GAME APPLICATION FOR CHILDREN WITH DYSCALCULIA

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I hereby declare that I have read this project report and found that project report is sufficient in term of the scope and quality for the award of Bachelor of Computer Science (Media Interactive) With Honors

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ABSTRACT

This project presents MyMathLexic; a mobile game application that was developed to support children with Dyscalculia learn Mathematics. The aim of this game was to provide a math quizzes that are suitable for the Dyscalculia children. The game consists of two methods which are ‘Ice-cream stick’ and ‘Sempoa’. The methods use in this game was practically used worldwide in teaching the Dyscalculia person. MyMathLexic was developed over six months and then was evaluated by two teacher and four Dyscalculia children. The study resulted in two key findings: (1) MyMathLexic have a potential in developing and enhancing Dyscalculia children mathematics skills. (2) MyMathLexic simple game design have promote the children engagement through excitement of the game. The MyMathLexic was successfully engaged the learning among Dyscalculia children and was expected to be used by learning disabilities society.

ABSTRAK

Projek ini membentangkan MyMathLexic ; aplikasi permainan mudah alih yang dibangunkan untuk menyokong kanak-kanak dengan Dyscalculia belajar Matematik. Tujuan permainan ini adalah untuk menyediakan kuiz matematik yang sesuai untuk kanak-kanak Dyscalculia . Permainan ini terdiri daripada dua kaedah iaitu 'Ice -cream stick ' dan ' Sempoa '. Kaedah digunakan dalam permainan ini telah digunakan secara praktikal di seluruh dunia dalam mengajar kanak-kanak Dyscalculia. MyMathLexic telah dibangunkan selama enam bulan dan kemudian dinilai oleh dua guru dan empat kanak-kanak Dyscalculia . Hasil daripada kajian ini ialah : (1) MyMathLexic mempunyai potensi dalam membangunkan dan meningkatkan kemahiran matematik dalam kalangan kanak-kanak Dyscalculia. (2) Reka bentuk permainan MyMathLexic menggalakkan penglibatan kanak-kanak melalui keseronokan permainan. MyMathLexic telah berjaya melibatkan pembelajaran dalam kalangan kanak-kanak Dyscalculia dan dijangka digunakan oleh golongan yang mengalami masalah pembelajaran.

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CHAPTER I

INTRODUCTION

1.1 Introduction

The uses of technologies among children are increasing from day to day. Children are being exposed to this gadget indirectly by the influence of the surrounding people. Many apps have been develop for the children especially games application. Children always practice what they learn; therefore, their interest should take into account while developing an app for them.

Designing a game for children is to support them to learn about specific subjects, extends their ideas, reinforce development, understand an historical event or culture or help them enhance the ability as they play. Children with Dyscalculia are a person that has an inability to understand numbers and learn math facts. Therefore, this project would help to improve their math learning besides bringing enjoyment towards the children through games technology.

1.2 Problem Statement

Teachers and parents often mistakenly assume that their child is not successful because they are just not very smart. One of the reason is the children is potentially have learning disabilities. Research stated that 50% of children with dyscalculia will also have dyslexia, and 20% are having ADHD (attentional deficit and hyperactivity disorder). (http://www.aboutdyscalculia.org, 2007-2008) Furthermore, children were usually exposed to gadgets and technologies at early ages and tend to immerse with it without being infused more with knowledge.

1.3 Objectives

The objectives for this project are:

i) To investigate how game can support children with Dyscalculia.

ii) To develop a mobile games application for children with Dyscalculia.

iii) To evaluate the usability of the mobile games for children with Dyscalculia.

1.4 Scope

This mobile game will be played by children aged four to six years old and especially for those having Mathematics leaning disorder or being called Dyscalculia. The range of numbers included in the game is from one until nine only.

There will be two quizzes in this game which are addition and subtraction. Each activities include three levels. The method used in all levels are divided by two which are ‘ice-cream stick’ and ‘sempoa’.

The target user for this game is children having dyscalculia. Therefore, the suitable environment that will be choose to perform the product testing is Persatuan Dyslexia Malaysia which located in Pulau Pinang. The number of participant that will involve in the trial are 5 people including Subject Matter Expert (SME) who is the teacher at the society. The teacher are included to perform an interview session to obtain information such as strength and weakness of the product toward users.

1.5 Project Significance

This project aimed to help children with the inability to understand numbers and learns math facts who is known as Dyscalculia person. Individuals with this type of learning disabilities may also have weak comprehension of math symbols, will struggle with remembering and organizing numbers, terrible in telling time or have problem with counting (www.idaamerica.org , 2015).

Furthermore, playing math games will help in decreasing child's math apprehensive, gives kids practical way to practice math skills and games usually may all about strategies as well as basic number skills. (www.understood.org , 2014)

1.6 Conclusion

This project is expected to attract kids with Dyscalculia to play. In addition, kids especially who having dyscalculia will improve in their math skill after using this application. Finally, the game is expected to be both enjoyable and interactive.

In this chapter, introduction about the application are introduced. Problem statement was to identify what can be done to pursue the application's achievement aside of all issues mentioned. The objective of the project is aimed so that at the end of project development, the concept is still the same. The scope was to briefly describe the target user and the contents of the application. Project significant stated the importance of conducting this project. Meanwhile, the expected outputs are things that will produce at the end of project development and how the user's responses.

CHAPTER II

LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

In this chapter, it will focus on literature review. Literature review is a collection of research of existing system and it will then be compared so that better product will be developed. Methodology is the measurement that will be used as a guide to complete this project. It encloses all aspects, approaches, technique, as well as tools that will be used in the project development.

2.2 Domain

The domain of this project is mobile game application. Mobile game is an application that is played on mobile devices. Game was initially developed in simple graphics and being played in computer. Nowadays, game is provided with very appealing visual presentation and being played in various devices.

In this part, past research, references, case study and other finding that relate to the project are being discussed. After research, two aspects has risen to become the references in developing the product which are game is potential to develop and enhance children's skill and the other is design is important to promote children engagement through excitement of the game.

i) Game is potential to develop and enhance children's skills.

As children grow up, they are learning new things in school which may develop their knowledge skills. It appears that game can act as tool to enhance their knowlege skill. (Griffiths, 2002) stated that video games have positive potential in addition to their entertainment value and there has been considerable success when games are designed to address a specific problem or to teach a certain skill such as memorization skill. Video games also more effective for children who started out with relatively poor skills and have been used in comprehensive programmes which help to develop social skills in who are severly retarded or who have severe developmental problems like autism. Griffiths also stated one of the benefits while children plays video games is an increase skills in mathematics as children learn to interact with the score counters on video games.

Furthermore, a study on Virtual Reality Computer Game which called Virtual Real modality, could teach fire safety skills to children diagnosed with fetal alcohol syndrome (FAS) as it allows the illusion of presence in a computer-generated environment, combined with explicit real world generalization techniques reinforces safety skills by using visual and verbal cues, spatial skills, and physical action in the learning process (Padgett, 2006).

In addition, (McFarlane, 2002) in their article stated that there was a recognition across the age range that games support the development of a wide range of skills which are essential to the autonomous learner. Some of these related directly to the context of the game which develop skills such as problem solving which include identifying and understanding problem, planning solutions, monitoring progress and reviewing solutions to a problem of a games.

ii) Simple design is important to promote children engagement through excitement of the game.

At the age of children, they have high power of imagination and creativity and as they grow up, they also have high level of curiosity about something surrounds them. Thus, something special or interesting might attract them as they can learn further about it. While for the aspects of the game, design must be creative and interesting yet simple so that the game can promote children engagement while playing it.

Malan(2015) stated that no guidelines exist to assist designers in establishing a balance between the needs of children and the needs of adults which is the application that are educational should also be fun and interesting.Thus, children won't notice that they are learning or should be said " immerse throughout the application".

But, a study ever stated that in order to develop a set of guidelines for the design of effective and motivational instructional computer games, some observations were done and found that three elements that can make computer games so interesting and in some way can motivate the learner which are challenge, fantasy and curiosity (Malone, 1981).Challenge in games can be described by preparing gradually increasing difficulty levels while curiosity and fantasy are by emotional aspects.

Furthermore, some articles were found to have similar opinion as the point stated above.Griffiths (2002),stated that videogames will allow participants to experience novelty, curiosity and challenge which then may stimulate learning process. There are some examples in the article that can explain the concept of the three elements above. First is challenge;Duration or timer that have been prepared in a certain game making it as personal challenge towards the participant to finish certain task during a given period of time. Other example such as difficulty level of the games and competition between other players may also be considered as element of challenging in games. Next, example that can relate with element of curiosity and fantasy is the type of the game itself. Type of game such as puzzles, mazes, fantasy or adventure and simulations create a fiction atmosphere among participant thus immersed themselves throughout the game.

2.3 Existing System

2.3.1 Kids Math Count Numbers Game

The first example is a mobile game called Kids Math Count Numbers Game. The game is quite charming with an attractive design. The game is suitable for the preschooler, kindergarten and children of grade 1. Figure 2.1 shows the home page for the game where several activities for the game have been prepared for the player.

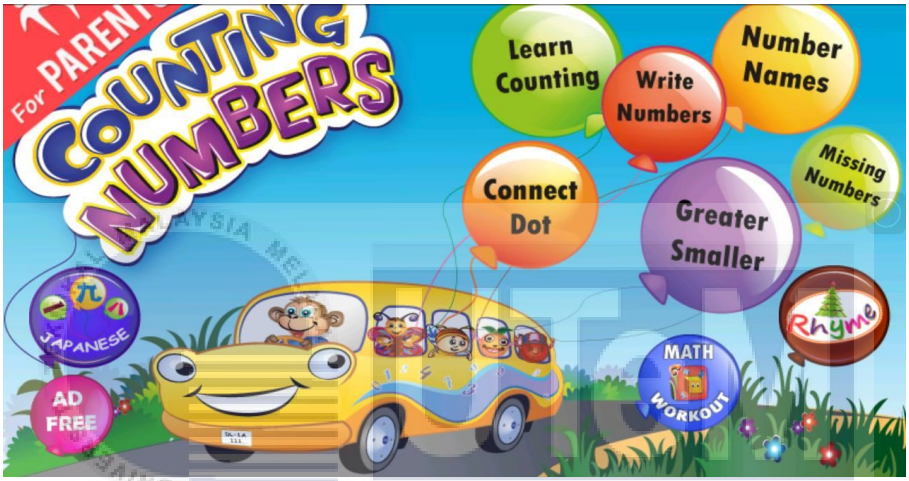

Figure 2.1: Kids Math Count Numbers Game homepage

While Figure 2.2 show one of the activities provided in the game.

Figure 2.2: Example of Kids Math Count Numbers Game Activities

2.3.2 Dyscalculia Games

Dyscalculia game is a game for a children having Dyscalculia. The design are not well attractive yet it provide two level which is Beginner (low level) and Beginner (high level) and there are several activities on each level. For Beginner (low level) the activities are; Color, Shape, Size and Number. Meanwhile for Beginner (high level) the activities provided are; Plus and Minus. Figure 2.3 shows the home page for the game.

Figure 2.3: Dyscalculia Game homepage

2.3.3 Kids Math Star

Kids Math Star is a unique educational math game for children. This application has been carefully designed with various adorable and fun characters for children to enjoy while learning. This application is suitable for all ages, including Preschool, Kindergarten and up.

This application designed using Unity3D which make the animation provided are very smooth. This application also been designed carefully with colorful graphic, soothing and relaxing background music. The activities provided are addition, subtraction, multiplication, and mix. It also provided cheerful music when kids answered the games correctly. Figure 2.4 shows the main page of the game.

Figure 2.4: Kids Math Star Homepage

2.4 Comparison of existing systems

A comparison was made between the three games stated above. The aspects being compared were techniques used type of visualization, advantages and also the disadvantages of all three games. Table 2.1 shows the comparison of all three games that have been identified.

Table 2.1: Comparison between existing games

	Kids Math Count Numbers Game	**Dyscalculia Games**	**Kids Math Star**
Techniques used	- Teach numbers counting from 1 to 10 -Teach writing and spelling numbers -Improve user understanding by testing user with arranging number sequences.	-Help user distinguish color, size and shape. -Teach user counting numbers ranged 1 until 10. -Quizzes consist of addition and subtraction. -All tasks are included with learning part which help user understand the concept first.	-Provided quizzes consist of addition, subtraction, multiplication and mix. -Encourage user creativity and enjoyment through adorable and fun characters.

Type of Visualization	2D animation	2D animation	3D animation
Advantages	-Interesting task and suitable for children. -Design are attractive	-Provide learning and activities part. -Suitable for children	-Animation provided is smooth. -Provide cheerful music when user answers the quizzes correctly. -Provided increasingly difficulties of levels.
Disadvantages	-User feels hard to distinguish between game menu and advertisement. -Not emphasize on gaining reward	-The instruction of the activities provided is not very clear. -The designs are plain and not attractive.	-The reward provided is not motivated and lame. -The design of the game are too complicated which may distract children focus.

2.5 Project Methodology

Methodology is a wide system of rules or principles on which way or steps taken to solve a variety of problems that exist within the scope to a particular discipline. Unlike the algorithm, a methodology is not a formula but it is a set of practices. There are many different ways that it can be used as an approach to meet the requirements.

The Rapid Prototyping methodology has been used as the project development methodology. Rapid prototyping is a methodology involves the early development of a prototype, either paper or computer-based. The prototype should be developed to stage which allows the client to get reasonable idea for how the system will look and how it will function.

The prototype then will be tested and evaluated to review either the system is adequate to the requirement. If not, the prototype will continue to be built until the system satisfies to the requirement which has been specified. Until then, the system will be delivered to the user. Figure 2.5 shows the flow of the rapid prototyping methodology.

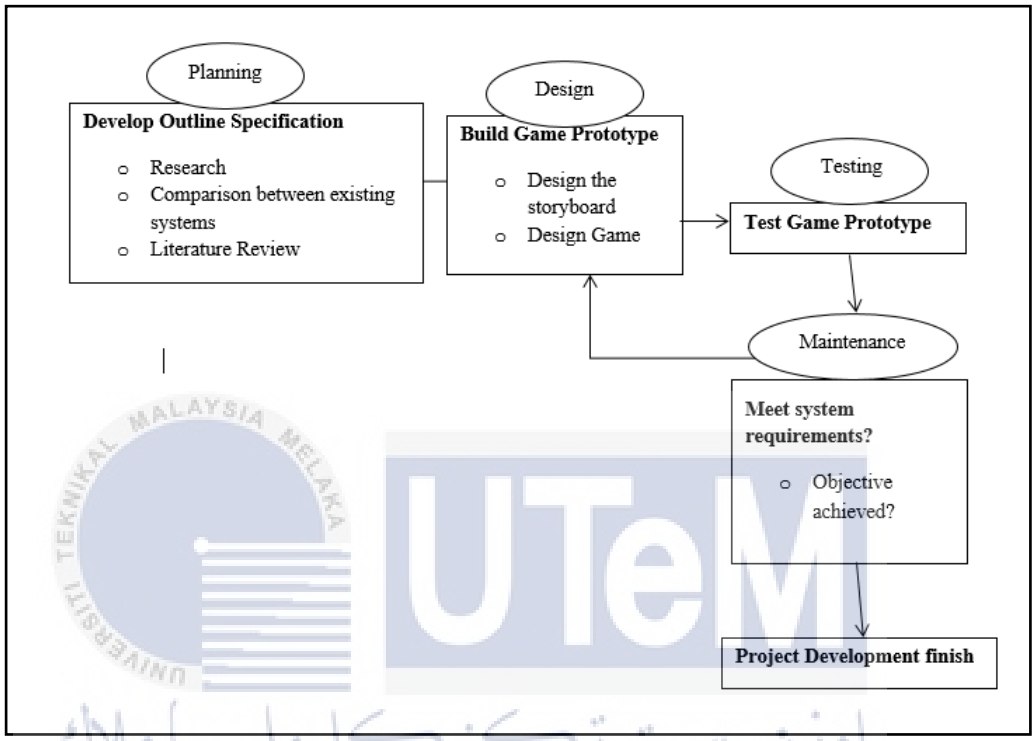

Figure 2.5: Rapid Prototyping Methodology

2.5.1 Develop Outline Specification

2.5.1.1 Research

Instructional issues will be explain in this part. This part also will identify the instructional goals, objectives, existing knowledge and the skills. Research of comparison between existing system and literature review will be conducted and the outcome will be used as the guideline to develop the project. Things that also will be explain include target user, scope of the project, current problems and the platform to overcome the problems and also the timeline for the project development accomplishment. This part is essential as it will ensure the developers are well known about the project goals and the overall concept of the product.

2.5.2 Build Game Prototype

2.5.2.1 Design

In any project development methodology, design phase is the most crucial part as the developers need to deals with objectives, content, assessment instruments, subject matter analysis, lesson planning and media selection. Thus, the design phase needs to be specified systematically.

Among things that need to be designed is the storyboard of the game. The storyboard of the game is sketched briefly so that overall concept will clearly shown. Next is design the user interface and when the design is finish. Then will proceed to making the prototype of the game. In the process of developing the game, developer will integrate with all related technologies to complete the project.

2.5.3 Test Game Prototype

In this phase, the game is actually not fully completed as it might have coding error or error in user interface but to check either it contains those errors, the game must be test first by performing debugging procedures. If there is no error, then the game will be checked either it meet the requirement that have been specified initially. Until then, the development will proceed to the next phase.

2.6 Project Requirement

In this part, all the software and hardware which being used in this project completion will be listed.

2.6.1 Software Requirement

List of software for this project are:

- Windows 7

- Adobe Animate CC 2015
- Adobe Illustrator CS6
- Adobe AIR
- Microsoft Word 2010
- Microsoft Power Point 2010
- Audacity

2.6.2 Hardware Requirement

List of hardware for this project are:

- **Laptop ASUS A43S**

  -Processor: Intel Pentium 2.2 GHz

  -Memory: 4.00 GB

  -Platform/OS: Windows 7

  -Disk: 500 GB
- **Smartphone Lenovo A7000**

2.7 Conclusion

In summary, the aim of this project is to develop a learning-based mobile game for kids. The methodology used for this project is Rapid Prototyping. The software used was Windows 7 OS, Adobe Animate CC 2015, Adobe Illustrator CS6, Adobe AIR, Microsoft Word 2010, Microsoft Power Point 2010 and Audacity. Finally, the hardware used were ASUS A43S laptop and Lenovo A7000 smartphone.

CHAPTER III

ANALYSIS

3.1 Introduction

In this chapter, it provides general idea of an overall process associated in the analysis phase. The analysis is made based on observation of the target user. Then, the system inputs, processes, products and interfaces are being considered in terms to determine the system in more detail.

To develop the project, the requirements for software, hardware and user need to be distinguish first. The software requirements for this project are Windows 7, Adobe Animate CC 2015, Adobe Illustrator CS6, Adobe Air, Microsoft Word 2010, Microsoft Power Point 2010 and Audacity.

The priority of this phase is to conclude which function should perform and how that functions operate. Information from the internet is being extract as resource. When the analysis is complete, the problem statement will appear and it will use as the reference of the analysis. Reference analysis is carried out to recover the problem statement set out to produce a better product at the end of the development process.

3.2 Current Scenario Analysis

This part is to investigate the existing scenario in terms to study the possibility of a concept that can be develop in the product. There are several mobile games that share the same concept as the project's product but the techniques used to deliver the information is vary. For Kids Match Count Numbers, the technique used is more towards teaching and improve user understanding about numbers meanwhile for Dyscalculia Game, it include teaching of colors, sizes, shapes, numbers and also consist of several quizzes. For Kids Math Star, it only provided quizzes but the quizzes are lot more than the other two.

3.2.1 Kids Math Count Numbers

Kids Math Count Numbers is one of the games that used teaching concept. As for the highlights, this application provide several activities which is; Learn to count from one to ten, Writing and spells numbers, Identifying greater and smaller numbers, Find missing number and arrange them in ascending and descending order, Learning Number names, Connecting dots to form a picture with a sub-activity to solve the puzzles, and also some number song for children to easily memorize the number order. Figure 3.1 show the flowchart of the Kids Math Count Numbers gameplay.

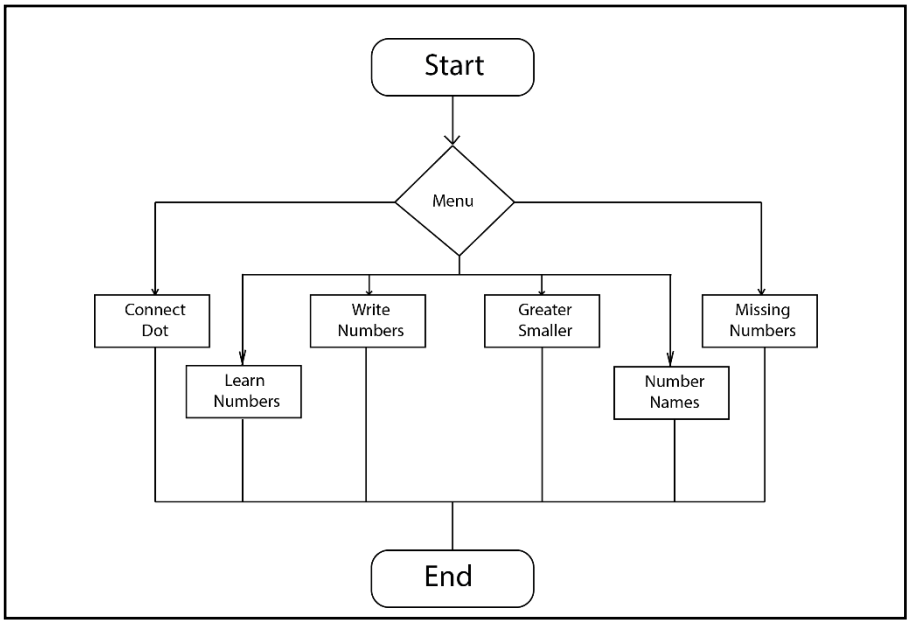

Figure 3.1: Flowchart of Kids Math Count Numbers

3.2.2 Dyscalculia Games

Next, Dyscalculia games which also use the same platform which is mobile game-based learning. This game prepared two level which is Beginner (low level) and Beginner (high level) .The activities provided are Identifying Colors, Shapes, Sizes, Numbers and two quizzes which is Addition and Subtraction respectively to each level. Figure 3.2 show the flowchart of the Dyscalculia Games gameplay.

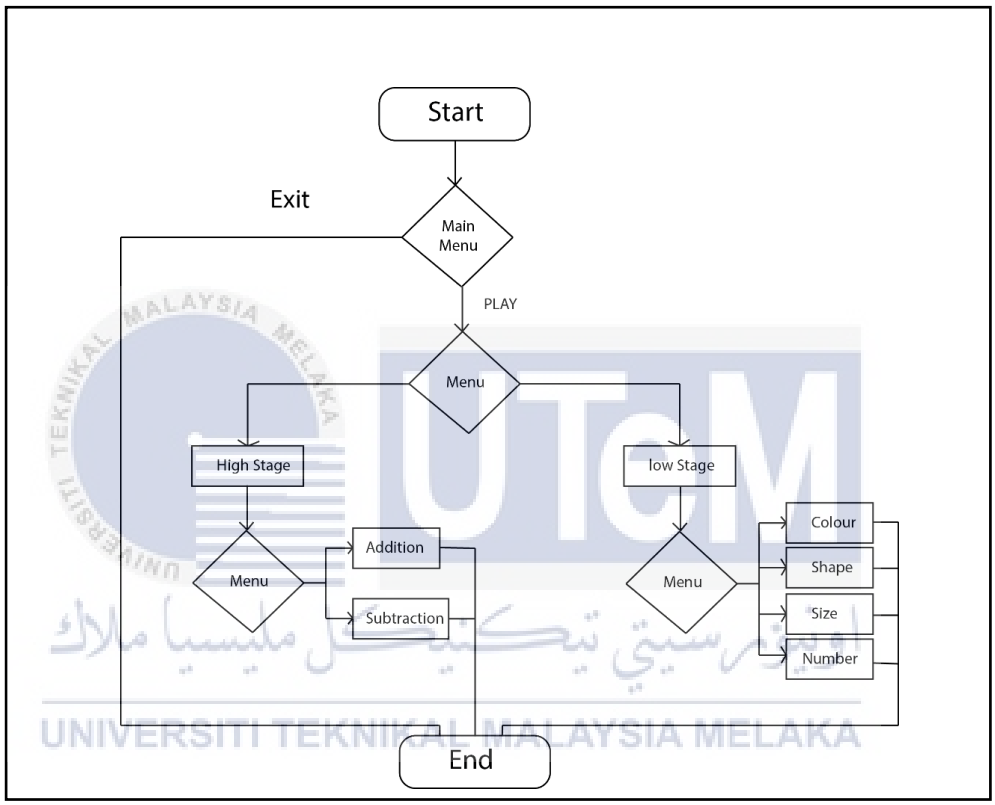

Figure 3.2: Flowchart of Dyscalculia Game

3.2.3 Kids Math Star

Kids Math Star is also an educational-based game that shares the same platform as the other two which is mobile. This game also is more likely to become as references in developing this project as the main idea for this project is quizzes-like educational-based mobile game.

The application which designed using Unity3D serve quit impressive animation and very smooth. In addition, it provides relaxing background music that gives mood towards user who plays the game. The activities provided are addition, subtraction, multiplication and mix. Furthermore, the rewards for answering correctly are enhanced with cheerful music. Figure 3.3 show the flowchart of the Kids Math Star gameplay.

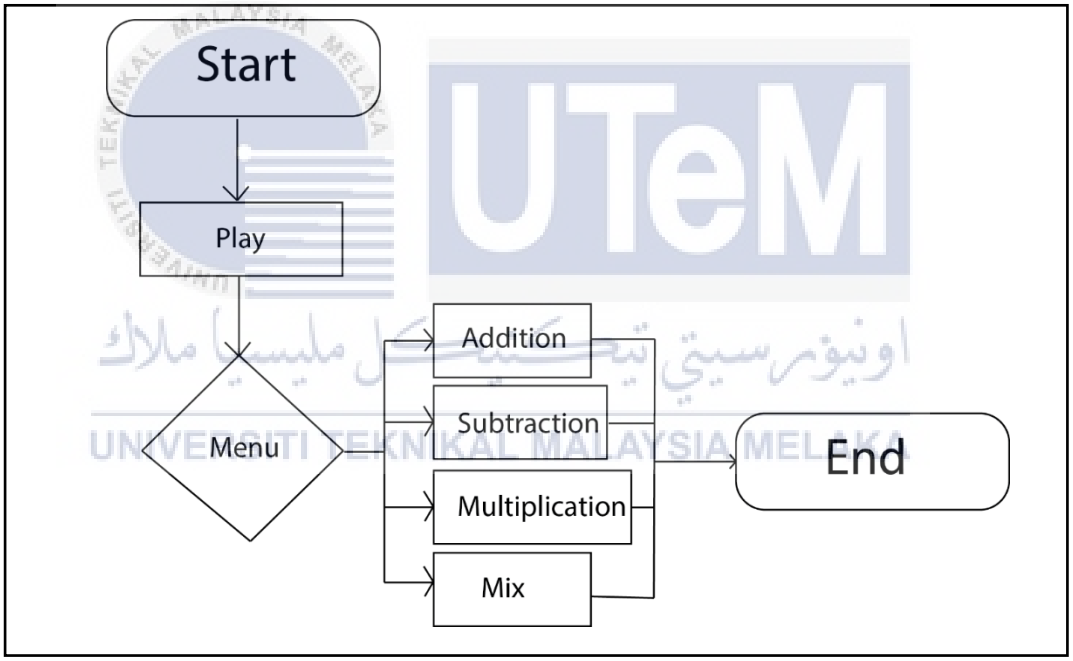

Figure 3.3: Flowchart of Kids Math Star

3.2.4 Proposed Idea

Therefore, for all the research stated above, the proposed idea for this project is to fuse some elements from other three games stated above and develop a new game which better in terms of concept and the conveying information techniques. This game will contain two main quizzes. One is addition and the other is subtraction.

3.3 Requirement Analysis

Requirement analysis is the process of identifying user's need and expectation toward the product that will be develop in this project. Meanwhile requirement is the expected behavioral of the product in term to achieve the objective stated initially in the project development. Furthermore, user's need also will be fulfill if the requirement analysis is done accurately.

3.3.1 Project Requirement

3.3.1.1 Requirement Gathering

In order to develop the game, the genre of the game need to be identify first. The genre of the game is important as it will attract the specified target user. The genre of the game is decided to be educational and entertainment. It is because the term of game is initially known to be enjoyable but this game is enhance with the element of learning.

In order to develop a better product, some of the existing system need to be analyze and the weakness need to be identify. The three game mentioned in the previous chapter are being used as a model to identify the deficiency of an educational game. As for the Kids Math Count Numbers Game, the weaknesses that can be detected are user feel hard to distinguish between game menu for games and advertisement. Moreover, the game is not focusing on gaining reward which is one of the important role for motivating children addiction toward the application.

Next, Dyscalculia Game are tested to have poor visibility and certain part of the activities prepared in the game are not very clear and the design are not attractive as it is too plain. Furthermore, the instruction provided also not very clear and difficult to understand.

Finally, Kids Math Star provides reward that is not very attractive and lame. Although the design is provided with colorful graphic, it is too complicated and may distract children focus while playing game. Furthermore, although the application provided four types of activities, only addition activities can be play and the others need to be purchase if user wants to play it.

3.3.1.2 Technical Analysis

Technical analysis is about defining the device of technologies that will be use in the project as long with the idea of creating a baseline of technical potencies and estimate the development cost and effort. The product will be play in smartphone that equipped with a touchscreen as the input, but it is also available to be use on computer because the flash file was initially develop on computer. Moreover, the important thing that user needs to apply before being able to play the game is to install Adobe AIR in the corresponding device. Otherwise, the game cannot run on the device. Finally, the project's development consumes lots of time and effort. Basically, the period to finish the product is approximately 16 weeks.

3.3.2 Software Requirement

In this part, it will describe all possible software used during completion of this product.

3.3.2.1 Windows 7

The main platform used in this project is Windows 7. The project's hardware needs this operating system in order to run the other software. It will receive inputs from the keyboard process the program in the system. Then, it will display the output on the hardware screen. Moreover, it will also act as a medium to save the project's data.

3.3.2.2 Adobe Animate CC 2015

Adobe Animate is an authoring tool to create an animation, applications and even game for this project. It can produces various animation, image, video and also can import certain format of data from other software to be include in the development of the project.

3.3.2.3 Adobe Illustrator CS6

This software is a powerful editing tool used for creating an image, logo and other corresponding format. This software is used in producing the button and design of the product. The icon for the product in the mobile device is also produced using this software.

3.3.2.4 Microsoft Word 2010

Microsoft word 2010 is a word processing that is made by the company Microsoft. It allows user to type a letter and save documents. For the project, it help making the report for the project efficiently and organize.

3.3.2.5 Microsoft Power Point 2010

Similar to Microsoft word, initially software develops by company Microsoft. It allows user to produce an attractive slide of presentation. It also contains various type of slide that can be edited based on user creativity.

3.3.2.6 Adobe AIR

Adobe AIR is a cross-operating-system runtime that lets developers combine HTML, JavaScript, Adobe Flash, ActionScript and Flex technologies to deploy rich internet applications (RIAs) on various types of devices, such as computers, tablet, smart phone, and television.

3.3.2.7 Audacity

Audacity is used as sound editing for this project. It can record, cut and edit the sound from the mic of the computer.

3.3.3 Hardware Requirement

Hardware requirement describe all hardware used during developing this project.

3.3.3.1 ASUS A43S

ASUS A43S is a personal laptop used in completing the entire project's task. It act as a medium for using all the software mentioned above.

3.3.3.2 Lenovo A7000

Lenovo A7000 is a smartphone that is used as a medium for running the product. In contains a resolution of 720 X 1280 pixels which is suitable for conveying the product.
It also has touchscreen input which is used for interaction with the application.

3.4 Project Schedule and Milestone

This section is about the project milestone of the activities (as in Table 3.1) that been done during the development of the project.

Table 3.1: Project Schedule

No	TASK	WEEK															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Briefing Session																
2	Discuss with supervisor / select the title of project / synopsis																
3	Preparation of proposal																
4	Submission of proposal																
5	Start design and development																
6	Discuss progress with supervisor																
7	Development and prepared documentation																
8	Demo progress with supervisor																
9	Submission report																
10	Presentation and demonstration																

3.5 Conclusion

For the conclusion, this chapter is describes specifically about the analysis phase. The weakness of the existing system are being identify so that better product will be produced in this project. Requirement analysis is about distinguishing the software and hardware that being used in the development of this project. Finally, the milestone are describing the activities that being done throughout the entire project development in order to finish the product in time.

CHAPTER IV

Design

4.1 Introduction

In this chapter, the design of the project is discuss for more detail. This chapter consists of three parts which are system architecture, preliminary design and user interface design.

4.2 System Architecture

This mobile game application contains two parts of quizzes which are plus and minus. Each part contains three levels of difficulties and the total range of numbers used in the application is one until nine. In each scene, user can navigate to home page and previous page. User also can activate timer mode for each scene to measure the user's reflect in answering the quizzes. In early scene of a new activities, instruction about how to answer the quizzes are being shown. User can skip the instructions if they want to proceed to play the game. The activities consist of two methods which are by using ice-cream stick and pins and the other one is by using sempoa. Figure 4.1 shows the flowchart of the system.

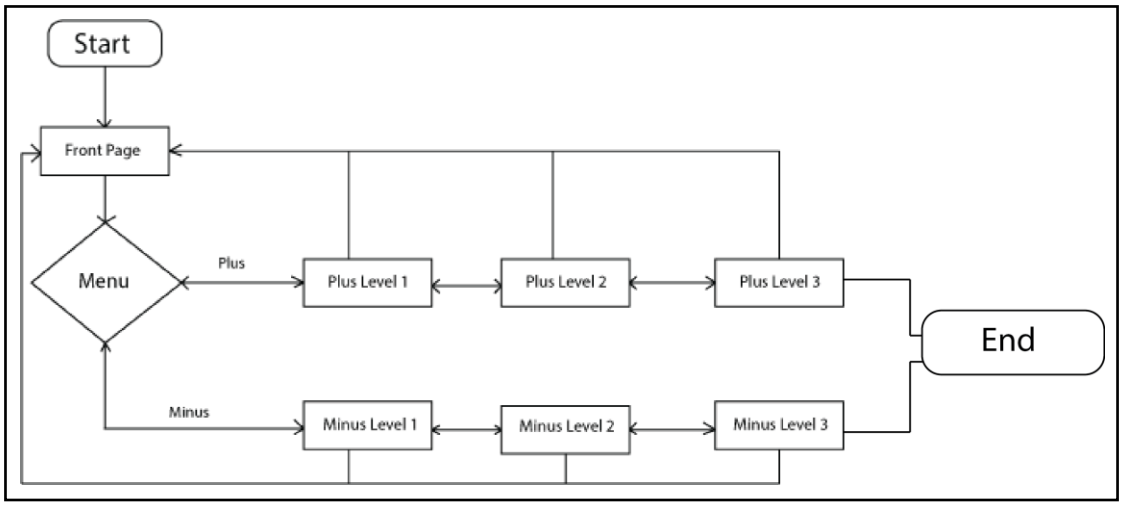

Figure 4.1 Flowchart of the system

4.3 Preliminary Design

Preliminary design is the first design which also known as conceptual design. During this phase, better design concept is being developed. This concept will be visualise in the form of box diagrams, design and information architecture and sketches.

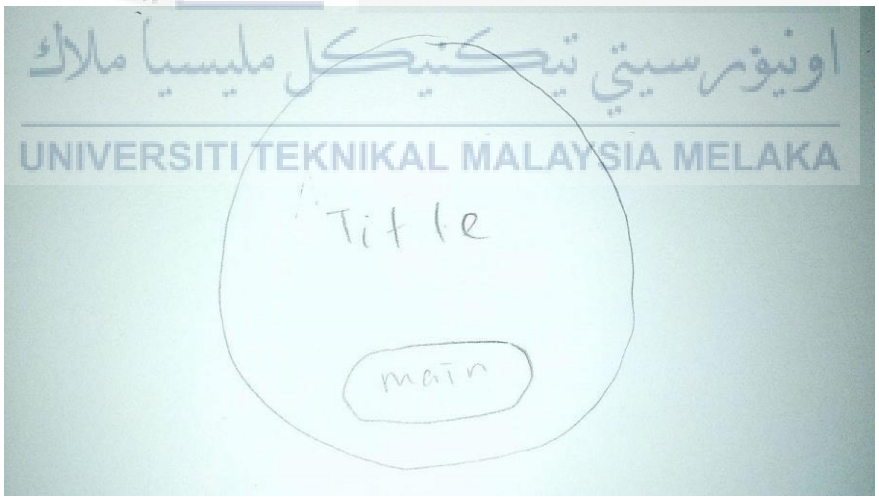

Figure 4.2: Homepage sketch

Figure 4.2 shows the homepage sketch for the product. The title and the play button were align center so that the design will look neat.

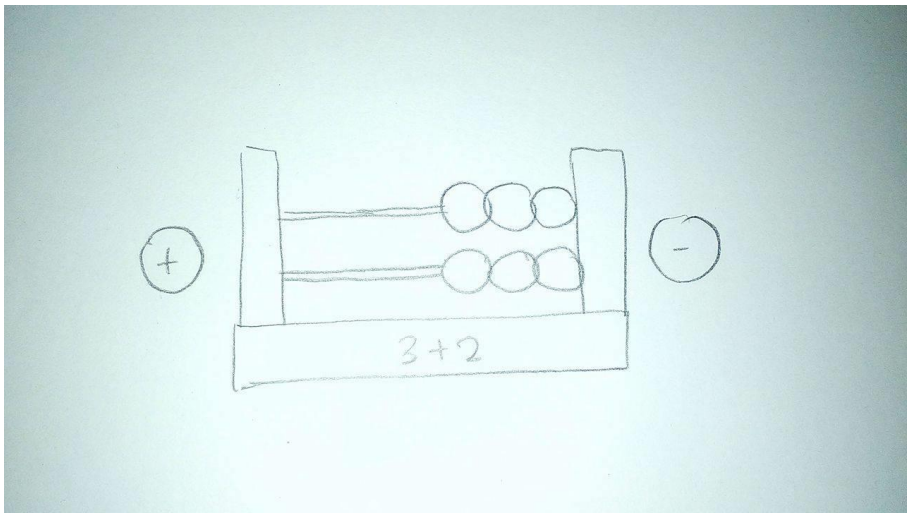

Figure 4.3: Sempoa method sketch

Figure 4.3 shows the method ‘Sempoa’ sketch. The sempoa is located in the middle while button ‘plus’ and ‘minus’ were located at left and right respectively. At first, there was two lines for the ball for the method but after discussing with the supervisor, the lines were reduce into one.

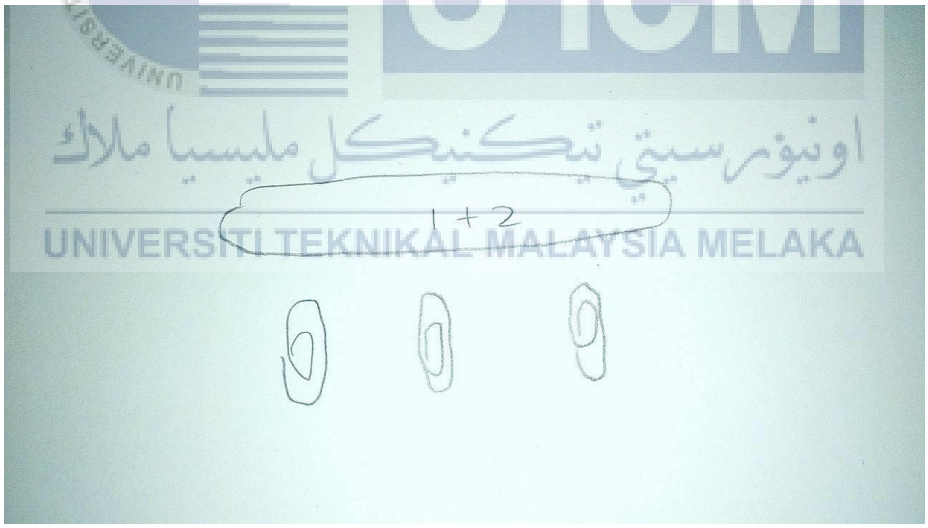

Figure 4.4: Ice cream stick method sketch

Figure 4.4 shows the ‘ice-cream stick’ method sketch. The stick located above while the pins are at below. The idea was to drag and drop the pins to the stick equivalent with the answers of the quizzes.

4.4 User Interface Design

4.4.1 Navigation Design

Figure 4.5 shows the flow chart of the navigation design of the project's product.

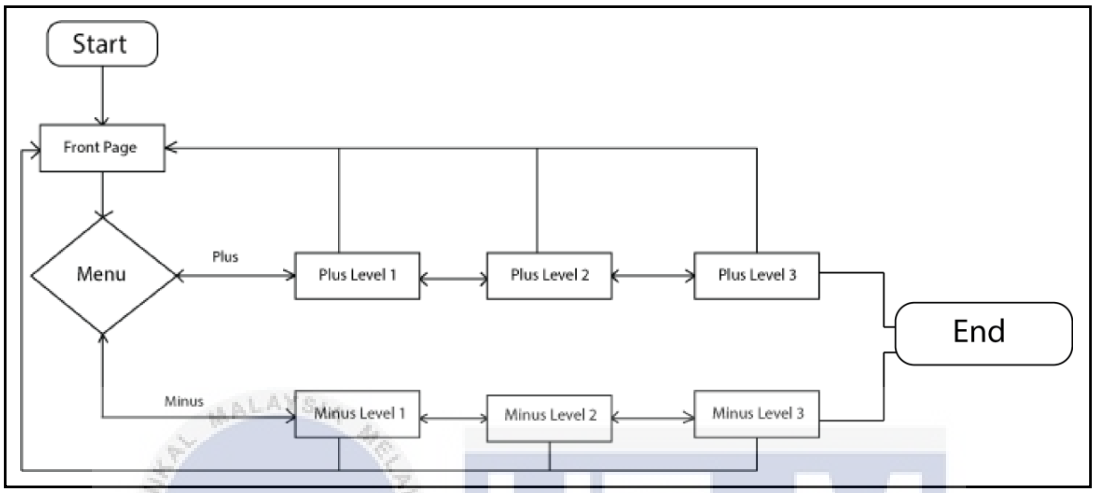

Figure 4.5: Navigation flow

4.4.2 Input Design

In this part, all inputs are in form of interactive button. These buttons consist of button to check the answers, navigate to previous scene and home scene and also button to activate timer mode. The design of all the buttons are flat design.

Figure 4.6: Design for Button Play, Plus and Minus

Figure 4.6 shows the design for button play, plus and minus. The idea was to create a 3-Dimensional button that will attract children's attention. To make that happen, a shadow was added below the buttons.

Figure 4.7: Design for Button back, home, and Timer Mode

Figure 4.7 shows the design for button back, home and timer mode. The design name was flat design. The design look plain but with an additional shadow for above symbol layer, the design will look like 3-Dimensional design.

4.4.3 Output Design

For this part, the output buttons for this product are only two which are the navigation button and check button. Navigation button will lead to the output which is the next scene whereas the check button will go to the next scene if the answer is correct.

4.4.4 Metaphors

Metaphor for this game is plain and not messy as the target user is children especially whose having Dyscalculia problem. Therefore, mostly the color used will be pastel color as research stated that the Dyscalculia person prefer pastel color while learning rather than usual color. There is also sound played if the user touch any button in the application and in reward scene so that they can easily attracted to the product. The application run in 2D and the design of the method are not too complex.

4.4.5 Media Creation and Integration

This mobile game aims to create learning yet fun application as well as the use of multimedia elements as a complement to this game. The combinations of the multimedia elements (as in Table 4.1) surely make the application more attractive to be play.

Table 4.1: List of Multimedia Element

Multimedia Element	Description
Text	The font used is Arial. Avoid using san serif fonts as it is difficult for children having learning problems. The color used for the font must be appropriate.
Image	The image of pins happened to be traced using Adobe Illustrator. There is also no plagiarism of making the stick and sempoa. The color used is suitable.
Audio	Button sound and other audio was edited using Audacity
Animation	Animation of the reward scene and the instructions are produced by using Adobe Animate CC 2015

4.5 Conclusion

In conclusion, this chapter described about system architecture, preliminary design and user interface design. The navigation flow of the product also shown visually in this chapter so that the overall navigation in the product will be understandable.

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CHAPTER V

IMPLEMENTATION

5.1 Introduction

This chapter focus on implementing the method, design or any ideas for doing something in this project. In other words, implementation is to run any ideas or plans described into practice or outcomes.

5.2 Media Creation

Media creation is media components created for this mobile game. Many type of media were used in this project such as image, text, audio video and animation to make the application more interesting. The use of this element also makes this mobile game a multimedia product.

5.2.1 Production of Text

Text is one of multimedia element that are important in this development of this product. The use of text makes the information conveyed smoothly. It also make user understood the rule that need to be follow while using the application. The target user of this application is person who are having learning disabilities. Therefore, the font that will be use should be taken into account so that user will clearly see the word. For example as shown in Figure 5.1, the edge of the font must be rounded to make children with dyscalculia read easily.

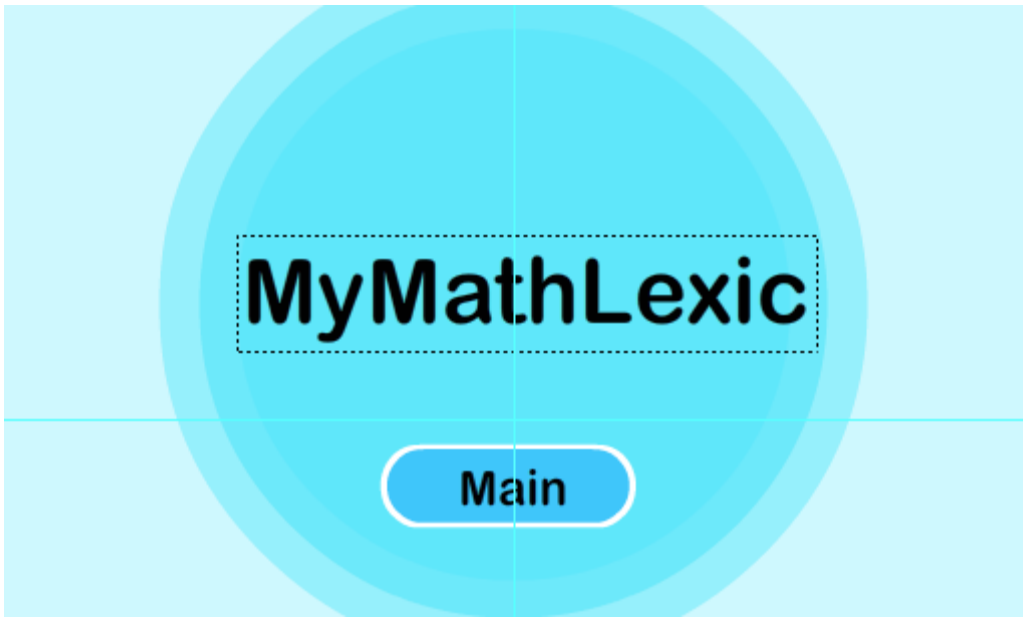

Figure 5.1: Font used in home screen

5.2.2 Production of Graphic

The images used in this application were produced using Adobe Illustrator. However, there were several design of the objects in the application that were obtained from internet. It was then traced using Adobe Illustrator to make the object become vector images (as in Figure 5.2).

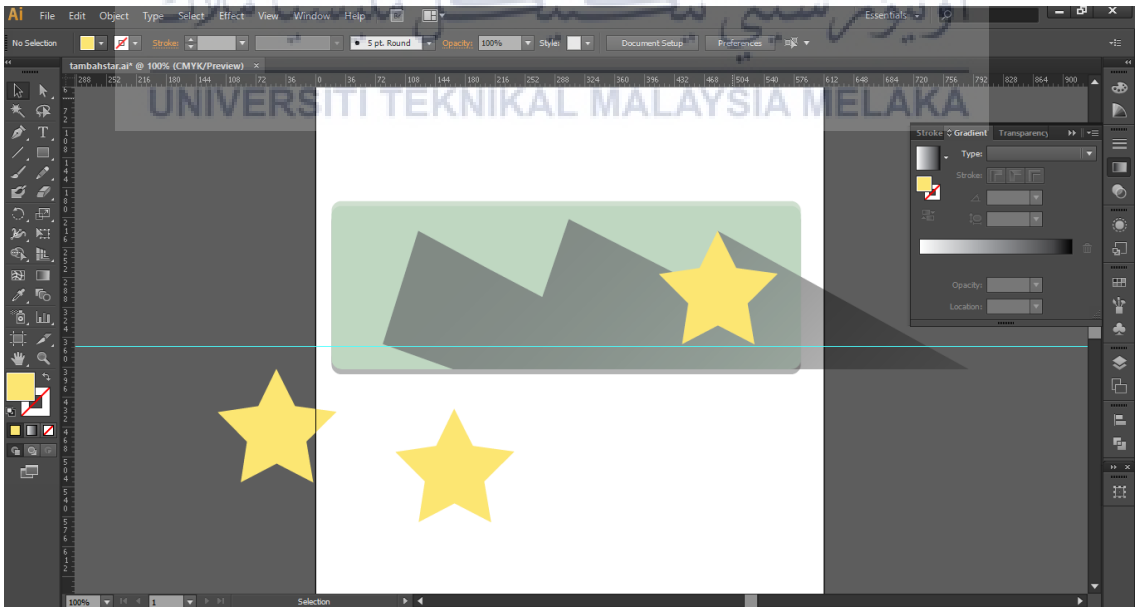

Figure 5.2: Production of graphic using Adobe Illustrator

5.2.3 Production of Audio

In this application, the use of audio is important as to attract user who are children to play the game. The audio such as correct sound and wrong sound were all downloaded from internet. Some audio were edited using Audacity to obtained suitable record of audio.

5.2.4 Production of Animation

The animation used in this application was produced using the main software itself which is Adobe Animate. There is only one animation in this application which can be seen in the home screen of the game (as shown in Figure 5.3).

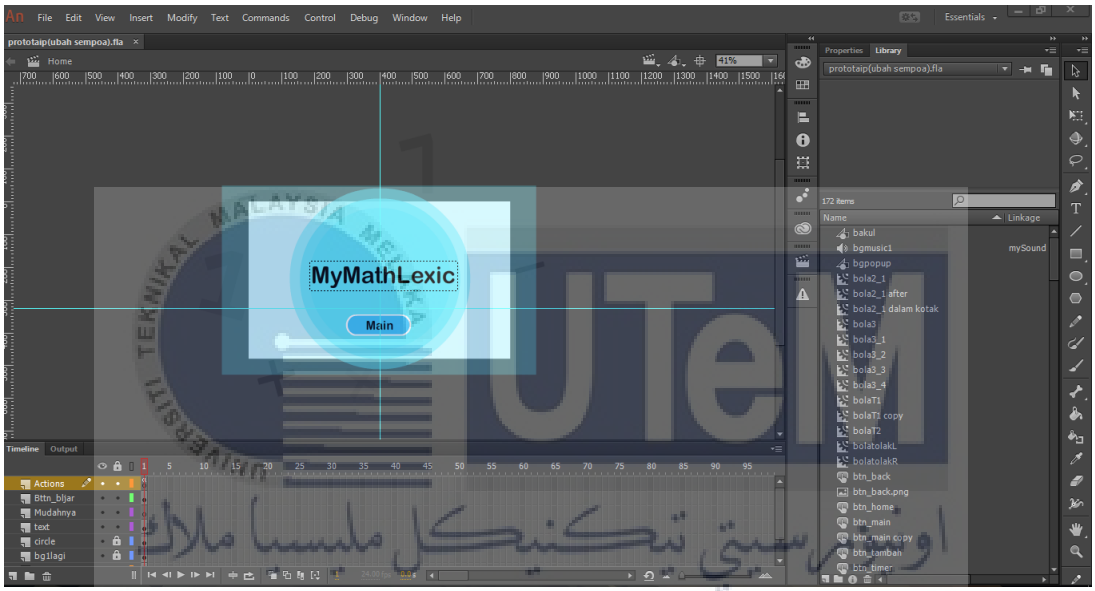

Figure 5.3: Production of animation using Adobe Animate

5.3 Media Integration

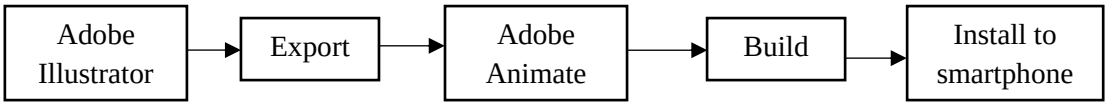

Figure 5.4: Process of Media Integration

Figure 5.4 shows the flowchart of process of media integration in the development of the project. Images from internet will be imported to Adobe Illustrator for editing purposes. The production of button and other images were all edited in Adobe Illustrator. Then, it will be exported to be vector image. This image is then imported into Adobe Animate to build into mobile game. Finally, the product which is Android Application Package (APK) is installed on the smartphone.

5.4 Product Configuration Management

This part will discuss about the project configuration environment setup and also the version control status.

5.4.1 Configuration Environment Setup

Configuration Environment Setup (as in Table 5.1) shows the things that need to be implemented to complete end product.

Table 5.1: Configuration Environment Setup

Software	Configuration
Windows 10	-Release 2015 -Operating System for the laptop used
Adobe Animate	-Version CC 2015 -Produce the mobile game
Adobe Illustrator	-Version CS6 -Produce and Editing Image
Audacity	-Version 2.0.4 -Editing Audio
Adobe AIR	-Version 20.0 -Enable flash file to run on smartphone
Microsoft Word	-Version 2013 -For report writing purpose

5.4.2 Version Control Procedure

There were few version of the application before the completion of the final product as shown in Table 5.2.

Table 5.2: Version Control Procedure

Version	Description
1.0	A complete Dyscalculia game without home screen and audio
1.1	Audio and home screen were added to the game
1.2	Few images and interaction button were edited
2.0	Animation was added into the home screen
2.1	Design of button were edited
3.0	Background Images of every quizzes were added
3.1	Background music was added to the home screen

5.5 Implementation Status

Table 5.3 shows the Image Design process which take 2 weeks to finishes. This process include design the object for quizzes and background color of the game.

Table 5.3: Image Design

Module	Image Design
Duration	2 weeks
Description	Design the object for the quizzes and choose the color for background

Table 5.4 shows the Audio Election process which take 1 day to finishes. This process include finding a suitable audio from the internet to be used as button sound and homepage background music.

Table 5.4: Audio Election

Module	Audio Election
Duration	1 day
Description	Find a suitable audio from the internet

Table 5.5 shows the Game Interaction process which take 4 weeks to finishes. This process include creating the gameplay of the game and build the coding for the quizzes.

Table 5.5: Game Interaction

Module	Game Interaction
Duration	4 weeks
Description	Create application gameplay and build the coding for the quizzes

5.6 Conclusion

For the conclusion, this chapter discuss the implementation process of the development of this project. Implementation process included are media creation, media integration, product configuration management and implementation status. The next chapter will discuss about the testing phase.

CHAPTER VI

TESTING

6.1 Introduction

This chapter will explain about the testing process of the project development. Testing process need to be done to clarify the objective by the expert. This process also determines that the product are suitable to be used by the target user or not. Furthermore, testing process also could identify the deficiency of the product that need to be improve in the future.

6.2 Test Plan

Test plan is a planning made by developer before product testing. The plan that have been made were test user, schedule, environment of the testing process, and strategy. This plan are consider important as to ensure better testing results.

6.2.1 Test User

For this project, the test user are children aged between 5 to 10 years old (Dyslexia person). Another user is the teacher in the association. The teacher are being test as to obtain information such as the product deficiency and improvement that can be made toward the product.

a) Children aged 5 to 10 years old

The test was for the main user of the product. The test include two cycle which is single user for the first cycle and peer-to-peer for the second cycle which make total of main user needs to complete the test was four person. Each cycle consume 5 to 7 minutes period.

b) Subject Matter Expert (SME)

This test was conduct for the teacher at the association. The test was done in order to clarify either the product are suitable for the children and matched their learning syllabus. In addition, SME's opinion should be taken into account to repair any deficiency and will be use to enhance the product in the future.

6.2.2 Test Environment

Test environment is important in order to enhance the effectiveness of the product presentation toward the user. Although the product does not produce many sound as it will distract user to focus on playing the game, the sound that need to be consider was audio and video recording from the testing process which will then use as data for the report.

The smartphone used for this trial is Lenovo A7000 and the testing took place at Persatuan Dyslexia Malaysia which is located in Penang, Malaysia. Below are some photos taken during the trial.

The two type of trial are Single User Testing (as in Figure 6.1) and Peer-to-peer Testing (as in Figure 6.2).

Figure 6.1: Single User Testing

Single user testing involve one user (Dyscalculia children) and one Subject Matter Expert (teacher) as a guide. The user are given 5-6 minutes to play the game. The ability of user to adapt and solve the game were recoded as data for the report.

Figure 6.2: Peer-to-peer testing

Peer-to-peer testing multiple user (Dyscalculia children) and one Subject Matter Expert (teacher) as a guide. The users are given 5-6 minutes to play the game. The interaction between users are being recorded as data for the report.

6.2.3 Test Schedule

Test schedule (as in Table 6.1) is a guidance of the testing process. The time and location are decided before the test accordingly both sides so that it will be more organized. An appointment has been made with the association teacher to test the product to the children at the time and date agreed.

Table 6.1: Testing Schedule

Element	Description	
Tester / user	Dyscalculia children aged 5 and 10 years old.	Subject Matter Expert (SME)
Number of tester / user	4 children : - 2 Dyslexia - 1 Dyscalculia - 1 Autism	1 person
Date	29st August 2016	29st August 2016
Duration	5 to 7 minutes (9.00 am – 9.20 am)	10 minutes (9.20 am – 9.30 am)
Venue	Persatuan Dyslexia Malaysia	

6.3 Test Strategy

Developer should conduct this test strategy first as to design the right steps in order to perform the product testing. In this case, single user testing (pre-test) and peer-to-peer testing (post-test) are the best strategy. Before both test being conduct, the gameplay of the product are explained to the teacher so that she can guide the children later.

Single user testing was conducted first in order to test the understanding and ability of the children to solve the problem given. The children solve the quizzes with a guide from the teacher. In addition, there are animation tutorial provided in the game so that children can understand better of the gameplay. The main issues that are being observe in this test is the ability of the user to adapt and understand the concept of the game visually using two method that were prepared in the game.

Next is the Peer-to-peer testing which categorized as post-test. Children from the pre-test session are being used as supportive subject in this test. The main objective of this test is to observe the interaction between the users while playing this game. Furthermore, this test also conducted to test either the game is suitable for single or multiple person.

In closing the test, an interview of several question to the teacher was conducted. This was to obtain the feedback from the test. In addition, teacher also being asked the deficiency of the product and the improvement that can be done towards the product in the future. The information then will be used as data in the report.

6.4 Test Implementation

This part explain more about the testing implementation that was conducted at the date and time agreed.

6.4.1 Layout of Single User Test

Single user test was conducted in two session thus require two student to undergo the first test. Figure 6.3 below show the draft of the position of the student and the developer during the product testing.

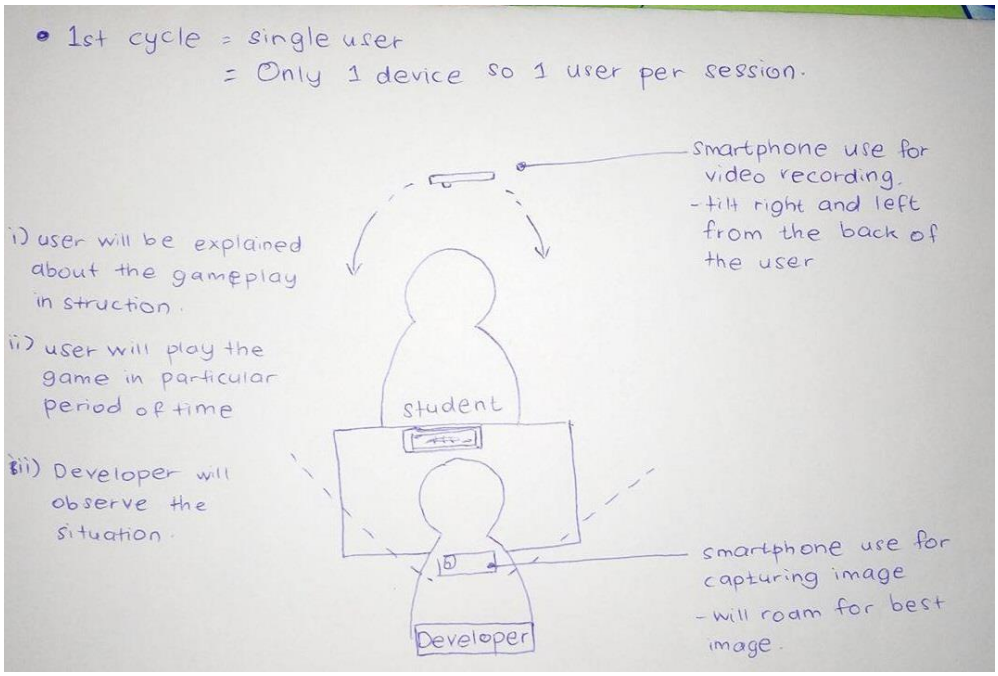

Figure 6.3: Position of Single User Testing

6.4.2 Layout of Peer-to-peer test

Peer-to-peer test require two or more student to undergo this second test. Figure 6.4 below show the draft of the position of the student and the developer during the product testing.

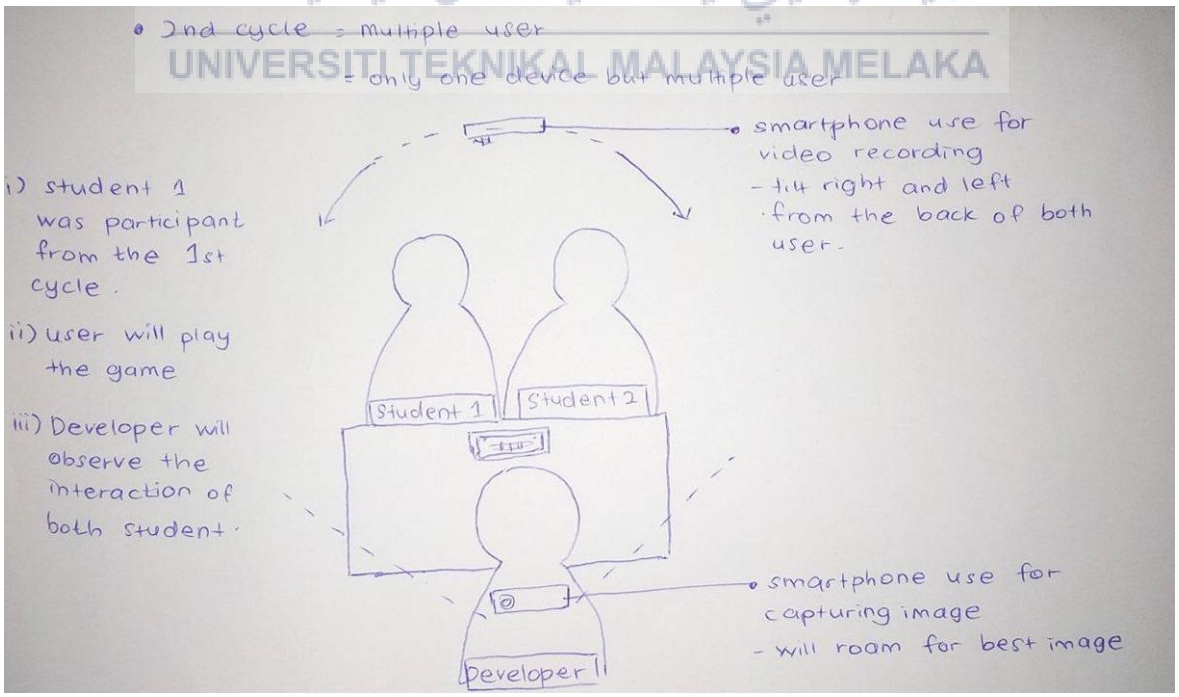

Figure 6.4: Position of Peer-to-Peer User Testing

6.4.3 Test Description

6.4.3.1 Test Case Identification

There are three objectives that serve as a guide in this product testing which are to investigate how game can support children with Dyscalculia, to develop mobile games application for those children and evaluate the usability of the developed mobile games.

6.4.3.2 Expected Result

The expected result of the project testing are as shown in the Table 6.2 below.

Table 6.2: Expected Result from each Session

Session	Expected Result
Single User Test	• User understand the gameplay of the product. • User can learn to solve the equation using the product. • User are comfortable with the method and layout of the product.
Peer-to-peer Test	• User are interacting with each other while solving the problem. • User understand the problem given and tend to cooperate with each other to solve the problem.

6.4.4 Test Data

The data that are collected from the observation of the test shows a good result where all user give a good feedback towards the application. The data that will be analyzed were from the observations, images, video recording and interview took during the testing process.

6.5 Test Result and Analysis

On 29th August 2016, a test was conducted in Persatuan Dyslexia Malaysia located in Penang, Malaysia. Four student from the association were selected to test the usability of a product named MyMathLexic that was especially made for children that have leaning disorder.

The main objective of the test were to test the ability of those children in adapting a learning method which have been simplified in the form of interactive media. Another objective is to observe the interaction between users while playing the application and conclude either the application are suitable for single user of multiple user at once. Hence, two session were conducted which are single user test and peer-to-peer test.

6.5.1 Single User Test

The student was given time to play and solve the quizzes with the guide from the teacher beside. From the observation, several analysis of the test were concluded based on literature review which was done earlier.

i) **Game is potential to develop and enhance children's skills.**

As shown in Figure 6.5, while playing the game students seem to think of how to solve the problem. This show that student are engaging with the application and tend to satisfy themselves by solving it. Such behavior will probably hone and sharpen their skills in identifying and understanding the problem thus practically apply these methods in the real world.

Study by McFarlane (2002) stated that there was a recognition across the age range that games support the development of a wide range of skills which are essential to autonomous learner.

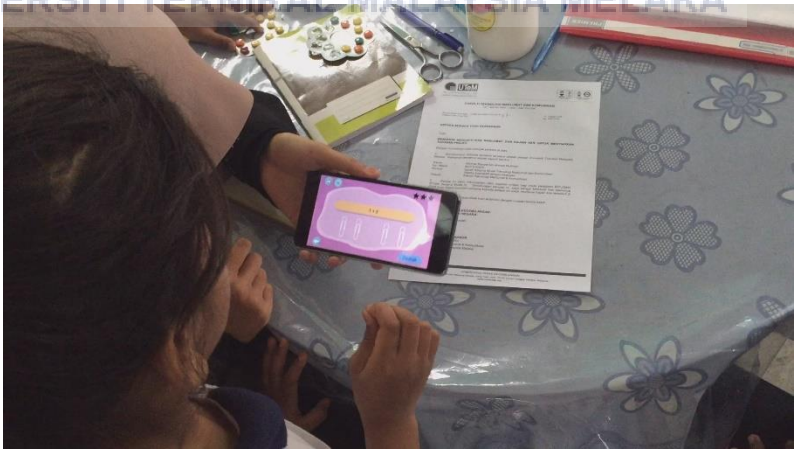

Figure 6.5: Student seems thinking of the game solution

ii) Simple design is important to promote children engagement through excitement of the game.

Game design are important as to attract children to play the game. The design of this game are not too complex yet attractive as the target user of the product are children who have learning disorder. During the test (as in Figure 6.6), although her friend are interrupting her, she seem devoted to the game. She are more likely to finish answering the quizzes than joking with her friend.

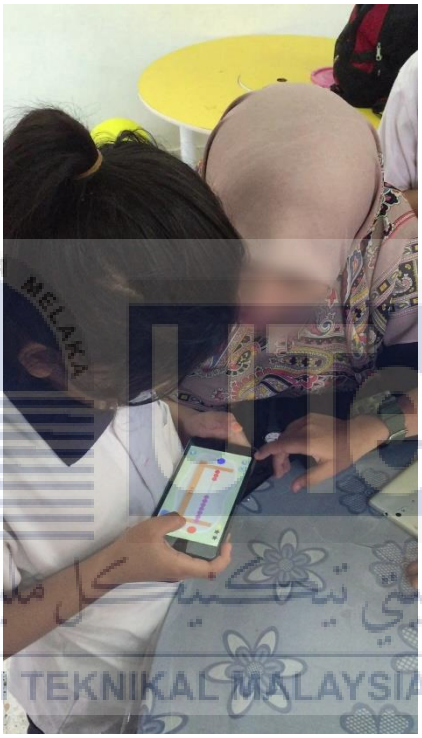

Figure 6.6: Student focusing on solving the quizzes

Her friend was reaching out to her to interrupt but getting ignored. This kind of immersion towards game have been stated by Griffiths (2002). It stated in the article that the type of game such as puzzles, mazes, fantasy or adventure and simulations create a fiction atmosphere among participant thus immersed themselves throughout the game.

iii) Level of difficulties and duration act as personal challenge towards participants in the game.

The game which include three phase of difficulties and timer to test user's thinking respond indeed give the student a little challenge in completing the game. As shown in Figure 6.7, student find it hard to solve the quizzes after completing each phase. The time takes to complete each quizzes also become longer but student keeps playing the game until finish.

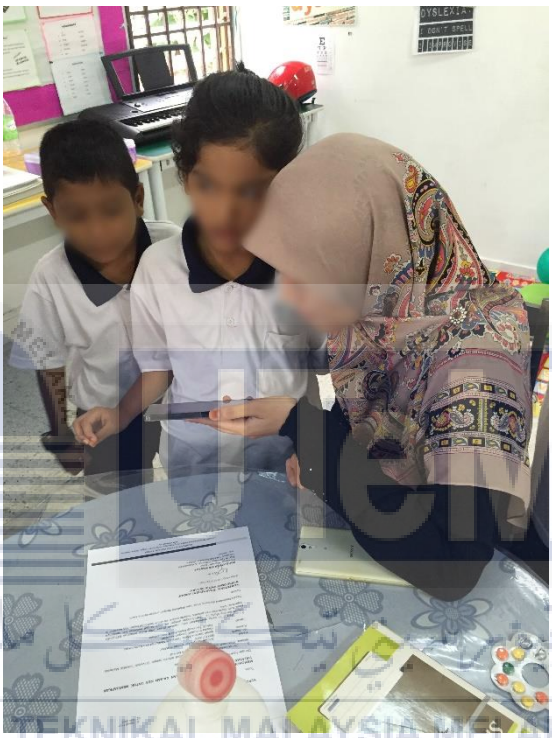

Figure 6.7: Student having trouble solving the quizzes.

The struggle itself also have been stated by Griffiths (2002) which stated that challenge that have been prepared in the game making it as personal challenge towards the participant to finish certain task during a given period of time.

6.5.2 Peer-to-peer Test

The student was given time to play and solve the quizzes with the guide from the teacher beside. This time one or more student can join to play the game. The objective was to observe the interaction between users in problem solving. In addition, this test also conducted to test either this product is suitable for single or multiple user at once. From the observation, several analysis of the test were concluded based on literature review which was done earlier.

i) Interactive Game Design lead to social engagement among peer-to-peer in classroom activity.

Peer-to-peer test was originally required two person only but when two student play the simultaneously, other are more likely to join too. The reason why developer did not prevent the others from joining the test because the interaction between users are the main thing that need to be observe. The larger the interaction, the more likely the evident of interaction among students to be seen.

Figure 6.8: Other students join the Peer-to-Peer User Testing

As the saying goes, “the more, the merrier”. As shown in Figure 6.8, other student want to take parts in playing and solving the quizzes. Indirectly, this will lead enhance their leaning process. As being stated by (Dickey, M. D., 2006), strategies of design that lead to engagement may include role playing, narrative arcs, challenges and interactive choices within the game as well as interaction with other players.

6.6 Conclusion

In conclusion, product testing is one of the most important phase in developing this game. It assists developer to identify which part of the game that are difficult for user to play. There are two main test that were conducted during project testing which are single user test and peer-to-peer test. Each of the test have different objective but both purpose on finding the weakness and the improvement that can be done towards the product in the future.

CHAPTER VII

CONCLUSION

7.1 Observation on Weakness and Strengths

This last chapter will conclude the overall project development and discussing the strength and weakness of the product. After the product testing, a number of strengths and weakness have been identified successfully. These information can be used to improve the product in the future.

7.1.1 Strengths

7.1.1.1 Multimedia elements

The combination of multimedia elements used makes the product more interesting. User seems immerse towards the game and the game design itself attract another user to play it simultaneously.

7.1.1.2 Portable

The game is portable to be play anywhere and anytime as long as the medium is a smartphone or tablet that are meet with the software requirement.

7.1.2 Weakness

7.1.2.1 Less operation

The game include only two operation which are addition and subtraction.

7.1.2.2 Lack of method

The method used in this game is ‘ice-cream stick’ and ‘sempoa’only.

7.1.2.3 Game Design

The ‘sempoa’ method did not satisfy the user as it does not meet with the concept of significant change which make user who is dyslexia person become confuse.

7.2 Propositions for Improvement

After a further look into the weakness and some analysis from the interview that have been done toward the Subject Matter Experts (SME) at the Persatuan Dyslexia Malaysia, there are some ideas which have been taken into account for the product improvement.

7.2.1 Need more operation

From the interview, the SME stated that most of these children already know how to perform such basic operation such as addition and subtraction but they hardly know about multiplication and divide. Therefore, these operation need to be add to the product so that the children can use the game as medium to learn all operations simultaneously.

7.2.2 Need more method

The SME stated that although the syllabus use real object for the method in their learning, the object may vary. It is because to prevent students from getting bored of using the same method every day. Therefore, several method that are suitable need to be added to the game so that teacher can use the game as a medium to teach the student mathematics every day.

7.2.3 Take into account of the concept of significant change in the method

Less concept of significant change that can be detected in the game is in ‘sempoa’ method. SME stated that student are getting confuse when the object only move in linear or still can be seen in the method while explaining the operations visually. Student who is having learning disorder need a method that can explain to them that the object are missing or increase in a platform so that they can understand the concept easily. Therefore, the design method that will be used must meet with the concept of significant change in the future.

7.2.4 Provide level menu

SME also stated that it is suitable to provide level menu at the initial of the game. This can give an option for user to choose which of the quizzes that he/she would like to solve and check out which level that has not been solve yet. This kind of improvement will act as an attraction and personal challenge towards users to solve all quizzes with full rewards.

7.3 Project Contribution

MyMathLexic is a mobile game for children having learning disorder especially dyslexia. The product contributes towards children in Persatuan Dyslexia Malaysia and also can be used towards children that need to improve their basic math skills. This game provide three levels and using two methods which is 'ice-cream stick' and 'sempoa'. The multimedia elements such as suitable color for background layout and audio button make the game more interesting.

7.4 Conclusion

In conclusion, this project is a success because all of the objectives have been met. MyMathLexic is a new approach of learning technique among children with dyslexia. This game can be used during learning session in the classroom.

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