AR Shapes: Making Contextual Learning Fun via Augmented Reality Book

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CERTIFICATION OF APPROVAL

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September 2013

CERTIFICATION OF ORIGINALITY

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

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ZAHARATUL MARDHIAH BINTI ZAINUDDIN

Abstract

AR Shapes is a mobile application that implements augmented reality technology to teach children basic geometry based contextual environment. Nowadays, the attention span of children are reducing thus affect the learning process. It is difficult to maintain their focus during learning. With the interactive element and some animation implemented in the AR shapes, the learning process becomes more fun and interesting. Contextual environment learning allows children to relate the subject with their environment. Thus, increase the children understanding. The application will be developed for 3-7 years old children by using the augmented reality technology based on the contextual environment to basic geometry. By using the Rapid Application Development (RAD) methodology, the application will be developed to ensure it meets the objectives of the project. Exploring further into the project, analysis, planning, design, testing and implementation are going to be carried out to support the progress of this project. As a result, an android application that is able to support the learning of basic shapes through AR book based on contextual environment is built. An informal pilot study was conducted to 5 children to observe user perception towards AR Shapes. The results indicate the children reacted positively towards the books. Besides, when doing the exercise that relate with their environment, they are able to relate the subject with the object surrounding. When testing their understanding by asking them to draw the shapes, the result shows the positive progress of the learning shapes process. These results suggest the potential of AR Shapes book as a medium for learning shapes based contextual environment.

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CHAPTER 1
INTRODUCTION

1.1 Background of study

Learning shapes is considered as one of the most basics subject that children need to know before learning other subject. By getting the strong basic in shapes learning can help the student to proceed in the more advanced subject such as mathematics and spatial subject. On the other hand, learning shapes also helps to increase children's creativity. There are 3 requirements that needed to meet in the shapes learning process which are shapes recognition, matching shapes and draw shapes (Barge, 2013). First requirement is shapes recognition where children must be able to recognize and name basic shapes. Next, matching shapes where children must be able to categorize which shapes that objects belongs to. The third requirement is draw shapes where student must be able to draw or at least copy the shapes with guidance from teacher or parent. Thus, the progress of children in shapes learning is very important to ensure the effectiveness of the learning.

On the other hand, there are many methods can be used to teach children at kindergarten. Methods such as story-telling, flash card, books, phonics are among the common methods that usually practiced by teachers in kindergarten. Contextual environment is one of the best method to teach shapes where children can relate what they have learnt with their environment (Klassen, 2006). This method can help children increase their understanding and apply the subject in their life.

However, it is difficult to keep the interest of the children nowadays to encourage them learn basic geometry. Most of the children get boring easily with the traditional plain book. Besides, they get easily distracted by things happen around

them. They are full of curiosity. This will disturb the learning process and due to that, the children cannot really learn the value in the book.

Interactive reading is a form of reading where the reader does not just look and read the content but it involves some interaction that require reader's participation such as clicking, touching, thinking and questioning. According to Fountas & Pinnell (2007), interactive reading is "A teaching context in which students are actively listening and responding to an oral reading of a text." This type of reading allows children to stimulate and help children to remember what they have read.

Children nowadays are more attracted with gadget as their parents have at least one gadget as part of communication tool or work purpose. Children are more attracted with gadget than story book. Before this, most of the gadgets only offer some basic functions and entertainment such as message, call, and game. Because of technology, gadgets or mobile devices make life easier. It makes the learning process through mobile device possible and more attractive.

The project is aimed to develop an application to teach basic geometry through AR book based on contextual environment by implementing augmented reality technology so that the learning process can be more interesting and enjoyable. By implementing this project, the children can learn basic geometry based on contextual environment. Through this project, children can relate what they learnt and apply it based on the real situation in their lives. From this process, they will understand and learn more. Children learn best from experience. They learn by doing, using their senses, exploring their environment of people, things, places and events (UNICEF, 1994).

1.2 Problem Statement

Nowadays, most of the children's attention span when learning is reducing. They easily get boring and distracted by their environment. According to Barton(2012), a normal attention span is 3 to 5 minutes per year of a child's age. This means a kindergarten kids should be able to concentrate for at least 15 minutes. However, most of them get easily distracted with things happen around them during

the learning process. Children nowadays can spend more than 2 hours using gadget, but cannot focus more than 2 minutes when doing homework without distraction (Sullivan, 2013).

The current traditional book can be boring, dull, and non- interactive activity. Nowadays, kids less interested to study rather than playing smart phones. They are more attracted to something different and interesting. According to the new study by Common Sense Media, "children under 8 are spending more time than ever in front of screens." Because of advanced in technology, children nowadays are exposed more with the gadgets or technology such as smart phone, laptop, tablet, video games and etc. Due to that, the traditional educational book seems less attractive to them. When dealing with book, they are not really excited to read until the end. This makes the traditional educational book less effective to be one of the education tools.

This problem should be overcome as kids cannot learn effectively if they are passive. As they are more attached with gadgets, this alternative should be used to attract the children to learn. Active engagement with things and ideas promotes mental activity that contributes to retain of new learning and integrate it with what children already know (UNICEF, 1994). Thus, learning shapes through AR book application should be developed to tackle this problem and ensuring the children can have fun while learning the basic geometry by using smart phone technology.

1.3 Objective of Study

The research study is aimed to develop Interactive Story Book Mobile Apps for Children. The objectives of the study are:

1. To explore the use of mobile apps for learning shapes.
2. To develop augmented reality based on contextual environment application that could motivate children to learn by experience.
3. To conduct usability testing and observation study among potential target users.

1.4 Scope of Study

There are several scopes of studies or areas involved in the development of this project.

1. Mobile technology is the current trends and become part of people life. The technology revolution has changed how people work. It offers more function to make life easier such as communication and business tool. Almost everyone in most part of the world has at least smart phone. Besides, the new generations of kids are also exposed with gadgets at the very young age. In fact, some of them know the function of smart phones better than adult. Android is the chosen operating system as most of the users of smart phones choose Android.

2. Target user: The target user for the application is to children who are in kindergarten between 3 to 7 years old.

3. Method of learning that is used for teaching children the shapes is based on contextual environment.

4. Augmented reality technology is implemented to make learning process more fun and interesting.

5. Language that will be taught in this application is English language.

1.5 Relevancy of the Project

The project is relevance because in the mobile apps market especially for AR books, only one AR book currently offered to teach children basic geometry. On the other hand, there are a few mobile apps offered to teach basic shapes for children. For other subject, such as for learning reading, alphabet, storybooks, there are many AR books provided for learning the subject. Besides, the technique used to teach children the shapes in the existing mobile apps are not really specified. The effectiveness of the existing

application is doubtful. This project focuses on teaching children basic geometry using contextual method which has been proved to be one of the best methods to teach children. In addition, the augmented reality technology is implemented in this project so that the learning process becomes more fun and enjoyable. On the other hand, compared to other operating system of mobile apps, Android has the most number of users. Since children nowadays already exposed with mobile apps technology, it is relevance to implement the learning process in mobile apps.

Therefore, it is relevance to develop the learning shapes mobile apps through AR book based on contextual environment.

1.6 Feasibility of The Project

In order to develop this project, it will take about 8 months or 2 semesters depending on the date that are allocated by UTP for my final year project. The first phase of the project or the first 4 months of the time frame will be used to do research, data collection and requirement of the project. This phase will focus more on the needs of the project or the research part.

The second phase will be focusing on the development of the project. The early stage of this phase will be used to familiarize myself with the software and program required to develop this project. Then, the project will be developed and will be tested on the potential users. At the end of the time frame, the project has to be completed.

CHAPTER 2

LITERATURE REVIEW

2.1 Early Education

Early education is very important to develop the foundation of the children brain for learning as they grow up. Recent finding suggest that early education is very crucial to help improve the academic paths of children in poverty, especially to those who are considered to be at high risk for early school dropout, poor academic performance and behavior problem (Olivia, 2010). So, parents and teachers must find the best alternative to educate children and develop their brain.

Early childhood education typically focuses on five domains which include cognitive, language, social-emotional, fine motor, and gross motor (Harville, 2010). All this aspects can be developed at home or at school. Parent plays important role in the development of the kids at the early stage. Basically, parent is the first idol or icon of the children. Children learn from the environment. They learn by see how parent act and behave at home and what they teach them. Thus, it is important for parent to ensure that they teach and be a good example to their children. They must monitor the progress of their children's education. If the children exposed too much with technology, parent must ensure that the tools or gadgets can beneficial the children.

Research shows that when parents and other family members monitor in what children are learning provide learning at home, and offer encouragement to a child's learning efforts it can give significant impact to the children. The earlier parents are engaged in their children's learning, the more likely they can contribute to children's development (Wisconsin Council, 2008).

2.2 Contextual Learning

Contextual learning is one of the best techniques in early education. It is where the children learn based on their context. Children learn best from experience. They learn by doing, using their senses, exploring their environment of people, things, places and events (UNICEF, 1994).

Contextual Teaching and Learning (CTL) is a learning system that links the academic content to the context of everyday life learners. According to Berns & Erickson (2001), contextual teaching and learning enable students to relate subject matter content to real world situation and motivates student to make connection between what they have learnt and application of it in their lives. Besides, Klassen (2006) propose that context is "the entities that connect to or surround a focal entity and contribute to the meaningfulness of the whole." The focal entity refers to the understanding the concept or the skill while meaningfulness involve factors such as familiarity, activity, interaction, logical relation and so on based on the context of the concept. Thus, contextual learning is a learning system that enable student to understand more by relate the theory in reality, apply to their lives.

On the other hand, Mooji (2004) suggests that to optimize the learning process in the generation today, multilevel educational and ICT characteristics are integrated in the contextual learning theory. The use of technology is very helpful to improve the learning process. Three types of contextual conditions are differentiation of learning procedures and materials, design of integrating ICT support, and improvement of development and learning progress which are related to four aspects of learning (diagnostic, instructional, managerial and systematic.)

The preceding information suggests that learning must start with some type of diagnostics with respect to the level of competence of the individual student within a specific domain and the context of peers. Specific instructional guidelines or prescriptions can then be developed on the basis of such diagnostics to assist each learner, small group, or class. The related learning processes and effects can be evaluated and managed in order to provide for further positive learning steps. And finally, diagnostics, instruction, and management have to be integrated within a sufficiently flexible multilevel system to provide adequate support for the differences in learning and development across students. A model to illustrate this cyclic process

of diagnostics, instruction, and management within a multilevel system (DIMS) is presented in FIGURE 1.

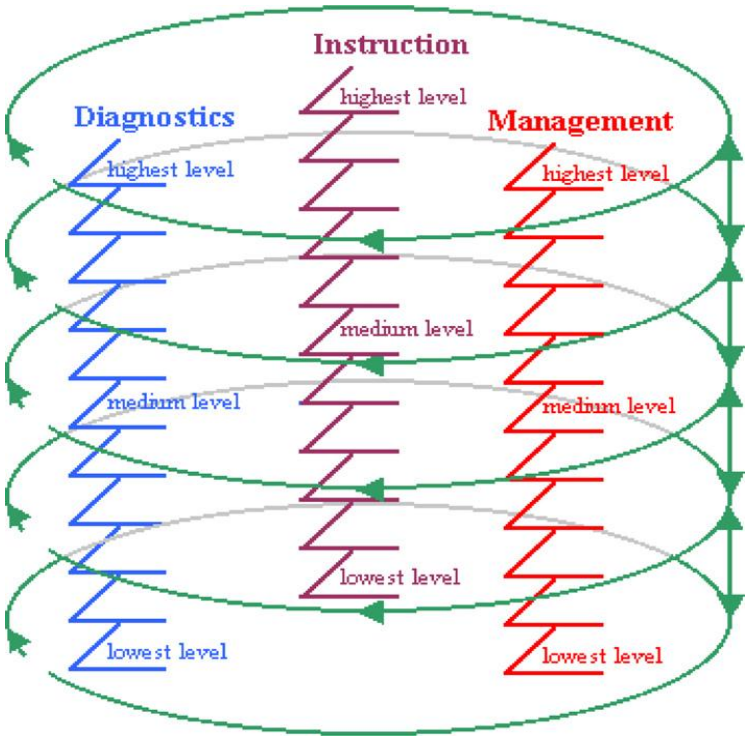

FIGURE 1. Modeling of multilevel diagnostic, instructional, and management systems (DIMS).

Glynn & Winter (2004) and Berns & Erickson (2001) agree that there are 5 strategies in the contextual learning which are inquiry learning, problem-based learning, cooperative learning, project-based learning and authentic assessment.

i. Inquiry learning

An approach that where the children starts to learn about their environment. Inquiry involves an understanding of how the things work and the recognition of the various things in the environment (Glynn & Winter, 2004).

ii. Problem-based learning

An approach that engages learners in problem-solving investigations which integrates skills and concepts from many content areas. This approach includes gathering information around a question, synthesizing it, and presenting findings to others (Berns & Erickson, 2001).

iii. Cooperative learning

An approach that organizes instruction using small learning groups in which students work together to achieve learning goals (Berns & Erickson, 2001).

iv. Project-based learning

An approach that focuses on the central concepts and principles of a discipline, involves students in problem-solving investigations and other meaningful tasks, allows students to work autonomously to construct their own learning, and culminates in realistic products (Berns & Erickson, 2001).

v. Authentic assessment

An approach that evaluates student performance based on their task associates with the context learnt. An example of authentic assessment is portfolio which the student works shows their progress, achievement and effort (Glynn & Winter, 2004).

2.3 Mobile Application in Education

Mobile application can be defined as a "type of application software designed to run on a mobile device, such as a smart phone or tablet computer" (Techopedia, 2012). It provides users with similar services or functions to those accessed in computer but in a more flexible and easier way.

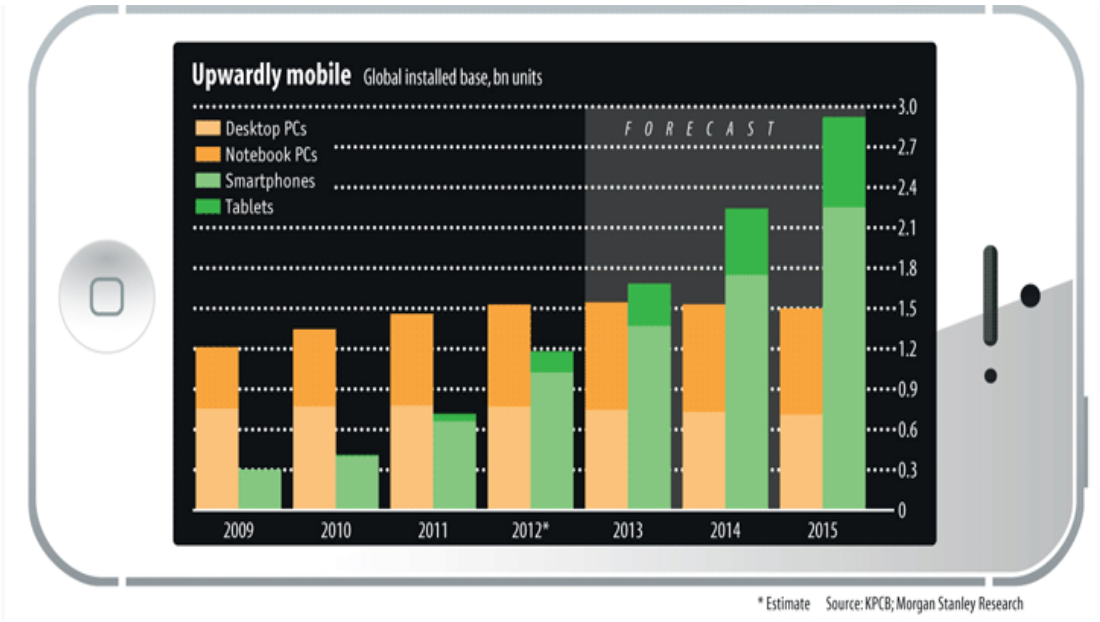

FIGURE 2. Statistics of Mobile Users

FIGURE 2 demonstrates the result of research done by Morgan Stanley in the statistical number of gadget users. They found that the number of smart phones and tablet users are more than the number of desktop and notebook users.

TABLE 1. Top Five Smartphone Operating Systems, Shipments, and Market Share, (Units in Millions)

Operating System	2012 Unit Shipments	2012 Market Share	2011 Unit Shipments	2011 Market Share	Year over Year Change
Android	497.1	68.8%	243.5	49.2%	104.1%
iOS	135.9	18.8%	93.1	18.8%	46.0%
BlackBerry	32.5	4.5%	51.1	10.3%	-36.4%
Symbian	23.9	3.3%	81.5	16.5%	-70.7%
Windows Phone/ Windows Mobile	17.9	2.5%	9.0	1.8%	98.9%
Others	15.1	2.1%	16.3	3.3%	-7.4%
Total	722.4	100.0%	494.5	100.0%	46.1%

TABLE 1 illustrates the record of top five smartphone operating systems, shipments and market share done by International Data Corporation (IDC) Mobile Phone Tracker on February, 14 2013. It shows that Android has the biggest demand in smart phones industry.

In 21 century, almost all parents have at least one mobile device for their communication and business tools. They usually will allow their children play with their mobile device. This is called as pass-back effect. The pass-back effect is when a parent or adult start to pass their mobile devices to children (Chiong & Shuler, 2010). The children usually will use the mobile device for entertainment especially to play games. Due to that, most of their time is spent on mobile devices.

Many innovative have been done to take advantage of mobile application technology in early education of children. In education, mobile device allow children to learn anywhere and anytime. Mobile devices enable students to gather, access, and process information outside the classroom. It encourages learning in a real-world context and help link school, afterschool, and home environments (Chiong & Shuler, 2010). Thus, learning process can be done anywhere and anytime they like. Previous research of exploring the ease with which pre-schoolers adapted to and were engaged by tablets, find that children were quick learners and were highly interested when dealing with mobile devices (Chiong & Shuler, 2010).

Besides, mobile devices encourage 21st century skills like communication and collaboration. By using mobile devices, they are exposed with the current technology thus benefit them in future in dealing with technology. For example, they can learn the various ways of communication tools such as email, or any networking media that can be used to communicate with other people.

Therefore, the technology of mobile device expands the learning environment of the children especially in early education. “It is possible to imagine that low- or no-cost apps will soon become an efficient and enjoyable way to help enrich young children’s environments with quality educational materials” (Chiong & Shuler, 2010).

2.4 Learning Shapes

Basic skills such as math vocabulary and geometry are the crucial foundation that children should know after leave the kindergarten. Geometry might sounds too advance for children at such a young age, but one of the basic geometry skills is recognizing and understanding different shapes. According to Clements & Sarama (2011), geometric and spatial thinking are not only important of themselves, but they also the fundamental skills for arithmetic concepts and skills. It is necessary that in certain periods, children be provided with geometric attainments that are consistent with their developmental processes where it is consistent with their developmental processes and individual differences (Inan & Dogan-Temur,2010).

Spatial thinking is an "essential human ability that contributes to mathematical ability" (Clements & Sarama, 2011). It is the basic skill that contributes a lot to physics and science understanding. Clements & Sarama (2011) also claim that many researches have proven that if a child is equipped with the necessary attainments in geometry during kindergarten period through accurate methods and techniques, this will contribute to that individual's future academic life and even raise his/her IQ .

On the other hand, Inan & Dogan-Temur (2010) stress the importance of geometry in our lives and states that geometry and spatial sense offer us ways to interpret and reflect on the physical environment. They also claim that there are four basic standards in learning shapes which are as follows:

Instructional programs from prekindergarten through grade 12 should enable all students to:-

- analyze characteristics and properties of two- and three dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- specify locations and describe spatial relationships using coordinate geometry and other representational systems.
- apply transformations and use symmetry to analyze mathematical situations.
- use visualization, spatial reasoning, and geometric modeling to solve problems .

Moreover, there are various products that offer the learning of shapes for children. This includes websites, mobile applications, books, songs and others. Different products may have different characteristics or different method used to teach children the basic shapes.

2.4.1 Websites

1) CBeebies Games

FIGURE 3 Cbeebies Games

CBeebies is a free website that teaches children step by step about shapes. It involves match the shapes to color the picture, then click the movie button to see the picture come to life. It has a few stages to make the children familiar with the shapes. "Easy" setting involves dragging the shape to the correct space. The "Hard" pictures take quite a long time to complete where children have to resize and rotate the shape to fit, which is quite challenging for the children.

2) Purpy's Shapes

FIGURE 4. Purpy's Shapes

Purpy's Shapes is a website that teaches children about shapes by simple drag and matching game. It only teaches children 3 basic steps which are rectangle, triangle and circle.

3) Tulli's World

FIGURE 5. Tulli's World

Tulli's World of Shapes introduces children with basic shapes such as rectangles, triangles and circles as well as additional geometric shapes, such

as ellipses and rectangles. Children are also exposed to other non-geometric but common shapes, such as stars and hearts.

TABLE 2 illustrates the advantages and drawbacks of several websites that offer learning shapes for children. In terms of the shapes introduced by the website, Tulli's World introduces many shapes compare to other. All of this websites have some advantages and drawbacks which have shown in the table.

TABLE 2. Comparison of learning shapes websites.

Product	Shapes offered	Advantages	Drawbacks
CBeebies Games	Circle, square, triangle, rectangle, oval	Have some level of difficulties	Does not teach children the word of the shapes.
Purpy's Shapes	Circle, triangle, square	Interactive and easy to play the game.	Teach 3 shapes only.
Tulli's World	Rectangle, triangle, circle, stars and hearts	Use contextual learning.	Does not introduce the name of the shapes.

2.4.2 Mobile Application

1) Baby Learns Shapes(kids)

FIGURE 6. Baby Learns Shape

Baby learns shapes uses two interesting methods to help children recognize different shapes, those two different methods are flooring jigsaw puzzles and room's cleaning up, which also guide the children to classify those shapes. Not only helps the children's enlightenment and cognition but also trains the small arms of the child and improves the hand eye coordination ability, develops the early childhood intelligence.

2) Kids Shapes

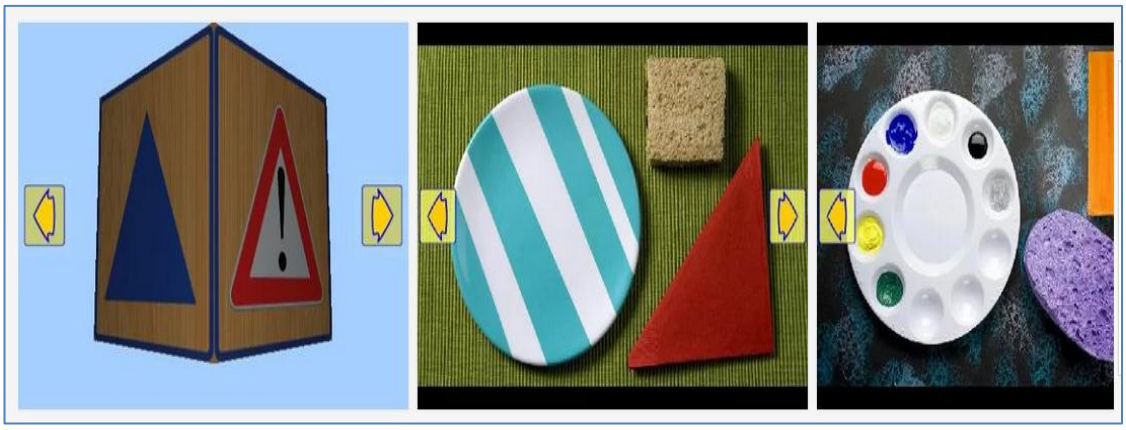

FIGURE 7. Kids Shape

Kids Shape is a mobile application that offers to teach shape where the children will learn to recognize shapes in their-life context. The shapes currently included are circle, rectangle, triangle, square, rhombus and oval. The activities offered include learning shapes using real-life objects and recognizing shapes in their real-life settings.

3) Shapes Toddler Preschool

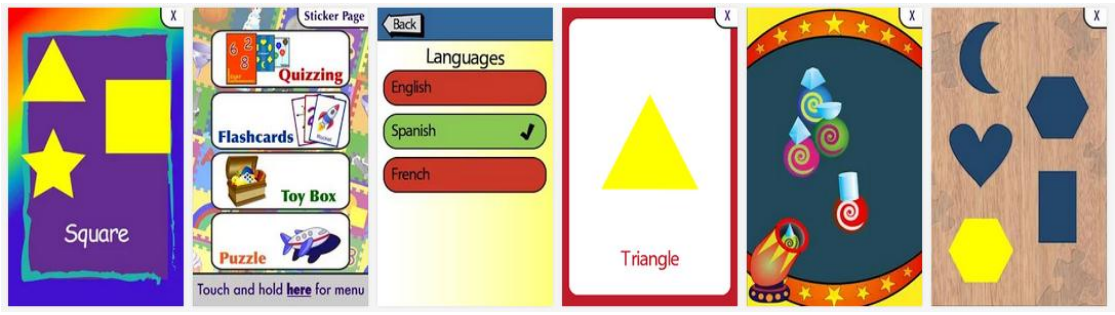

FIGURE 8. Shapes Toddler Preschool

Toddler Teasers Shapes teaches while it entertains. With a focus on simplicity and full voice overs, toddlers play and learn without the need for extra help. The app displays colorful quizzes, flashcards, puzzles and games while offering positive reinforcement and fun rewards. The child-safe menu allows parents to customize game play and difficulty.

TABLE 3 illustrates the advantages and drawbacks of several mobile applications that teach basic shapes for children. Shapes Toddler Preschool offers many shapes for learning. However, because of this features, the application is quite heavy which may result on problem on the device. Based on the review of the application, some of the parent encounter problem where the application is not working. Baby learns Shapes application teaches children shapes by developing game which based on contextual environment. However, it does not introduce the shapes properly to the children. Last but not least, Kids Shapes use contextual environment to teach children basic shapes. But, the application is quite boring as it is lack of interactive element.

TABLE 3. Comparison of learning shapes mobile application.

Product	Shapes offered	Advantages	Drawbacks
Baby Learns Shapes (kids)	Circle, triangle, square, rectangle	Use contextual learning and use interactive game.	Does not teach children the word of the shapes.
Kids Shapes	Circle, rectangle, triangle, square, rhombus, oval	Use contextual learning.	Lack of interactive element.
Shapes Toddler Preschool	2D and 3D shapes	Offers many shapes for learning	The application is quite heavy which may result on problem on the device.

2.5 Augmented Reality

Augmented reality (AR) is defined as the technology of combining real word images, video, etc. with computer-generated information or image. It can be live, direct or indirect view of physical world whose elements are augmented or changed by the CGI sensory input (Billinghurst, 2012). Augmented reality is a live view of a physical, real-world environment whose elements are supplemented by computer-generated sensory input such as sound, video, graphics or GPS data. It is not something new but has been used in some industry such as vehicles, multimedia and communication. In vehicles industry for example, augmented reality technology is used to build the simulation of the vehicles.

Mobile augmented reality explores utilizing camera equipped mobile devices as platforms for sensor-based, video see-through mobile augmented reality. Recently mobile augmented reality has been used for the tourism especially. Besides, it also has been implemented to develop games and advertisement.

On the other hand, game-engine technology animates the character and creates an entertaining encounter, which users find more enjoyable than learning about art from traditional print sources (Billinghurst,2012). The features that offered by augmented reality technology make learning process become more interesting. This will retain children's focus when they learn to read. With mobile devices, users can have an AR experience anywhere, which means that children can remain actively engaged in the learning process outside as well as inside the classroom.

Thus, augmented reality technology can attract children to learn more. Its future makes the learning process more interesting and possible at anywhere and anytime.

2.5.1 AR Books

Augmented Reality book make textbooks "alive" (Wang, 2012). Books have been widely uses as a tool of learning in many decades. The book is one of the most well know formats to deliver knowledge and information for learners of all ages

because of its simplicity and flexibility (Vate-U-Lan, 2012). The advancement of technology can make the book more interesting.

By adding virtual information and graphic into physical book, the features of AR have been applied to enhance the reading experience of the learners (Matcha & Rambli, 2012). One of the earliest work of innovation project integrated AR technology on the physical book form namely the MagicBook which had been designed to enhance a traditional 3D pop-up book version (Vate-U-Lan, 2012).

According to Eleftheria et al. (2013), text, graphics, video and audio can be integrated into a student's real time learning environment by implementing AR features. Textbooks and other teaching reading material can contain embedded "markers" that, when scanned by an AR device, produce supplementary information to the learner extracted in a multimedia format. AR books have two parts which are the virtual and real content (Matcha & Rambli, 2012). The virtual content is part of physical content but require a device to display the virtual content. This concept is known a s multimedia integrated (Matcha & Rambli, 2012). Thus, AR features make the traditional boring book into an interactive book which is more fun and interesting. Many researches proved the experience of using AR book was easy to use and useful and the training had a measurable and positive impact on student's spatial ability (Wang, 2012).

2.5.2 AR Mathematics

Spatial ability is an importance component of human intelligence. According to Kaufmann & Schmalstieg (2003), the term spatial abilities covers five components, spatial perception, spatial visualization, mental rotations, spatial relations and spatial orientation. In general, the main goal of mathematics and geometry education is to enhance the spatial skills. Besides, Kaufmann & Schmalstieg (2003) also claim that spatial abilities can be improved by virtual reality (VR) technology. However, only a little works has been done to develop the application in geometric field.

Among one of the augmented reality work in geometric field is Construct3D which is a 3D geometric construction tool specifically designed for mathematics and geometry education. It is based on the mobile collaborative augmented reality system ‘‘Studierstube’’. The main advantage of this Ar application is that students actually see 3D objects which they until now had to calculate and construct with traditional (mostly pen and paper) methods where by working directly in 3D space, complex spatial problems (Kaufmann & Schmalstieg, 2003). However it focuses only for higher level of geometric education.

Besides, GeoAR is also one of the latest AR work in geometric field focusing the basic geometric learning for children. GeoAR is an interactive book which incorporates Augmented Reality resources, developed to support teaching and learning of Geometry topics covering the main geometric shapes. According to Kirner et al.(2012), the book comprises basic concepts of Geometry related to the main geometric shapes (circle, rectangle, square, pentagon, triangle and trapezoid), with explanations of calculation of perimeter and area of each geometric object. The book also includes the calculation of the volume of each respective solid. The GeoAR uses images, animations, rotations of objects, narrated explanations, alert sounds, etc.

2.6 Reflections

After doing research on the literature review, many important points have been found to support the project. By doing this research, the necessary requirement to develop the project can be highlighted.

First, contextual learning method is chosen because it help student to relate the subject they learnt to their environment. It has been proved that contextual environment can increase children understanding and make learning process easier and interesting. This statement is supported by many researchers including Klassen (2006), Glyn & Winter (2004) and Berns & Erickson (2001). In addition, Mooji (2004), claim that the integration of technology with contextual learning method can

enhance the learning system. Thus, contextual learning is the best way to teach children shapes.

The second point is the significant of augmented reality technology. Augmented reality is a technology that makes real word into augmented element such as picture, video, sound. It makes the interaction with real world element using the technology becomes possible. Thus, integration of this technology into early education make learning process becomes more fun and interesting. According to Eleftheria et al. (2013), the interactive part that offered by augmented reality technology can attract the children to learn.

Next is the important of learning shapes in early education. Learning shapes is considered as one of the most basic subjects that children need to know before learning other subject (Barge, 2013). To get strong basic in Mathematics for example, need the logic skill which can be learnt in shapes learning. Shapes are always around us. Thus, learning shapes is a vital knowledge that children need to have as they start learning by observing their environment.

In conclusion, there are many tools that can be used to teach children shapes. However the efficiency and effectiveness of these tools as doubted. Some of the applications are not really interesting and children might get easily boring using it. While some do not use the appropriate method to teach children shapes. Although some of the applications are quite good for children, there are some elements that can be improved. Thus, the project is aimed to improve the existing learning shapes tools.

The interesting part of this project is it integrates the contextual learning in learning shapes education through the use of augmented reality technology. Besides, in augmented reality field, only a few applications that focuses on the early education of Mathematics. AR Shapes can be considered as the first augmented reality application that offers learning shapes for kindergarten school.

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

It is important for developers to understand the process or phases involved in the development of the new application. Else, the project may be abandoned due to the system failure and result on waste of costs and energy. The methodology that will be used for this project is Rapid Application Development (RAD).

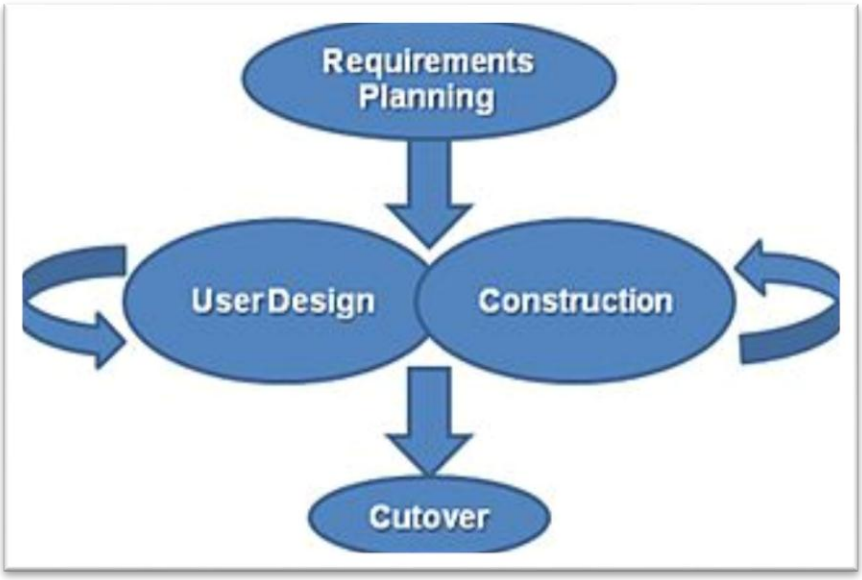

FIGURE 9. Rapid Application Development (RAD) Model

Rapid Application Development is a method of developing system or software that requires minimum planning in favor for rapid prototyping. It allows

changes of system with minimum cost and increasing the quality of the system produced. User's involvement is very important in this model to ensure that the requirement and user expectation are clearly understood. The RAD approach thus includes developing and refining the data models, process models, and prototype in parallel using an iterative process.

Why RAD?

Due to the constraints of time and money, the project may face several changes throughout the process. RAD is actually a model that is used for the development of software. However, the project that the author will be doing is a mobile application. Because of the flexibility in this model, the developer can use the stages of this model for my project.

RAD is different from traditional way of development. In traditional method, every stage or phase only allowed to be carried out at most once. A stage cannot proceed if another early proceed is not completed. On the other hand, in RAD development the project is first being analyzed and planned properly. After that, the iterative of user design and construction phase enable user to design, improve, and refine the prototype. This is the flexibility that offered by RAD model for the developer to improve and develop their project properly.

Therefore, the author found out that, it is the best to refer RAD model for the methodology as the project may need a few changes based on the requirement as the developer is still new with augmented technology.

Throughout this model, there are four stages involved to develop this project which are:-

- Requirement Planning
- User Design
- Construction
- Cutover

3.1.1 Requirement Planning

During this stage, the project requirement and the necessary information need to be understood by the author. The author needs to define the problem statement and objectives of the project first. At this stage, it is crucial for the author to understand the current technology used in mobile devices for early education, the concept of AR book and how it can be used to teach children. Then, the author needs to determine the scope involved in the project. This is important to ensure that the project will satisfy all the requirement needed and cover the area related to the application. The author needs to identify the best approach to deliver the knowledge contents effectively to the kids using the mobile device technology.

a) Define research problem

For this project, first, the author identified the problem where there is a need to develop a mobile apps which can encourage children to learn basic shapes by link the subject with their daily activity, using contextual environment techniques. Since children nowadays attach more with gadget such as tablet, this opportunity should be used to develop their logic skill. By implementing AR technology in the mobile apps, learning shapes based on contextual environment will be very useful.

b) Review concept and theories/ Review previous research findings

After defining the problem, critical analysis on the literature is conducted to have a better understanding on the early education for kids, learning shapes method, contextual environment learning and AR technology. Previous researches are analyzed to review the existing theory and various types of approaches to teach children to read.

c) Data Gathering

Information on the user requirement is gathered by using different type of data gathering such as program observation of current method being used in the school and review the existing mobile application developed by other developer to teach children basic geometry.

Technically, this project require the author to develop an augmented reality mobile application that can detect and able to read the marker or flash card used for shapes learning, and display animated object based on the corresponding shapes that the children want to learn. The application must be in Android form to allow tablet or smart phone users use it.

After doing research on what kind of software that needs to develop the application, it is found that there are many SDK that can be used to develop augmented reality application such as Vuforia, Wikitude, Layar, Metaoi and NyarToolkit. After doing some comparison, it is found that it is the best for the developer to use Vuforia to develop this project. This platform offers a wide set of features and capabilities, giving developers the freedom to extend their visions without technical limitations. With support for iOS, Android, and Unity 3D, the Vuforia platform allows developer to write a single native app that can reach the most users across a wide range of smartphones and tablets. Besides, there are some tutorials of developing augmented reality application offered by some individuals or organization in the internet.

On the other hand, Unity extension is used to build AR apps with the popular cross-platform game engine. It is essential to recognize and track the markers or the image.

FIGURE 10. Vuforia SDK for Augmented reality Development

FIGURE 11. Unity Extension for Augmented Reality

3.1.2 User Design

Also known as analysis and design phase where the author has to analyze the target user, where and how the product will be used. This stage requires the author to model the application's data and process by building a prototype of critical component of the applications. The author need to identify what is the main function of the system and design it functions and operation in details. For this project, the application is designed according to user's usability and requirement of the syllabus.

System Architecture

FIGURE 12 illustrates the system architecture of the application. Based on the project development, a set of database will be developed which includes all the shapes image, sounds and music that will be used in this application. By using the database, combining the augmented reality, images, sound and android platform, the project is going to produce an end product that involved user interface which allow the users to communicate with the app. The children will be the main user for this application based on the feedback from the children further development is going to be carried out. Parents are going to be the support system that is going to assist the children in using this application.

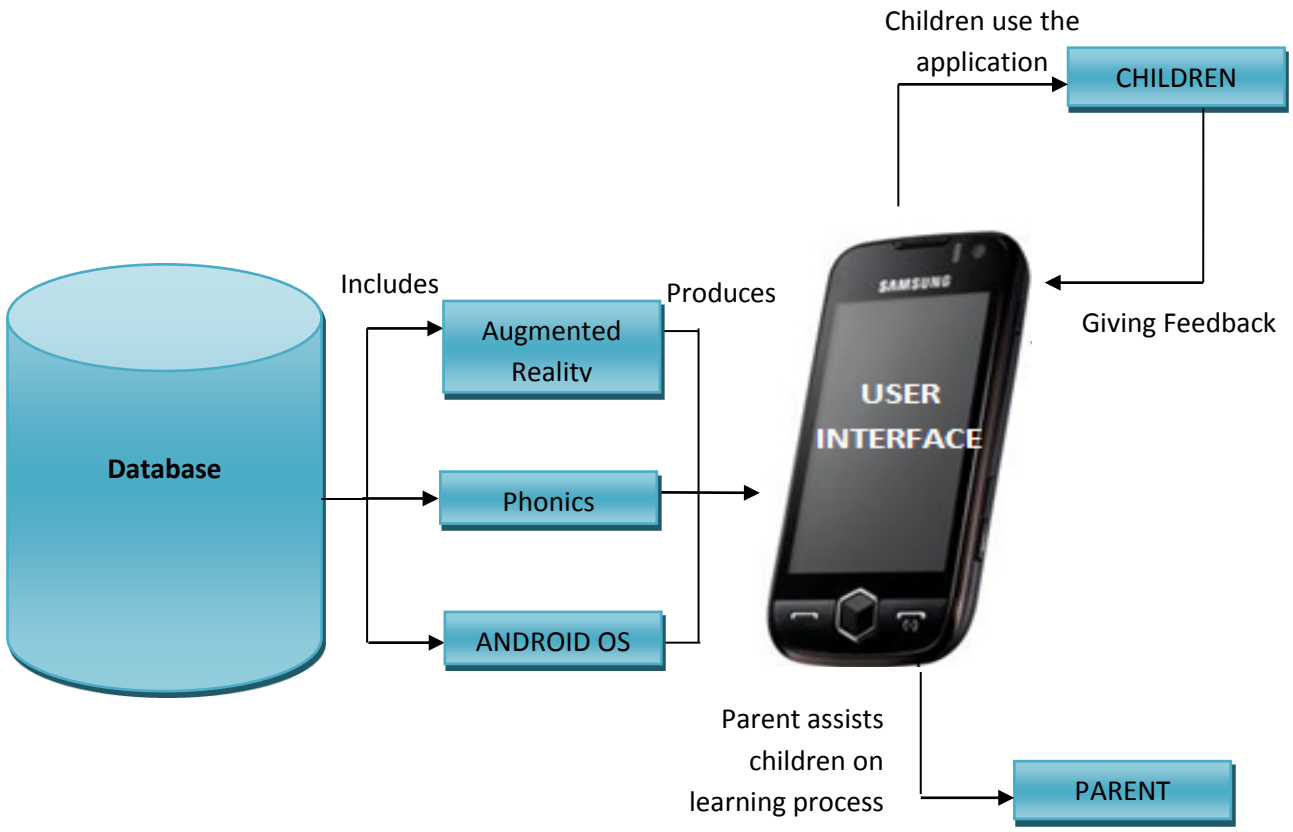

FIGURE 12. System Architecture

Database Diagram

For the database of the application, there are 2 options can be choose which are device database or cloud database. Device database is used when the images that will be tracked or recognized is known.

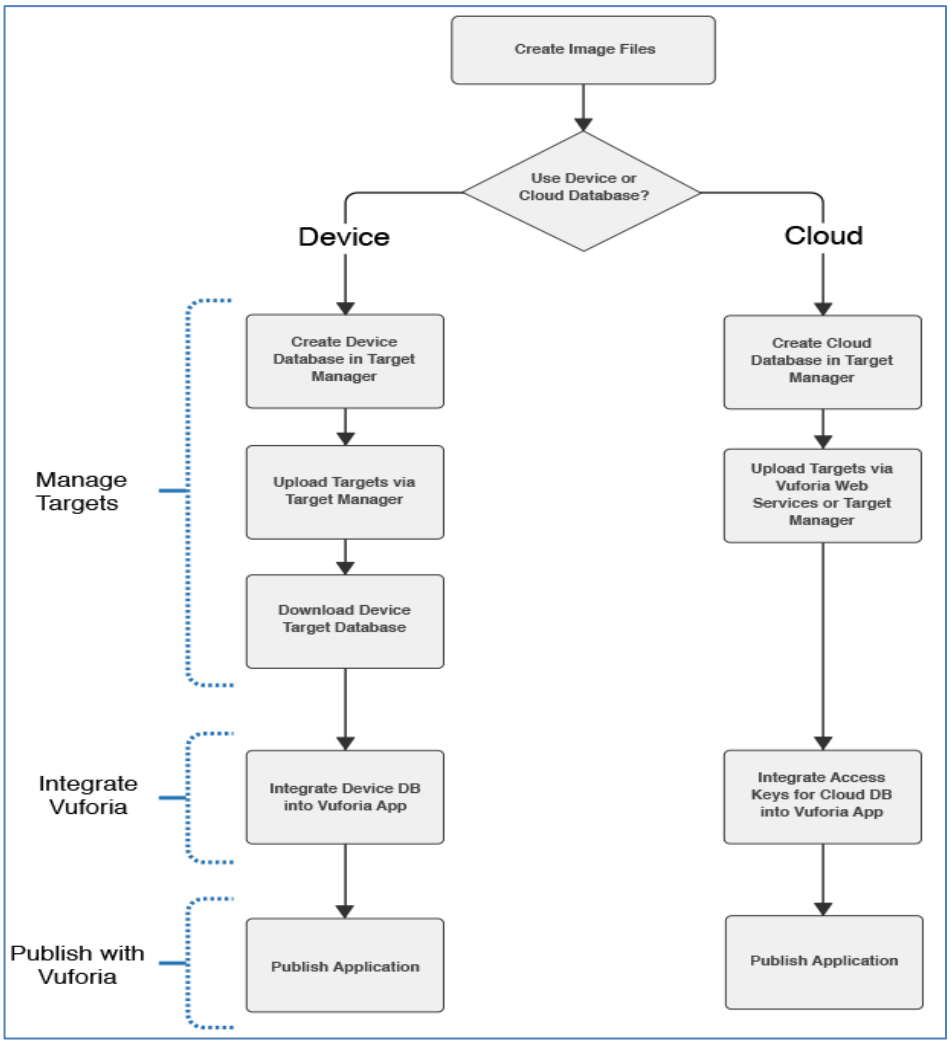

FIGURE 13. Database for augmented reality

Since, the project involves the AR book which the images to be tracked is already known, device database will be used. This database does not require any network connection and the response time is faster than cloud database. Hence, it fits the requirement of my projects where the response time must be fast to keep the children‘s interest to learn.

3.1.3 Construction

Construction phase also known as implementation phase. During this stage, the project prototype is built based on system analysis and design. This stage completes the construction of the physical application system, builds the conversion system, and develops user aids and implementation work plans. At this stage, the

author must develop the Android application of learning shapes based on contextual environment.

3.1.4 Cutover

This stage also known as Deployment stage. It includes final user testing and training, data conversion, and implementation of the application system. During this stage, the author needs to ensure that all the functionalities of the application are worked and fix any bugs that occur within the application. User's involvement is highly needed to ensure that it meets the entire requirement needed. Once the application is error-free and satisfy user's expectation, it will be deployed and ready to be used.

3.2 Tools

The tools required for this application are :-

Hardware

- An Android smart phone, as a platform to develop this project
- Computer/ laptop
- Printer: to print the image or flash card

Software

- Eclipse: To develop the application
- Blender: To develop a 3D object
- Vuforia AR SDK : Extension for Augmented Reality development
- Unity: Development platform for android application

3.3 Challenges and Issues

Throughout this project, there are some challenges and difficulties encountered during the development of this project. Fortunately all the issues have been overcome with the help of many parties.

First, to design the AR book require a good design so that it can easily be tracked by the camera. By using the Vuforia extension, it is easier to design the AR book as it gives the rating on the image how easily the camera can detect the image. In addition, Vuforia also gives suggestion on what can be improved on the image to increase the rating. This part is crucial to ensure that the user can use the application easily without any difficulty in tracking the image.

Secondly, without any background or basic knowledge in augmented reality field, it is difficult for the developer to develop the project. With the help of the supervisor and some colleagues, plus the tutorial provided in the internet, the developer managed to develop the application.

Last but not least, since the project is developed at the end of the year, the testing procedure is difficult to conduct as all of the schools in the Malaysia are in holiday session. With the help of some friendly residents around Tronoh, Perak, the testing can be conducted to some of the children.

Therefore, with the help of many parties, all of the difficulties and issues encountered by the developers have been overcome.

3.4 Key Milestone

FIGURE 14 shows the key milestone for final year project 1 documentation and report submission date and FIGURE 15 illustrates key milestone for final year project 2.

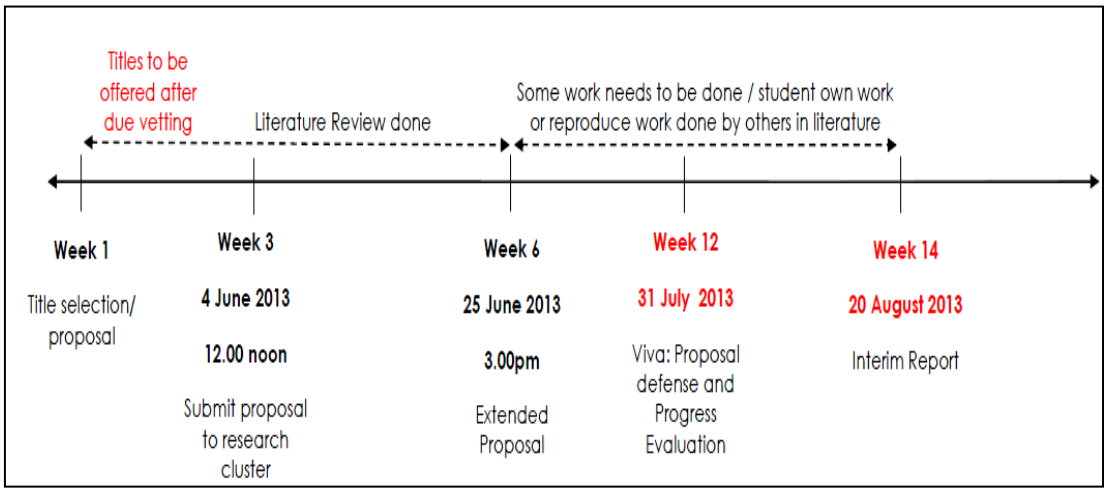

FIGURE 14. Key Milestone for FYP1

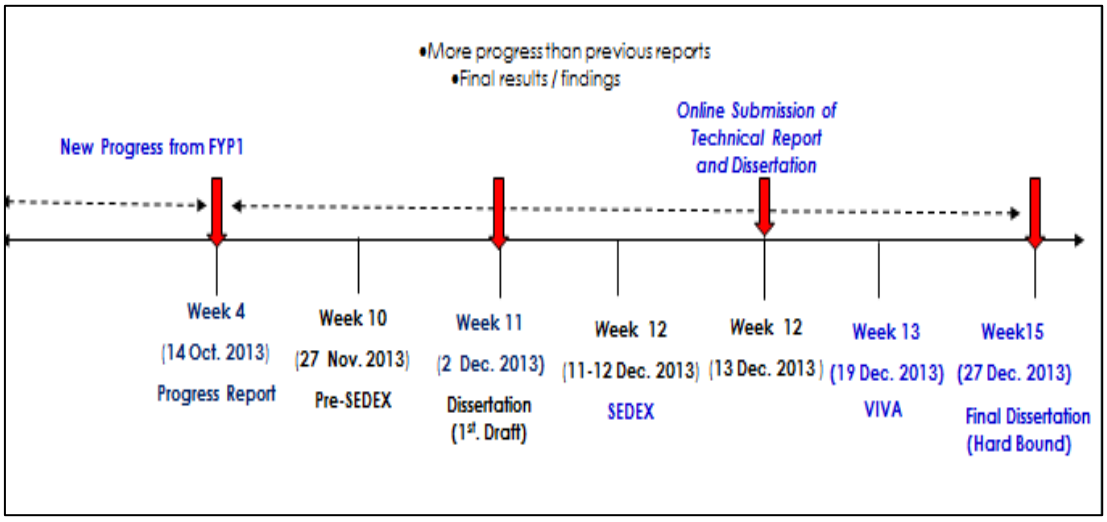

FIGURE 15. Key Milestone for FYP2

3.4 Gantt Chart

TABLE 4 shows the Gantt chart of the project for Final Year Project 1 while TABLE 5 below illustrates the Gantt Chart for Final Year Project 2.

TABLE 4. Gantt Chart of Final Year Project 1

No	Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	(FYP 1) Selection of Project Topic															
2	Preliminary Research															
3	Submission of Project Proposal															
4	Planning and Analysis Phase															
	Literature Review Research															
	Define System Scope															
	Determine System Outline															
5	Submission of Extended Proposal															
6	User Design															
	System Design															
	Interface Design															

7	**Submission of Interim Draft Report**															
8	**Submission of interim Report**															

Process

Suggested Milestone

TABLE 5. Gantt Chart of Final Year Project 2

No	**Activities**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	**Project Development**															
2	**Project Documentation**															
3	**Submission of Progress Report**															
4	**Construction Phase**															
	Design of AR Book															
	Development of the Application															
5	**Pilot Study**															
6	**Pre-SEDEX**															
7	**Submission of Draft Report**															
8	**Testing**															
9	**Submission of Dissertation**															
10	**Submission of Technical Paper**															
11	**Oral Presentation**															
12	**Submission of Project Dissertation**															

Process

Suggested Milestone

CHAPTER 4
RESULT AND DISCUSSION

4.1 Preliminary Study

After doing research on the literature review, it is found that the concept of his project will meet the project objectives. Some of the findings are as below:-

- Early education is very crucial to help improve the academic paths of children in poverty (Olivia,2010).
- Active engagement with things and ideas promotes mental activity that helps students retain new learning and integrate it with what they already know. (UNICEF,2009).
- Contextual teaching and learning enable students to relate subject matter content to real world situation and motivates student to make connection between what they have learnt and application of it in their lives (Berns & Erickson, 2001).
- Multilevel educational and ICT characteristics are integrated in the contextual learning theory to optimize the learning process (Mooji, 2004).
- Game-engine technology animates the character and creates an entertaining encounter, which users find more enjoyable than learning about art from traditional print sources (Billinghurst,2012).
- Mobile application encourages learning in a real-world context and help link school, afterschool, and home environments (Chiong & Shuler, 2010).
- Previous research of exploring the ease with which pre-schoolers adapted to and were engaged by tablets, find that children were quick learners and were highly interested when dealing with mobile devices (Chiong & Shuler, 2010).

- Spatial abilities can be improved by virtual reality (VR) technology (Kaufmann & Schmalstieg, 2003).

4.1.1 Websites

TABLE 6. Comparison of Current Websites with Proposed Project

Features	CBeebies Games	Purpy's Shapes	Tulli's World	Proposed Project
Shapes offered	Circle, square, triangle, rectangle, oval	Circle, square, triangle, rectangle, oval	Rectangle, triangle, circle, stars and hearts	Circle, rectangle, triangle, square and oval
Target User	Kindergarten Student	Kindergarten Student	Kindergarten Student	Kindergarten Student
Technology used	Websites	Websites	Websites	Augmented Reality Mobile Apps
Method used to teach basic geometry	Step by step learning	Drag and Matching game	Contextual Environment	Contextual Environment

Table above shows how proposed project is different from the current learning shapes websites. The most unique element of proposed project from other websites is it does not require any internet connection.

4.1.2 Mobile Application

TABLE 7. Comparison of Current Mobile Applications with Proposed Project

Features	Kids Shapes	Baby Learns Shapes (kids)	Shapes Toddler Preschool	Proposed Project
Shapes offered	Circle, rectangle, triangle, square, rhombus and oval	Circle, triangle, square, rectangle	2D and 3D shapes	Circle, rectangle, triangle, square and oval
Target User	Kindergarten Student	Kindergarten Student	Primary School Student	Kindergarten Student
Technology used	Mobile Apps	Mobile Apps	Mobile Apps	Augmented Reality Mobile Apps
Method used to teach basic geometry	Contextual Environment	Contextual Environment and Game	Flash Card, puzzles and games	Contextual Environment

Table above shows the comparison of the proposed project with the existing mobile applications.

4.1.3 Augmented Reality (AR) Application

TABLE 8. Comparison of Current AR Application and Proposed Project

Features	Construct3D	GeoAR	Proposed Project
Shapes offered	3D Geometric Construction	Circle, rectangle, square, pentagon, triangle and trapezoid	Circle, rectangle, triangle, square and oval
Target User	Higher level (Secondary and	Primary School	Kindergarten Student

	University)		
Technology used	‘‘Studierstube’’	Augmented Reality	Augmented Reality Mobile Apps
Method used to teach basic geometry	Working directly with 3D object	Calculation for the main geometriy	Contextual Environment

TABLE 8 illustrates how the proposed project becomes different from the current similar applications. First, in focusing the learning of the basic geometry for early education, the propose project can be label as among the first AR technology application that come out with this. The proposed project teaches the basic geometry for kindergarten student. Besides, it also focusing in learning based on contextual environment.

On the other hand, in Augmented Reality area, currently there are two applications offered to teach in geometry field. However, none of it focusing for early education. First, Construct3D is an AR application that offers the geometry learning for higher level of education such as secondary schools and university level. It used ‘‘Studierstube’’ technology which is a mobile collaborative augmented reality system.

Besides, GeoAR also teaches the basic geometry for children. However it focuses on the calculations of the basic shape which involves the perimeter, area and etc. This concept is suitable for primary school student where they already know the basic calculation. In comparison, the proposed project focusing to introduce the basic geometry to the children. To make children more familiar with this concept, the contextual environment method is used so that children can apply what they learnt in their lives.

4.2 The AR Shapes Prototype

AR Shapes was developed to improve the existing shapes learning by integrating mobile application technology with AR technology. In the development of AR Shapes, Vuforia is used as this platform offers a wide set of features and capabilities. With support for Android and Unity 3D, Vuforia platform allows the implementation of Augmented Reality in the mobile application. On the other hand, Unity extension is used to build AR Shapes to recognize and track the markers or the image.

Basically, to view the virtual models, first, the user needs the mobile camera to capture the image of the real world image or known as pattern markers. Then, after pointing the camera to the marker, the virtual model will be viewed overlay over the pattern marker in the mobile screen. FIGURE 16 illustrates how the AR Shapes application works. Sounds are also produced when running the application to give the instructions and introduce the shapes to the users.

FIGURE 16. AR Shapes book component

AR Shapes can be divided into two main sections which are the introduction part and the exercise part. The first part is the introduction part where the children are introduced with the basic geometry which are square, circle, triangle, rectangle and oval. This part supports the first requirement of learning shapes claimed by Barge (2013). The second part is the exercise or the hidden game where the children's understanding is tested. The objective of this part is to ensure that children are able to recognize the shape in the given environment. This part is developed to meet the

second requirement of shapes learning which is revealed by Barge (2013) where children need to match objects according to their shapes.

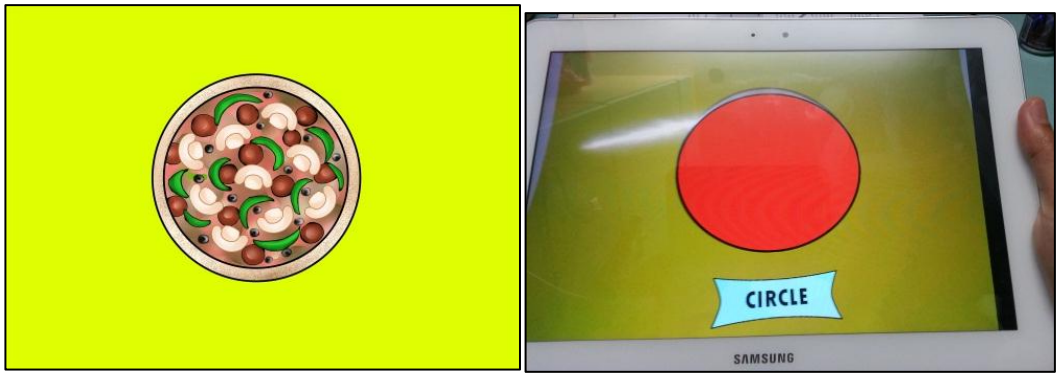

FIGURE 17. AR Shapes: Introduction

Figure 17 illustrates how the introduction part looks like for the circle shape. The shape will be viewed together with the word and sounds when the camera of AR Shape is pointing to the image or pattern marker. The same concept is applied when introducing the other shapes (square, triangle, oval, and rectangle). The flow of the first part is coded as below.

```
IEnumerator startshow() {
        audio.PlayOneShot (audioClipQ);
        yield return new WaitForSeconds (3);
        shape.renderer.enabled = true;
        shape.animation.Play (animationClip);
        yield return new WaitForSeconds (4);
        caption.renderer.enabled = true;
        audio.PlayOneShot (audioClipA);
    }
```

FIGURE 18. AR Shapes: Hidden shapes

The second part of this application is the hidden game. Figure 18 illustrates how this part will look alike. In the AR book, there will be some scenery that is related to children daily activity such as, at the room, zoo, playground and etc. The AR part is children need to identify the hidden shapes in the scenery using the application. First, the sounds will be played to give instruction which shapes that the children need to find. Then, the children need to touch the object in the image that matches with the shape given. When he or she finds the correct answer by touch on the object that have the shape given, the actual shape will appear and produce some sound. On the other hand, if the user touches at the wrong object which it shape does not belongs to the shape given, nothing will happen. This part is important to ensure that the children can identify basic geometry in their daily activities. The coding for this part is as below.

```
void Update () {
        if(Input.GetMouseButtonDown(0)) {
            ray = Camera.main.ScreenPointToRay(Input.mousePosition);
            if(Physics.Raycast(ray, out hit)) {
                if(hit.transform.name == "Trigger") {
                    Debug.Log("picture clicked!");
                    //count++;
                shape = hit.transform.FindChild("Plane").gameObject;
                    hit.transform.collider.enabled = false;

                    StartCoroutine (startshow ());
                }
            }
        }
    }
```

4.3 The Pilot Study

A pilot study was carried out to 5 children near Tronoh, Malaysia. Their age ranges from 3 years old to 7 years old. The objective of this study is to investigate users' perception towards the AR Shapes. The children were first briefed on how to use the applications. Then, they are allowed to explore the application freely and as long as they want. Since the application is not fully developed, they were tested only for square shape. Their actions and behavior is observed and noted. Figure 19 shows how they use the applications. After finished using the application, they were asked 4 simple questions which are "Do you enjoy the book?", "Are you comfortable to use the book?", "Do you want to play again?" and "Do you want to have the book?" After finish the survey, the children were asked to draw back the shape that they have learnt.

FIGURE 19. Children explore AR shapes book

4.4 Result and Discussion of the Study

The time taken for the children to explore the AR Shapes ranges from 5 to 10 minutes. This result supports the Sullivan (2013) statement where children will spend more time when dealing with interactive gadget. For the survey part, the result shows a positive reaction from the children. For question 1, 60% of them strongly agree that they enjoy the AR Shapes book. 60% of them agree and one of them is moderate that they are comfortable using the book. This is due to the large size of the pattern

marker which children find some difficulties in handling the application. On the other hand, 80% of the children strongly agree to play the book again and majority of them want to have the book.

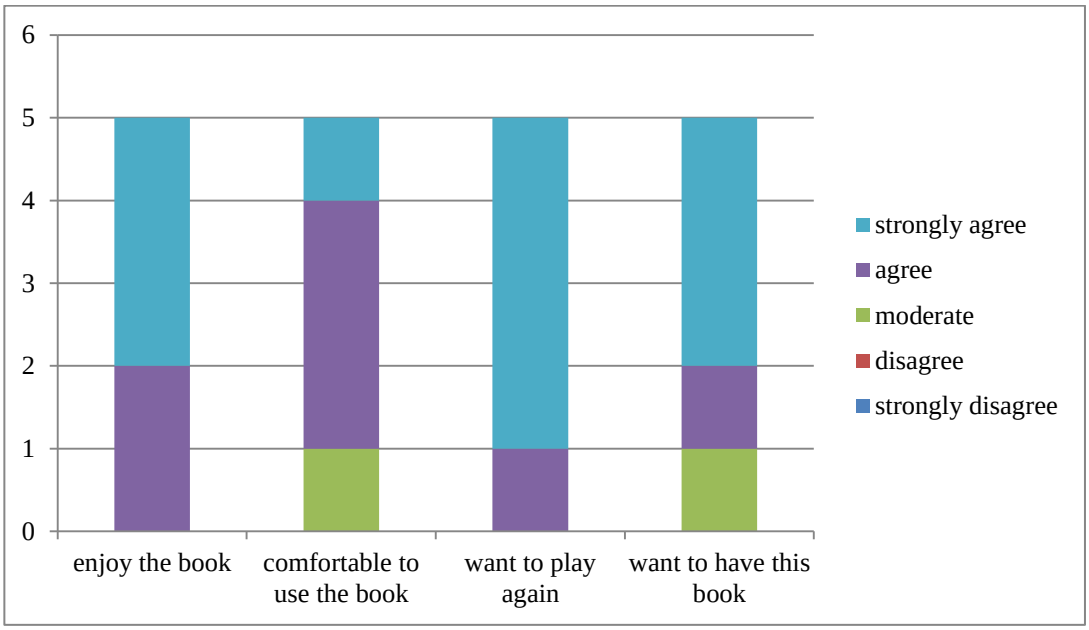

FIGURE 20. Results of questionnaire

Besides, to test children progress, they were asked to draw the shape after using the application. The result shows the positive progress of their understanding in basic geometry. The result may be varied because of the range of their age. Figure 21 illustrate the result of their drawing. All of them are able to recognize the characteristic that the shape square has.

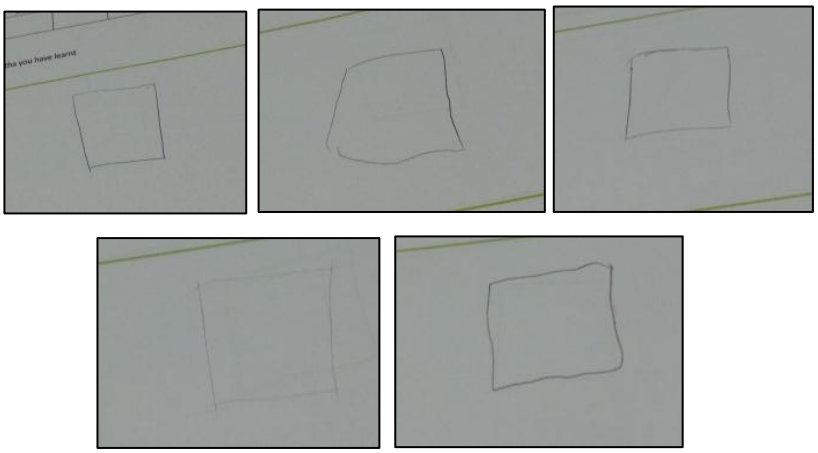

FIGURE 21. Result of testing

The results of the study are consistent with several researchers' findings which include Barge (2013), UNICEF (2013), Berns and Erickson (2001) and Wang (2012). The interactive element and the augmented part make the learning process more enjoyable. The results of testing the children understanding by ask them to draw the shape support the Barge (2013) requirement of learning shapes. The result might be different if the children were asked to draw all the shapes after using the full version of the application. This is because children might get confused as there are more than one shape that they have learnt. Most of the children are really enjoy using AR Shapes. They anticipate exploring the next development of this application.

Besides, parents also give many positive feedbacks about the application. Some of the parents also complaint that their children spend too much time playing games on gadget. They claim that the interactive element offered by AR Shape can attract their children to learn shapes.

CHAPTER 5
CONCLUSION

Early education is very important for children to survive in the future. Reading is a basic skill that each child should develop. Because of technology, traditional method of learning seems boring to them. Due to that, it is difficult to retain their attention during learning. By using the mobile apps technology, this project is aim to develop a learning shapes AR book application to make learning process more enjoyable and interesting. Although there are many applications in the mobile apps industry that offers some educational apps for children, the effectiveness is doubtful as they do not really focus on the kid's progress and how they can apply it in their lives. Contextual environment method is used to ensure the effectiveness of this application in order to teach children basic geometry

On the other hand, the augmented reality is a very futuristic field, and it is believe that in the future, there are going to be more software of program that implement the usage of augmented reality. Augmented reality geometry learning is a very good start in getting allowing augmented reality to pierce through the daily usage of software among the smart phone users. Because of its interesting future, it will encourage and motivate children to learn basic geometry.

For the future plan of this project, the framework for this application will be finalized. Then, the author will start to develop this project. After completed the development phase, testing and observation will be conducted to ensure it meets the user requirement. If there is a need for improvement, the author will change or improve the application to ensure it meets the objective.

Therefore, the project is hoped to achieve and contributes to the early education of the children especially in geometry field. With the help of technology, it is hope that children can improve spatial skills by using this application.

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APPENDIXES

ARShape Testing

Name:

Age:

1) Do you enjoy the book?

				
Best	Good	Just ok	No idea	Bad

2) Are you comfortable using the book?

				
Best	Good	Just ok	No idea	Bad

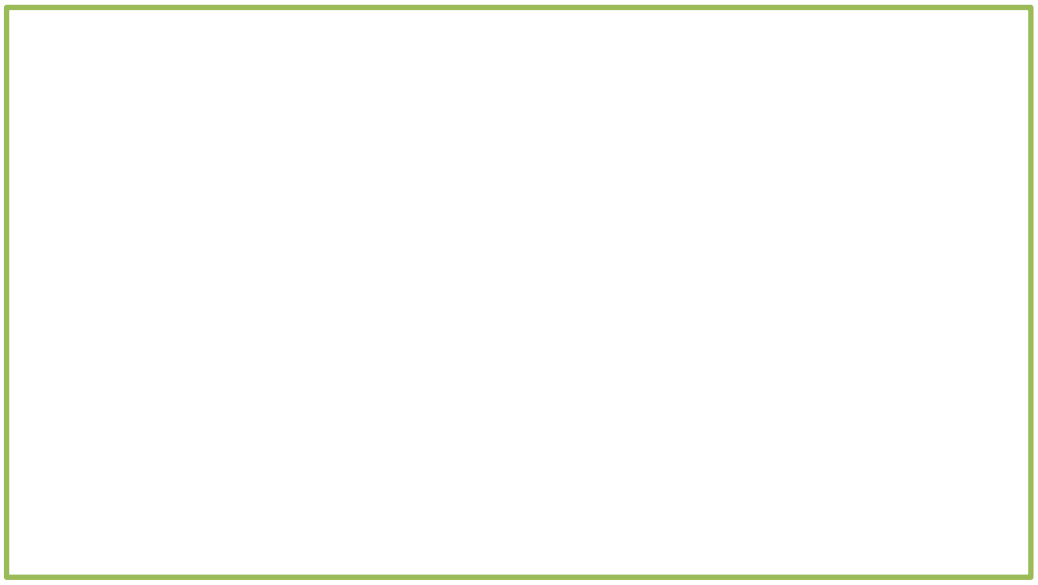
3) Do you want to play again?

				
Best	Good	Just ok	No idea	Bad

4) Do you want this book?

				
Best	Good	Just ok	No idea	Bad

5) Draw shapes that you have learnt

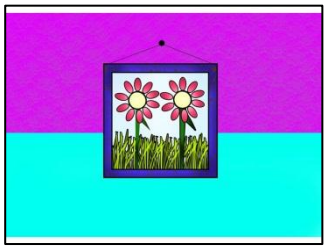


6) Time taken using the application :_____

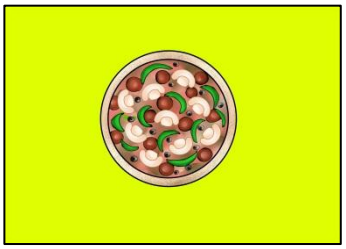
7) Comment

_____
_____
_____
_____
_____

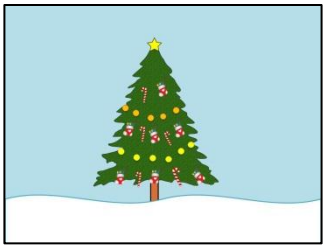
AR Shapes Book



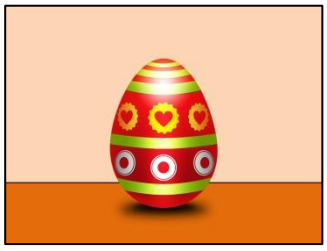
Introduction : Square



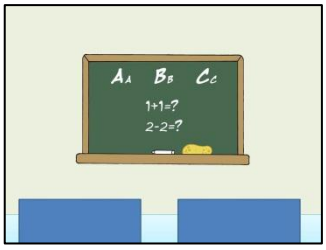
Introduction : Circle



Introduction : Triangle



Introduction : Oval



Introduction : Rectangle

Exercise : Hidden Shape