustomed to using more interesting and more colourful applications like games.

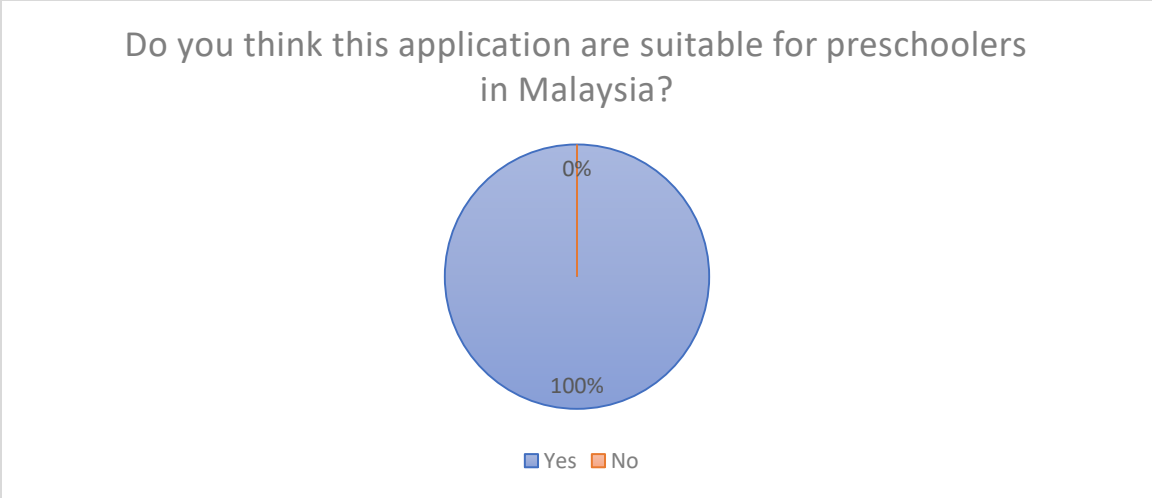


Figure 4.45 Result for question 6

Result for question 6 in Figure 4.45 shows 100% of respondent agree that this application is suitable for preschoolers in Malaysia. This is because not many applications for mathematic content with Malay language available in the application market.

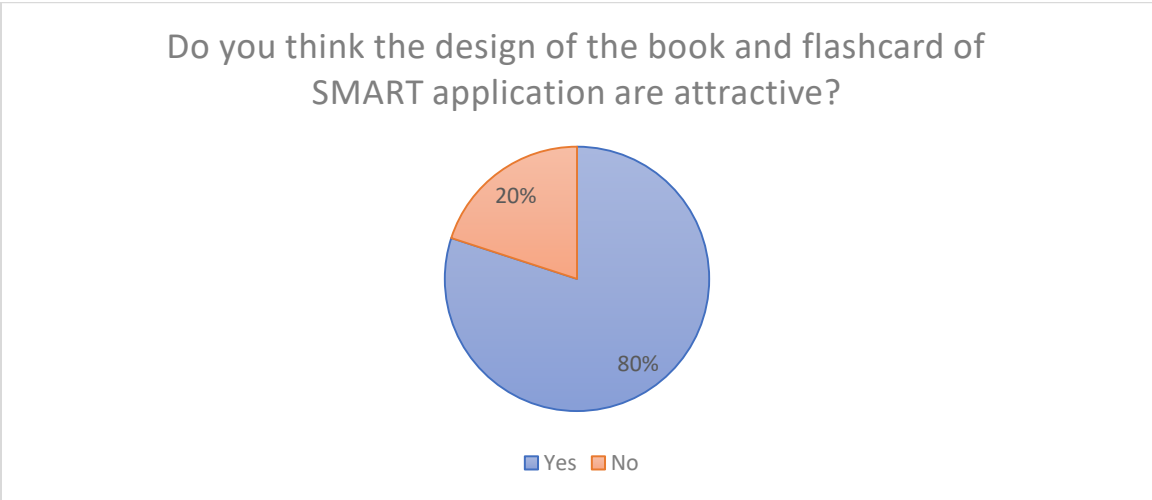


Figure 4.46 Result for question 7

Question 7 is asking the respondent about design of book and flashcard. The book and flashcard also function as marker to this application. Figure 4.46 show the result that 80% respondent agreed that the design of the book and flashcard of SMART application are attractive. While 20% respondent disagree that the design of the book and flashcard of SMART application are attractive.

4.4.3 Result of Pre-testing and Post Testing

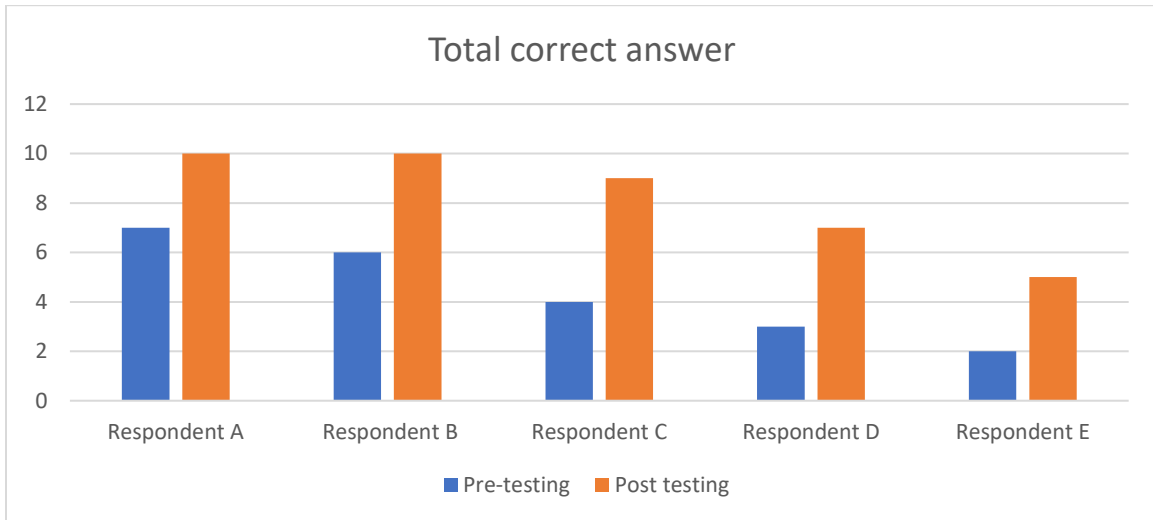


Figure 4.47 Comparison between pre-testing and post testing

Figure 4.47 shows comparison the total of correct answer between pre-testing and post testing. The graph shows the increasement of total correct answer in post-test compare to pre-test for all respondents. Respondent A and B get 7 and 6 correct answer on pre-test, but both get 10 in post-test. Respondent C get 4 in pre-test and increase to 9 in post-test, which is the highest increasement occur. While the total of correct answer for Respondent D increase by 4 where he get 3 in pre-test and 7 in post-test. Finally, Respondent E who get only 2 correct answer in pre-test then get 5 in post-test. Overall, from the result we can conclude that SMART application was effective for being used by preschoolers.

4.5 SUMMARY

This chapter has discussed and explained in detail regarding the steps taken to build the project from the beginning of the project until it is completely build. The testing showed how effective this application to the preschoolers by integrating an augmented reality (AR) technology into the preschool teaching materials for early math education. This test help to achieve the objective of creating this application. While result report shows that this application helps to provide a new learning experience and more encourage the preschoolers to explore the math. Besides, this application also help teacher to improve the effectiveness of their teaching and learning materials.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This chapter will conclude the overall project that has been made. It will include with explanation about the achievement of the objectives project, project constraint during the development and the future work suggestion to improve this application.

5.2 CONCLUSION

For conclusion, SMART application is an early mathematics application that emphasized the introduction of concept number topics that have been created according to the National Preschool Standard Curriculum. SMART application was created using Unity3D by using C# programming language. This application is functioned to increase the effectiveness of early math education learning by integrating an augmented reality (AR) technology into the preschool teaching materials.

There are four phases in SMART application which is introduction of number one to ten (*Mengenal*), writing number one to ten (*Menulis*), counting number one to ten (*Mengira*) and exercise (*latihan*). Through chapter 4, the results show that this application are effective. This application was able to encourage preschoolers to explore the math subject in effective way. Moreover, this application seems like able to help the teacher improve their teaching materials in attractive and interactive way by replacing traditional teaching methods with a technology-based teaching and learning tools and facilities which followed the growth of current technologies.

According to Result and Discussion from chapter 4, this application has fulfilled the objective. This application was built with augmented reality technology and will be used in preschool education system to produce highly IT iterate future generation. Since the use of technology was able to support the tendency of children to learn, the gadgets given to kids supposed to be filled with edutainment application rather than giving them play the games that more wasting their valuable time.

5.3 PROJECT CONSTRAINS

i. Software and device problem

At early stage of development, 3D software which is Autodesk Maya cannot be installed into developer personal laptop. This matter solved by change the 3D software to Blender to build few 3D models which quite challenging for developer who are a beginner with Blender software. Second, Unity 3D version 2017 are not compatible with developer laptop which required the developer to reinstall the Unity 3D software to 2018 version.

ii. Version complexity

There is plenty feature we can come up with the combination of Vuforia and unity. Only several versions of unity can support some features by Vuforia. This scenario can cause much time to consume to find the solution and switching to the suitable version.

iii. Development and testing constrains

The applications have broken several times during the development of the application. This make the delayed of time of the development. More time needed to build the big and complex system.

5.4 FUTURE WORK

There are several enhancements that can be carried out for future improvement of SMART (Smart Mathematics with Augmented Reality).

- i. The application can cover more mathematic topic such as the addition, subtraction, minus and many more topic which is cover for the whole preschool topic based on National Preschool Standard Curriculum.
- ii. Developer create the application with multi language which will enable this application to be used by universal.
- iii. Developer create more educational game as their exercise.

REFERENCES

1. Alisa, D. (2016). AR books and pre-school children ' s engagement.
2. Cascales, A., Pérez-López, D., & Contero, M. (2013). Study on parents' acceptance of the augmented reality use for preschool education. *Procedia Computer Science*, 25, 420–427. <https://doi.org/10.1016/j.procs.2013.11.053>
3. Constatine Stephanidis, & Margherita Antona. (2014). *Universal Access in Human-Computer Interaction: Universal Access to ... - Google Books*. (Constatine Stephanidis & Margherita Antona, Eds.) (2nd ed.). Heraklion, Crete, Greece: Springer. Retrieved from https://books.google.com.my/books?id=CES5BQAAQBAJ&pg=PA302&dq=markerless+and+marker+based+of+augmented+reality&hl=en&sa=X&ved=0ahUKEwjPysKX7v_ZAhUIqI8KHfNNCSYQ6AEIPDAE#v=onepage&q=markerless and marker based of augmented reality&f=false
4. Menon Nani, & Abdullah Rohani. (2003). *Panduan Kognitif Kanak-Kanak Pra Sekolah - Google Books. PTS PROFESSIONAL*. Retrieved from <https://books.google.com.my/books?id=dIEBPKMH9ooC&pg=PA19&dq=Panduan+Kurikulum+Prasekolah&hl=en&sa=X&ved=0ahUKEwiG0dmRxfvZAhWGE7wKHRz1BqwQ6AEIPzAE#v=onepage&q&f=false>
5. Najibah Abu Bakar. (n.d.). Teknologi AR dan buku bergambar kanak-kanak – MukaSurat.my. Retrieved March 10, 2018, from <http://mukasurat.my/2017/12/11/teknologi-ar-dan-buku-bergambar-kanak-kanak/>
6. Pendidikan Dan Pembangunan Manusia, F. (2016). The Analysis Of Cognitive Application In Bahasa Malaysia Communication Strand At Preschool. Retrieved from <http://pustaka2.upsi.edu.my/eprints/1183/1/Analisis Aplikasi Kognisi Dalam Tunjang Komunikasi Bahasa Malaysia Prasekolah.pdf>

7. Prof. Madya Dr. Rohani Abdullah, Nani Menon, & Mohd. Sharani Ahmad. (2007). Panduan Kurikulum Prasekolah - Google Books. Retrieved March 10, 2018, from https://books.google.com.my/books?id=o4x94w6r_mwC&pg=PP6&lpg=PP6&dq=Panduan+Kurikulum+Prasekolah.+Kuala+Lumpur:+PTS+Publications+%26+Distributors+Sdn.+Bhd&source=bl&ots=jIaeeMSX8R&sig=Dy1ggmyYrIQWFazPOJrvo4qeTDs&hl=en&sa=X&ved=0ahUKEwitwLajwvVZAhUTR48KHYY
8. Prof Dr M. Swamenathan. (2014). Dunia Digital: Kebaikan dan Keburukan Terhadap Perkembangan Kanak-kanak - Positive Parenting. Retrieved March 20, 2018, from <https://mypositiveparenting.org/ms/2014/10/08/dunia-digital-kebaikan-dan-keburukan-terhadap-perkembangan-kanak-kanak/>
9. Razlan, M. F., Pendidikan, F., Khalid, F., & Pendidikan, F. (2017). Penggunaan Bahan Ilustrasi Objek Padanan Abjad (Ioap) Bagi Meningkatkan Keupayaan Mengecam Huruf Kanak-Kanak Prasekolah, 179–184.
10. Vincent Aleven, Judy Kay, & Jack Mostow. (2010). *Intelligent Tutoring Systems: 10th International Conference, ITS 2010 ... - Google Books*. Springer (Part 1). Berlin Heidelberg New York. Retrieved from <https://books.google.com.my/books?id=xyxqCQAAQBAJ&pg=PA296&lpg=PA296&dq=Traditional+methods+of+learning+spatially-related+content+by+viewing+2D+diagrams+create+a+sort+of+resistance+to+learning+at+cognitive+level.+This+resistance+exists+even+when+working+w>

APPENDIX A



Universiti Malaysia Pahang
Lebuhraya Tun Razak, 26300 Gambang
Kuantan, Pahang Darul Makmur
Tel: +609-549 2133| Faks/Fax: +609-549 2144

Fakulti Sistem Komputer & Kejuruteraan Perisian
Faculty of Computer Systems & Software Engineering

UMP.12.02/13.11/01/08Jld 3(83)

6 Mac 2018

KEPADA SESIAPA YANG BERKENAAN

Tuan/Puan,

TAJUK : SMART (SMART MATHEMATICS WITH AUGMENTED REALITY TECHNOLOGY) APPLICATION FOR PRESCHOOL

NAMA PELAJAR : KARTIKA IDAYU BINTI TAJUL ARIFIN (CD15017)

TAHUN/PROGRAM : 3/ IJAZAH SARJANA MUDA SAINS KOMPUTER (TEKNOLOGI GRAFIK & MULTIMEDIA) DENGAN KEPUJIAN

Adalah dengan hormatnya dimaklumkan bahawa pelajar di atas ialah pelajar berdaftar Fakulti Sistem Komputer & Kejuruteraan Perisian, Universiti Malaysia Pahang.

2. Sukacita sekiranya pihak tuan/puan dapat memberikan kebenaran bertulis serta data dan maklumat yang berkaitan untuk pelajar menyiapkan projek berkenaan. Untuk makluman tuan/puan, projek ini ialah satu keperluan bagi kandungan kursus berkaitan.

Sekian, segala kerjasama dan perhatian tuan/puan di dahului dengan ucapan ribuan terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan tugas,

DR. MOHAMAD FADLI ZOLKIPLI
Timbalan Dekan (Akademik & Hal Ehwal Pembangunan Pelajar)
Fakulti Sistem Komputer & Kejuruteraan Perisian
Universiti Malaysia Pahang
☎ 09-5492467/2147
☎ 09-5492144



APPENDIX B

INTERVIEW QUESTIONS

1. What language is used during teaching and learning mathematics session?
2. How many preschoolers do not know numbers 1 to 10?
3. Can you tell a little bit about the background of preschoolers who still weak in a mathematical subject?
4. What are the reactions or behaviors of preschoolers during mathematics teaching and learning sessions?
5. How does student work performance?
6. How do you attract preschoolers in mathematic teaching?
7. What is the teacher's suggestion to improve mathematical teaching and learning to overcome the preschooler's problem who have not yet understood the concept of numbers?
8. Does the technology able to fully use during teaching and learning sessions?
9. What are the preschoolers reactions when using a mobile device during a teaching and learning session?

APPENDIX C

BORANG SOAL SELIDIK IBU BAPA

Kepada Ibu bapa,

Borang soal selidik ini adalah mengenai Pendidikan Awal Matematik Prasekolah. Mohon kerjasama pihak ibu bapa untuk menjawab soalan soal selidik ini berdasarkan pengalaman sebagai ibu bapa kepada murid prasekolah. Kerjasama pihak ibu bapa sangat saya hargai. Terima Kasih.

Sila tandakan jawapan anda di ruang yang telah disediakan.

Bahagian A

1. Anda adalah : Ibu Bapa

2. Bilangan anak yang pernah/sedang belajar di prasekolah:

3. Penggunaan Bahasa di rumah

Bahasa Melayu Bahasa Inggeris

lain-lain | nyatakan

Bahagian B

(1) Sangat Setuju (2) Setuju (3) Tidak Pasti (4) Kurang Setuju (5) Tidak Setuju

No.		1	2	3	4	5
1.	Anak saya sangat teruja untuk ke prasekolah setiap hari					
2.	Anak saya sangat berminat dengan subjek matematik					
3.	Anak saya sering memerlukan bantuan untuk membuat latihan matematik					
4.	Mudah bagi saya untuk membantu anak saya membuat latihan matematik					
5.	Anak saya memberikan kerjasama yang baik ketika membuat latihan matematik					
6.	Anak saya sangat berminat dengan buku latihan matematik					
7.	Saya sering membelikan buku-buku latihan matematik prasekolah untuk anak saya					

Bahagian C

No.		1	2	3	4	5
1.	Saya ada menyediakan telefon pintar atau tablet untuk kegunaan anak saya					
2.	Saya membenarkan anak saya bermain permainan (game) di dalam telefon pintar atau tablet					
3.	Saya ada memuat turun aplikasi Pendidikan awal matematik di dalam telefon pintar atau tablet					
4.	Mudah untuk saya mencari dan memuat turun aplikasi Pendidikan awal matematik yang bersesuaian di telefon pintar atau tablet					
5.	Anak saya lebih gemar menggunakan telefon pintar atau tablet berbanding buku					

APPENDIX D
USER ACCEPTANCE TESTING FORM

Event	Test Case	Expected Result	Actual Result	Pass/Fail	Comment
Main Interface	Click <i>Mula</i> (start) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	pass	
	Click guide button	- Display guide panel - Hide guide panel when click any place	- Display guide panel - Hide guide panel when click any place	pass	
	Click info button	- Display info panel - Hide info panel when click any place	- Display info panel - Hide info panel when click any place	pass	
	Click credit button	- Display credit panel - Hide credit panel when click any place	- Display credit panel - Hide credit panel when click any place	pass	
	Click exit button	- Display exit panel - Hide exit panel when click no - Exit when click yes	- Display exit panel - Hide exit panel when click no - Exit when click yes	pass	
Menu Interface	Click <i>Mengenal</i> button	Navigate to <i>Mengenal</i> interface	<i>Navigate to Mengenal interface</i>	pass	
	Click <i>Menulis</i> button	Navigate to <i>Menulis</i> interface	<i>Navigate to Menulis interface</i>	pass	
	Click <i>Mengira</i> button	Navigate to <i>Mengira</i> interface	<i>Navigate to Mengira interface</i>	pass	
	Click <i>Latihan</i> button	Navigate to <i>Latihan</i> interface	<i>Navigate to Latihan interface</i>	pass	

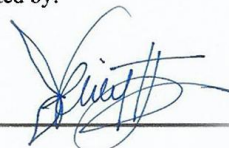
	Click guide button	- Display guide panel - Hide guide panel when click any place	- <i>Display guide panel</i> - <i>Hide guide panel when click any place</i>	pass	
	Click back button	Display Main interface	<i>Display Main interface</i>	pass	
	Click exit button	- Display exit panel - Hide exit panel when click no - Exit when click yes	- <i>Display exit panel</i> - <i>Hide exit panel when click no</i> - <i>Exit when click yes</i>	pass	
Mengenal Interface	Click <i>Mengenal Nombor</i> button	Play <i>Mengenal Nombor</i> video	<i>Play Mengenal Nombor video</i>	pass	
	Click <i>Mari Menyanyi</i> button	Play <i>Mari Menyanyi</i> video	<i>Play Mari Menyanyi video</i>	pass	
	Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	pass	
Menulis Interface	Click button 1	Play write number 1 video	<i>Play write number 1 video</i>	pass	
	Click button 2	Play write number 2 video	<i>Play write number 2 video</i>	pass	
	Click button 3	Play write number 3 video	<i>Play write number 3 video</i>	pass	
	Click button 4	Play write number 4 video	<i>Play write number 4 video</i>	pass	
	Click button 5	Play write number 5 video	<i>Play write number 5 video</i>	pass	

	Click button 6	Play write number 6 video	<i>Play write number 6 video</i>	pass	
	Click button 7	Play write number 7 video	<i>Play write number 7 video</i>	pass	
	Click button 8	Play write number 8 video	<i>Play write number 8 video</i>	pass	
	Click button 9	Play write number 9 video	<i>Play write number 9 video</i>	pass	
	Click button 10	Play write number 10 video	<i>Play write number 10 video</i>	pass	
	Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	pass	
	Click guide button	- Display guide panel - Hide guide panel when click any place	<i>- Display guide panel - Hide guide panel when click any place</i>	pass	
Mengira Interface	Scan book 1	- Display one 3D object with animation and audio - Display text panel = "satu"	<i>- Display one 3D object with animation and audio - Display text panel = "satu"</i>	pass	
	Scan book 2	- Display two 3D object with animation and audio - Display text panel = "dua"	<i>- Display two 3D object with animation and audio - Display text panel = "dua"</i>	pass	
	Scan book 3	- Display three 3D object with animation and audio - Display text panel = "tiga"	<i>- Display three 3D object with animation and audio - Display text panel = "tiga"</i>	pass	

	(back) button				
	Click guide button	- Display guide panel - Hide guide panel when click any place	Display guide panel Hide guide panel when click any place	pass	
Latihan Interface	Scan flashcard 1	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	
	Scan flashcard 2	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	
	Scan flashcard 3	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	
	Scan flashcard 4	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	
	Scan flashcard 5	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	
	Scan flashcard 6	- Display 2D object - Display question panel and choice of answer panel	Display 2D object Display question panel and choice of answer panel	pass	

Scan flashcard 7	- Display 2D object - Display question panel and choice of answer panel	- <i>Display 2D object</i> - <i>Display question panel and choice of answer panel</i>	pass	
Scan flashcard 8	- Display 2D object - Display question panel and choice of answer panel	<i>- Display 2D object</i> <i>- Display question panel and choice of answer panel</i>	pass	
Scan flashcard 9	- Display 2D object - Display question panel and choice of answer panel	<i>- Display 2D object</i> <i>- Display question panel and choice of answer panel</i>	pass	
Scan flashcard 10	- Display 2D object - Display question panel and choice of answer panel	<i>- Display 2D object</i> <i>- Display question panel and choice of answer panel</i>	pass	
Click <i>Kembali</i> (back) button	Navigate to Menu interface	<i>Navigate to Menu interface</i>	pass	
Click guide button	- Display guide panel - Hide guide panel when click any place	<i>- Display guide panel</i> <i>- Hide guide panel when click any place</i>	pass	

Tested by:



HERMANI BINTI TAJUL ARIFIN
Guru Prasekolah / DG 41

APPENDIX E
USABILITY TESTING QUESTIONNAIRES

This questionnaire is used for usability test.

Please tick (/) inside the provided box

Section A (General Information)

1. You are? Parents Teacher Preschool staff

Section B (Experience Level)

2. Have you ever used any mobile application for early mathematic learning?
 Yes No
3. Have you experience using any Augmented Reality application before?
 Yes No

Section C (Application Features)

No.	Question	Yes	No
1	Do you understand how to use this application?		
2	Does the application suitable enough for preschoolers?		
3	Does the Augmented Reality Technology help to increase the interactivity of the application?		
4	Does the 3D models in the application attractive enough?		
5	Do you think this application can help teacher to gain full attention from preschoolers to learn mathematic?		
6	Do you think this application are suitable for preschoolers in Malaysia?		
7	Do you think the design of the book and flashcard of SMART application are attractive?		

APPENDIX F
TEST RESULTS BEFORE AND AFTER USING THE SMART APPLICATION

Test Results Before Using The SMART Application

Respondent	Question: numbers of object									
	1	2	3	4	5	6	7	8	9	10
Respondent A	/	/	/	/	/	/	X	X	X	/
Respondent B	/	/	/	/	/	X	X	X	X	/
Respondent C	/	/	/	X	X	X	X	X	X	/
Respondent D	/	/	/	X	X	X	X	X	X	X
Respondent E	/	/	X	X	X	X	X	X	X	X

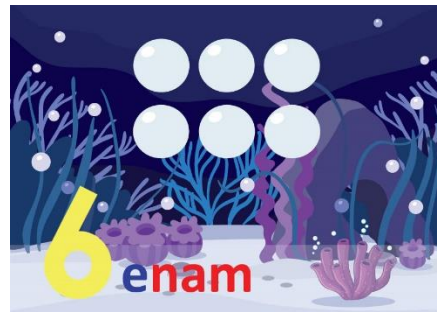
Test Results After Using The SMART Application

Respondent	Question: numbers of object									
	1	2	3	4	5	6	7	8	9	10
Respondent A	/	/	/	/	/	/	/	/	/	/
Respondent B	/	/	/	/	/	/	/	/	/	/
Respondent C	/	/	/	/	/	/	/	/	X	/
Respondent D	/	/	/	/	/	/	/	X	X	X
Respondent E	/	/	/	/	/	X	X	X	X	X

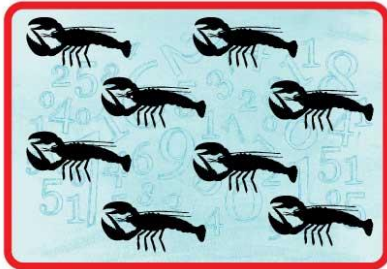
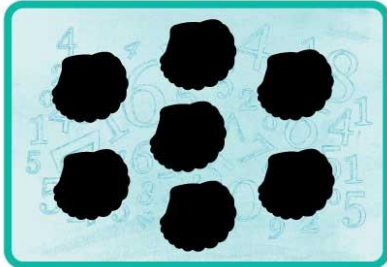
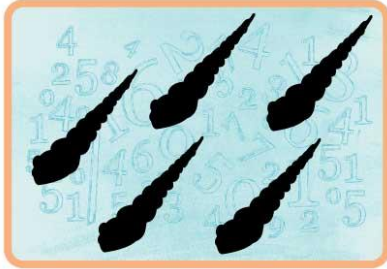
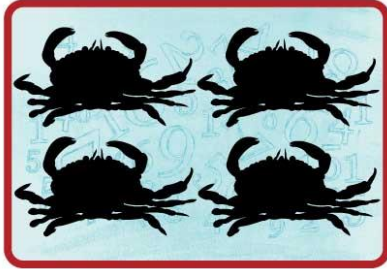
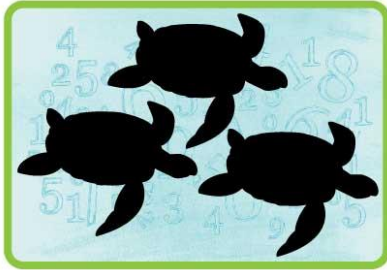
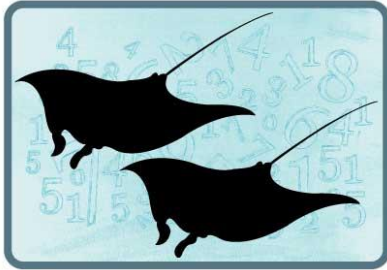
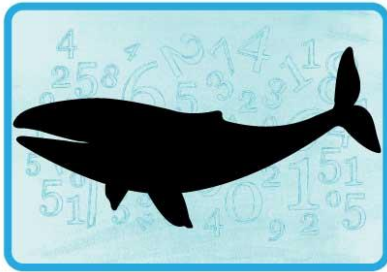
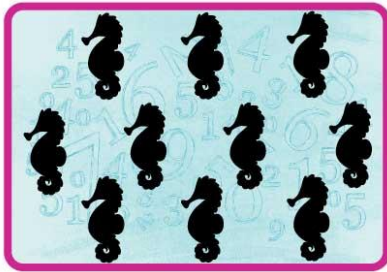
Correct Answer: /

Wrong Answer: X

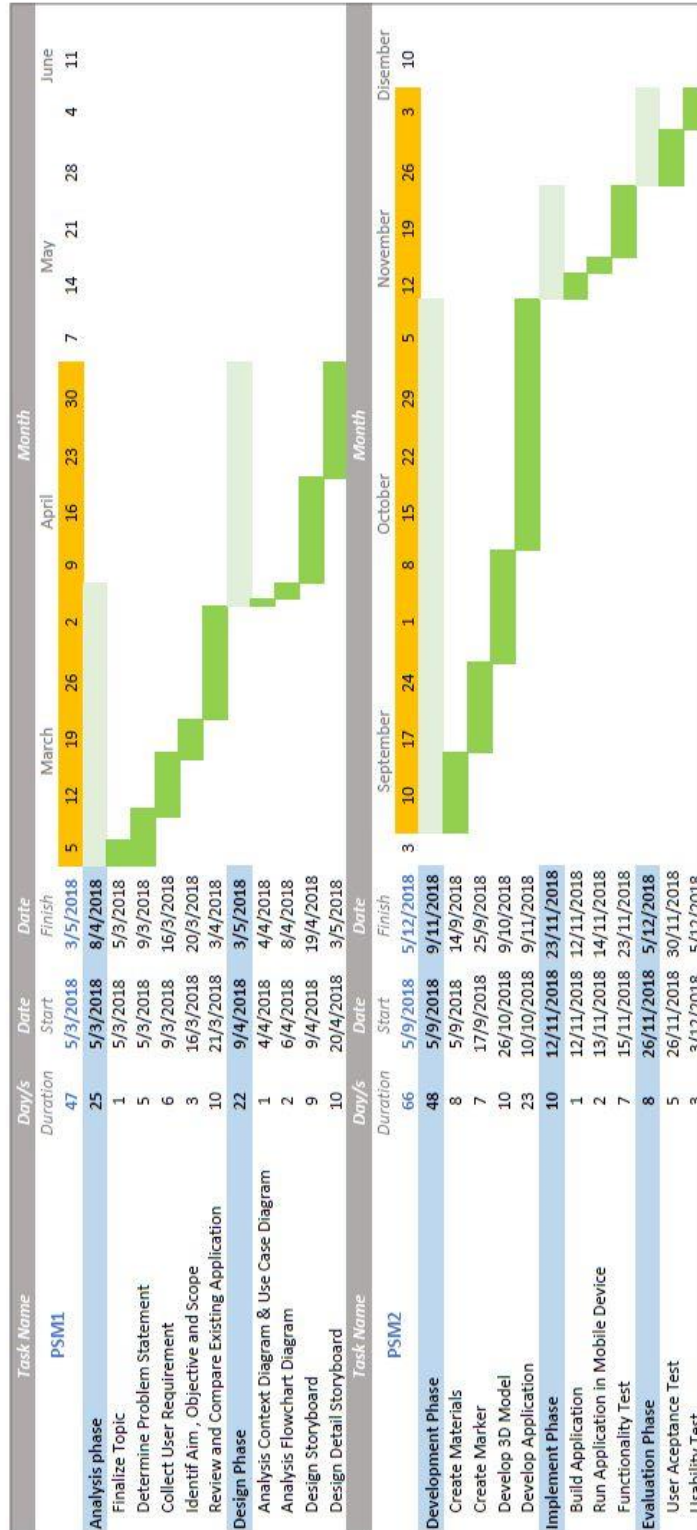
APPENDIX G
SAMPLE OF BOOK



SAMPLE OF FLASHCARD



APPENDIX H GANTT CHART



APPENDIX I
PRASEKOLAH SK KUALA SERUPAI

