A LEARNING-ORIENTED SYSTEM TO SUPPORT KIDS WITH AUTISM SPECTRUM DISORDER

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
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DECLARATION

I declare that this report entitled “A Learning-Oriented System to Support Kids with Autism Spectrum Disorder” is the result of my own work except for quotes as cited in the references.

Signature :

Author : Shazwani Binti Qasim

Date : 26 June 2020

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : _____

Supervisor Name : Dr Anis Suhaila Binti Mohd Zain

Date : 26 June 2020

DEDICATION

Specially dedicated to my family, supervisor, and friends, who help me finish my final year project and report.

ABSTRACT

The ability to respond to concurrent multiple cues is one of the common challenges faced by children with autism spectrum disorder (ASD). This project is about a learning oriented system to support kids with autism spectrum disorder (ASD). Children with ASD are more likely than others to respond to small, irrelevant cues, which significantly limit their ability to recognize and generalize more complex stimuli. This project will develop an applications that can attract interest of children with autism spectrum disorder (ASD) to learn. The 'Thunkable' software is used to develop this application. The goals of this project is to educate children within the age range of three years old until five years old to identifying numbers and colors. This project managed to help 80% kids with autism spectrum disorder (ASD).

ABSTRAK

Keupayaan untuk memberi tindak balas terhadap pelbagai arahan ialah salah satu cabaran yang dihadapi oleh kanak-kanak yang menghidap autisma. Projek ini adalah mengenai aplikasi yang boleh membantu kanak-kanak yang menghidap autisma. Kanak-kanak yang menghidap autisma lebih cenderung untuk bertindak balas terhadap arahan yang mudah atau arahan yang tidak berkaitan yang secara signifikannya membatasi kemampuan mereka untuk mengenali dan menggeneralisasikan arahan yang lebih kompleks. Projek ini akan membangunkan aplikasi yang dapat menarik minat kanak-kanak yang menhidap autisma untuk belajar. Perisian "Thunkable" akan digunakan untuk membangunkan aplikasi ini. Matlamat projek ini adalah untuk membantu kanak-kanak dalam lingkungan umur tiga hingga lima tahun untuk mengenal nombor dan warna. Projek ini berjaya membantu 80% kanak-kanak yang menghidap autisma.

ACKNOWLEDGEMENTS

I hereby would like to take this chance to thank all those who have been personally or indirectly with supporting and encouraging me in completing final year project which is mandatory for all Universiti Teknikal Malaysia Melaka students to complete their degrees.

First of all I would like to express gratitude to my supervisor Dr Anis Suhaila Binti Mohd Zain for her support, time, guidance and patient to help me through this project. Thank you for your expertise and your spiritual advice to make this project a success. Furthermore, her thinking behavior inspires me to always think more to gain more ideas.

Next, a special thanks goes to my family, who always gave words of motivation and passion, followed by prayer and hope for me to move ahead. Finally, my colleagues who continued to support me through the whole semester.

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LIST OF SYMBOLS AND ABBREVIATIONS

ASD : Autism Spectrum Disorder

UTeM
اونيۏرسيتي تيکنيکل مليسيا ملاک
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1

INTRODUCTION

This first chapter will focus on the introduction of a learning oriented system to support kids with autism spectrum disorder (ASD). More details on the learning-oriented system are discussed in this chapter.

1.1 Project Background

The ability to respond to several concurrent stimuli is one of the main barriers encountered by children with autism spectrum disorder (ASD). The rise in the number of children with Autism Spectrum Disorder (ASD) indicates that these children need comprehensive care to incorporate them into their communities, beginning with their family, teachers and peers. Developing communication technologies such as smartphones, tablets and PDA's may help this kind of cognitive impairment by

creating smart apps to resolve some of their behaviors and physiological problems, as well as providing key features for parents and teachers to store the data and information of their children or student about the level of progress rather than the traditional way of archiving. This project is about a learning oriented system to support kids with autism spectrum disorder (ASD). Children with ASD are more likely than others to respond to small, unrelated cues that significantly decrease their abilities to interpret and generalize more complicated stimuli. This project will develop an application that can attract interest of children with autism spectrum disorder (ASD) to learn. The 'Thunkable' software is used to develop this application because it has the amazing design capabilities and live testing that make it so much easier to design an application in real-time. The goals of this project is to educate children within the age range of 3 years old until 5 years old to identifying numbers and colors.

1.2 Problem Statement

The ability to respond to several concurrent stimuli is one of the main barriers encountered by children with Autism Spectrum Disorders (ASD). Children with this limitation have often learned to respond to a single cue that interferes with learning new behaviors and generalizes learned behaviors.

1.3 Project Objective

1.3.1 To develop an education application for children with autism spectrum disorder (ASD).

1.3.2 To analyze the education application performance of system from data collected.

1.4 Scope of Work

This project will used 'Thunkable' software to develop an application. The interface of an application will consists of colors, numbers and music. This project will be conducted upon five children with autism spectrum disorder (ASD) within the age range of 3 years old until 5 years old.

1.5 Project Outline

This project is divided into five main chapters. Chapter 1 briefly explains the background of the project which is include the objectives, problem statement, and scope of work in completing the project.

Chapter 2 will be covered on the literature review, where the knowledge gathered from the papers, video tutorials and dissertation is used to better understand the concept of the project.

Chapter 3 describes the complete methodology used in the implementation of the project. The Methodology section discussed the software and programming language used to create an application.

Chapter 4 sets out all the details and the findings of the review. All observations and results will be examined and analyzed in this chapter. The results of the system performance analysis using an effective diagram will be discussed in this section.

The conclusion and recommendations of the project will be presented in the last chapter of Chapter 5.

CHAPTER 2

LITERATURE REVIEW

This chapter consists of a critical review of the project carried out by the previous researcher. In addition, this part was made up of other sources to support the arguments of research and analysis.

2.1 Autism Spectrum Disorder (ASD)

In 2018, the report presented by Autism and Developmental Disabilities Monitoring (ADDM) Network in America reflected that autism spectrum disorder (ASD) was becoming a serious concern of many countries in the world [3]. Autism spectrum disorder (ASD) is a complex developmental disorder associated with the well-known signs of social and communication difficulties, self-stimulatory and

repetitive behaviors, and restricted or over-focused interests. Unfortunately, over time, studies have shown that autism has grown ten-fold in the past half-decade. About 1 in 68 children were said to be diagnosed with autism spectrum disorder (ASD) and the disorder is more commonly found in boys than girls; nearly 4.5 times more [4]. Children with autism spectrum disorder (ASD) often have difficulties processing sensory knowledge by under-or over-processing of various signals, which in effect influences their learning. Even though children with autism spectrum disorder (ASD) are gradually becoming part of mainstream classrooms, little is known about the difficulties that teachers face in including them as full participants in the classroom. The teachers reported on a variety of challenges, including: understanding and managing behavior such as socio-structural barriers and creating an inclusive environment [16]. Furthermore, teachers recommend that more funding, training and support are needed to improve the learning and integration of children with ASD.

2.2 Treatment and Learning

Almost all of the treatments assist in developing the necessary skills, such as communication, behavior and learning. Marchese [18] states that, autistic children are believed to benefit not only from the use of interactive tools, but also their parents and teachers will be able to monitor and provide educational services and try to meet their immediate needs. With the data obtained from all these tests over a period of time, gradual progress can be monitored to see whether or not the user has responded well to the application.

In the other side, autism children appear to react well to visual stimuli, such as pictures or videos, which make conceptual communication simpler.

2.3 User Experience

Based on ISO 9241-210, the international standard on ergonomics of human system interaction [13], describes user experience as ‘user’ perceptions and feedback coming from the use and/or expected use of a program, product or service. Particularly, user experience is the degree of "satisfaction" that the end user has with the program or service after using it, which is dependent on each of the experiences that the end user has [28].

On the other hand, as stated by Peter Morville, user experience is important and useful when a product, service or program is of useful, usable, desirable, credible, valuable and locatable [22].

2.4 Learning Tool for Kids with Autism Spectrum Disorder (ASD)

Research have shown that children with autism can achieve more computer-based learning goals than traditional teaching methods, and are more engaged and motivated to learn by computer-assisted training. [5].

For more than 50 years, research has shown that the basic teaching unit on which all learning and teaching are based is a three-term contingency. (i.e. a learn unit) [8, 9]. The learning system is an observable and measurable relationship between the instructor and the learner and consists of two or more ancestor-comportment-consequence contingencies. A-antecedent is a stimulus/stimuli presented by a teacher or a computer/teaching device (i.e. visual stimuli - picture of a bird and an auditory stimuli - find a bird); B-behavior is a response to an antecedent (i.e. student touching a bird on the screen); and a C-consequence is presented in a way that confirms correct

responses and corrects incorrect responses. Corrections to incorrect response guide the student to provide a correct response so as not to deter the learner and provide him / her with a learning opportunity. Skinner's tree-term-contingency has been proven effective not only as a teacher-student interaction, but as one between a learner and a teaching tool, famous Skinner's teaching machine [25, 26] or Emurian et al. 's computerized instruction [8].

2.4.1 Game-Based Learning

Technology-based games are commonly used to teach people conceptual knowledge and skills. There are various games, such as gamification, serious game and e-learning. Therapeutic computer games are particular interest in the field of autism research, because their rules-based environments provide a secure and enticing means of interaction to enhance a person's level of socialization [20]. Several researcher have been focusing on educational games for children with ASD. The use of cognitive techniques in computer games makes these games special and useful for treating autistic children [21].

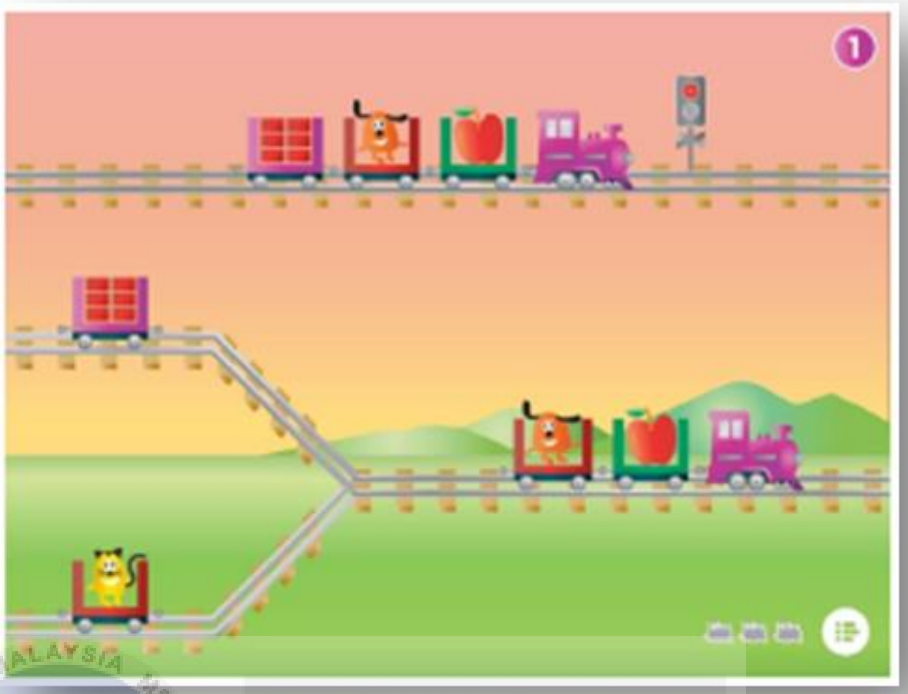

Figure 2.4.1.1: A picture from ‘Build-a-train’ game [21].

2.4.2 Mobile Application

These day, the extensive use of smartphones and tablets play an important role in assisting autism children by developing applications that help to overcome their behavior and physiological problems. Existing applications for autism children enable children to express their interests and emotions in an engaging environment and to be utilized as a guide to learning processes. Mobile applications can provides autistic children with the ability to feel the independence of their parents and teachers by interacting directly with the application without intervention from others, where they can use the applications given to them on their personal devices [11].

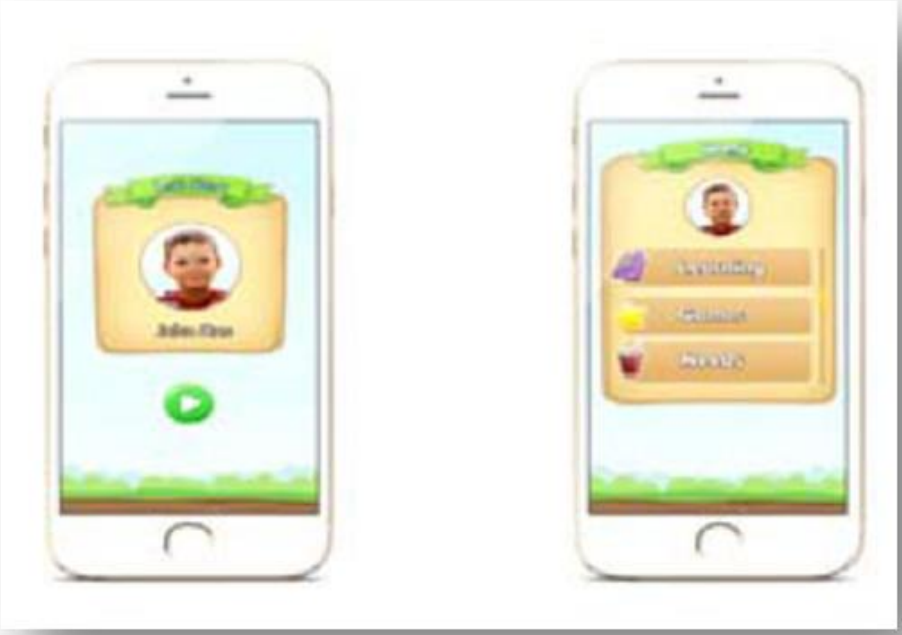

Figure 2.4.2.1: The interface of DISSERO applications [11]

2.4.3 Novel Educational (NOESIS)

A novel educational environment for kids with autism spectrum disorder (ASD) is includes the autism spectrum disorder (ASD) kids individual characteristics (level of autism, sensitivity, reaction target, etc), their emotional state (stress level, hyper-/hypo-tension) during the educational program, and creativity during guided and unguided activity. Moreover, it also assists educators in the planning, configuration and optimization of educational materials for each kid and offers enhanced evaluation procedures (scores / tools) through well-managed Web Services [32].

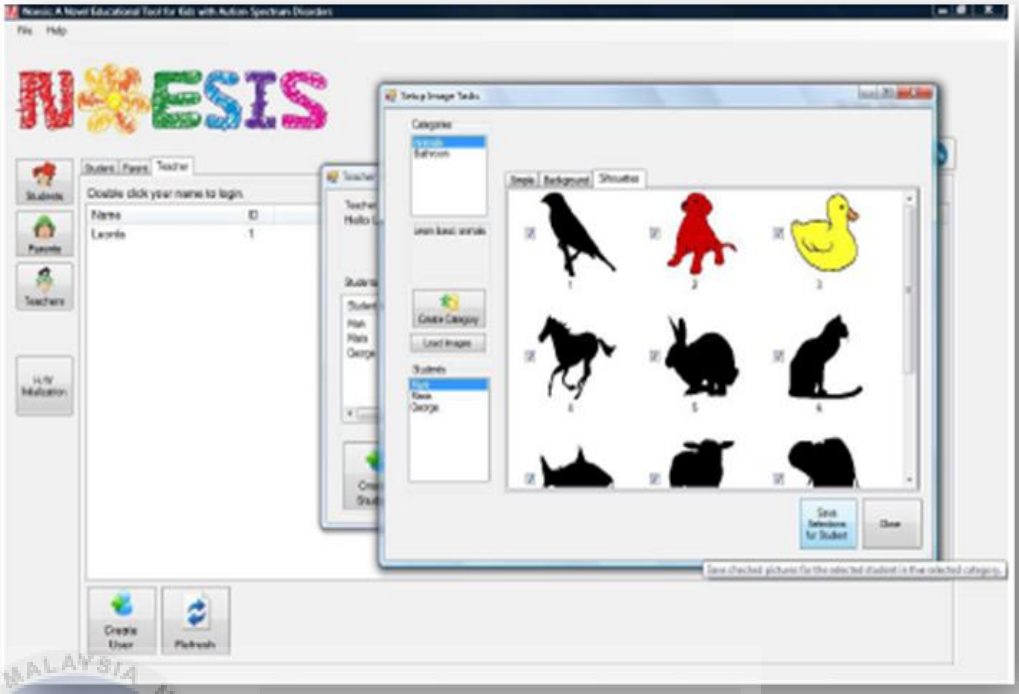

Figure 2.4.3.1: The Educator Palette Tool [32].

2.4.4 E-Book

Serious game may quickly draw children, capture or keep their interest, and encouraging them both to learn from adult, or on their own. But, teaching children with autism spectrum disorder (ASD), requires a particular set of strategies and methods, due to a decreased level of attention to the stimuli presented and a reduced potential to understand in a typical child's way. Then, an immersive, multi-sensory, computer-based teaching seems to be a perfect fit for such varied learners, because it provides multi-sensory learning experience, interactive practice with constant feedback, increased learning opportunities and customization for each child's needs [12].

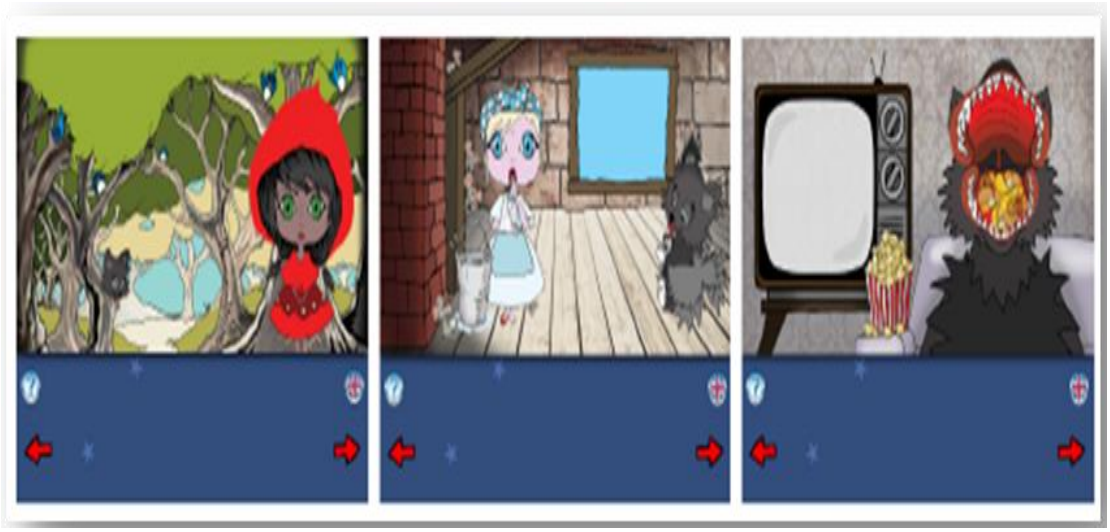

Figure 2.4.4.1: Three scene from the E-Book [12]

2.4.5 Interactive Whiteboards

Technology-enhanced schooling has been a focus in recent years at schools and special education are no exception. The analysis of current literature demonstrates that the students with Autism Spectrum Disorders (ASD) are excited to engage with technology as the simple rule-based structures utilized with computer and visual technologies render them particularly suited for these persons. The interactive whiteboards is analyzed as a tool that can be used to enhance the teaching practices of teachers (within the teacher's activity); and secondly, the interactive whiteboards are analyzed as a resource that helps the teacher to fulfill the specific needs of ASD students. Interactive whiteboards is one such tool that gives children with ASD the opportunity to learn in a format that supports their visual modality [29].

Figure 2.4.5.1: The interactive whiteboards [29].

2.4.6 A Learning Mobile Application

Autism is one of the main psychiatric disorders that occur today; a behavioral illness that creates a great deal of difficulties in understanding and acquiring complex ideas, as well as in creating and maintaining trustworthy partnerships. Communication is lacking in Autistic people because they are more confident engaging and connecting with their loved ones (which might also not be the case) as compared to acquaintances. It leads to a difficulty in terms of improving their learning skills, particularly where learning involves contact and understanding between the teacher and the autistic child. Due to the need for the necessary one-on-one attention, education can pose an enormous challenge to autistic people, where special techniques and tasks are needed to develop conceptual and operational skills. This applications may lead to the autism diagnosis (in the context of learning) and tracking (both treatment progress and physical location) of autism child. The Manage Game package handles the assignment of games and the viewing of these scores by the parent and teacher. The system includes features that allow teachers to customize games and set them as a child's assignment to play with, according to pre-defined selections [2].

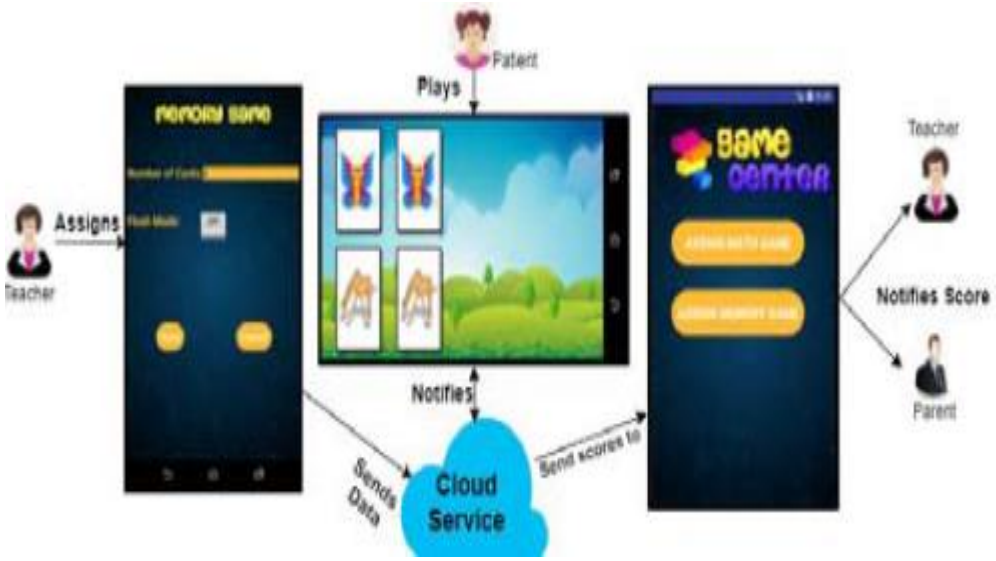

Figure 2.4.6.1: Conceptual Implementation View of the Manage Game [2].

2.4.7 A Learning Tool

The technology development of smart devices and applications has created a number of convenient approaches to dealing with such illness effectively and easily. Although basic education is a must for everybody else, it is still quite complex to teach the autism community through a traditional approach. There with this learning tool, it will introducing a cost-effective, compact and user-friendly immersive learning platform to provides basic academics to autistic children. The tool consists of a pressure sensing keypad to provide an easy and flexible means of interaction for autistic children. The tool is also evaluated in a laboratory environment to assess its efficacy and usability. Autistic children have different types of disabilities that require different types of requirements to be careful when using any hardware or software application. To provide

basic academic and literacy services to the autistic community, this tool will help them learn English alphabets [33].

Figure 2.4.7.1: A Learning Tool [33]

CHAPTER 3

METHODOLOGY

This chapter will explain the methods to achieve the objective of the project. This section involves the software used to develop an applications and the design of an application interface.

3.1 Project Planning

There are several sections for the methodology of this project research section, implementation section, troubleshooting section and analysis section. Every section is linked to each other.

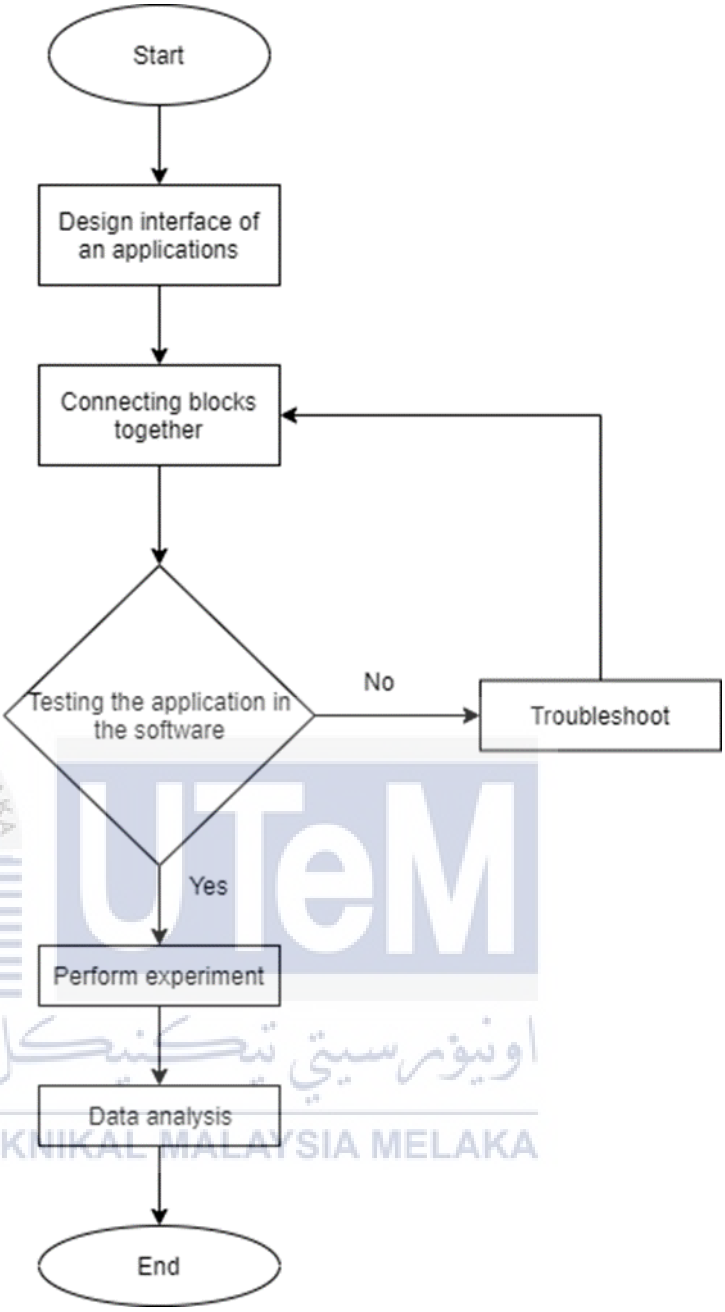

Figure 3.1.1: The flowchart of the overall project

3.2 Software Design

To develop an applications, this project will proceed with software ‘Thunkable’ which is an online software that enables anyone to create beautiful and powerful mobile applications. In ‘Thunkable’, anyone can build an applications without using any coding but will be replaced by dragging and dropping blocks and connecting them together to function an applications. An applications that have been developed can be tested using live test. After an applications have been finish, it can works on both Android and iOS devices.

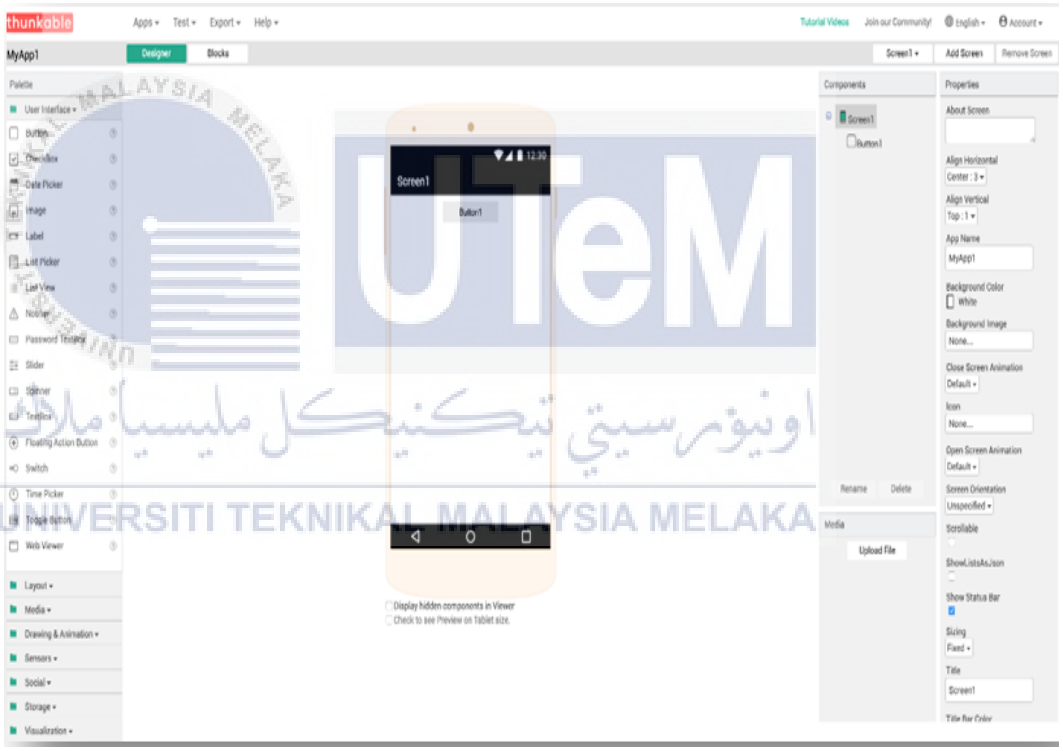

Figure 3.2.1: The interface in ‘Thunkable’ software for design

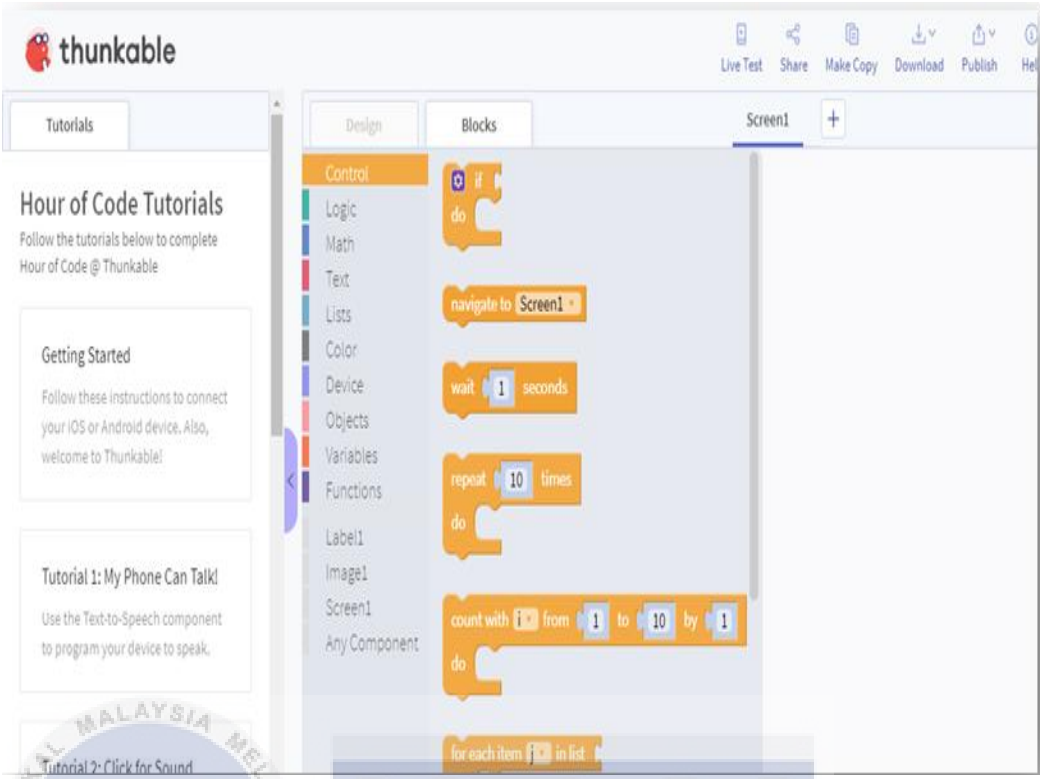

Figure 3.2.2: The interface in 'Thunkable' software for blocks

3.2.1 Interface Design

Figure 3.2.1.1: The frontpage of the application

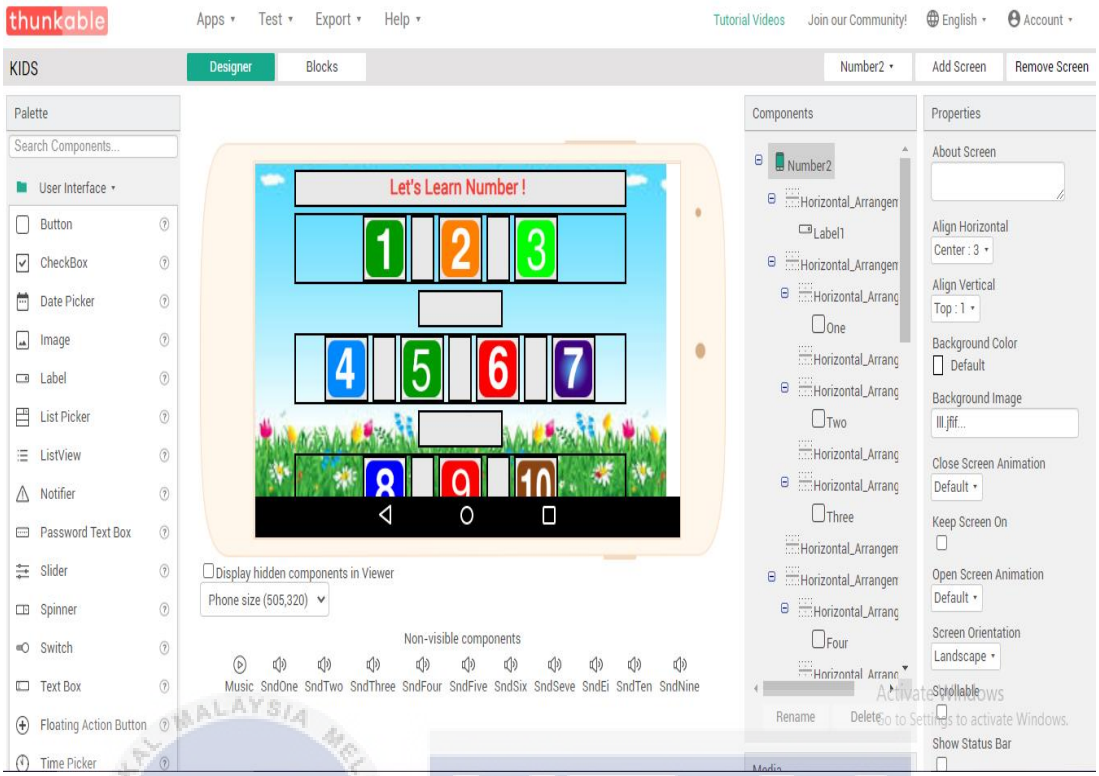

Figure 3.2.1.2: The page to learn number of the application

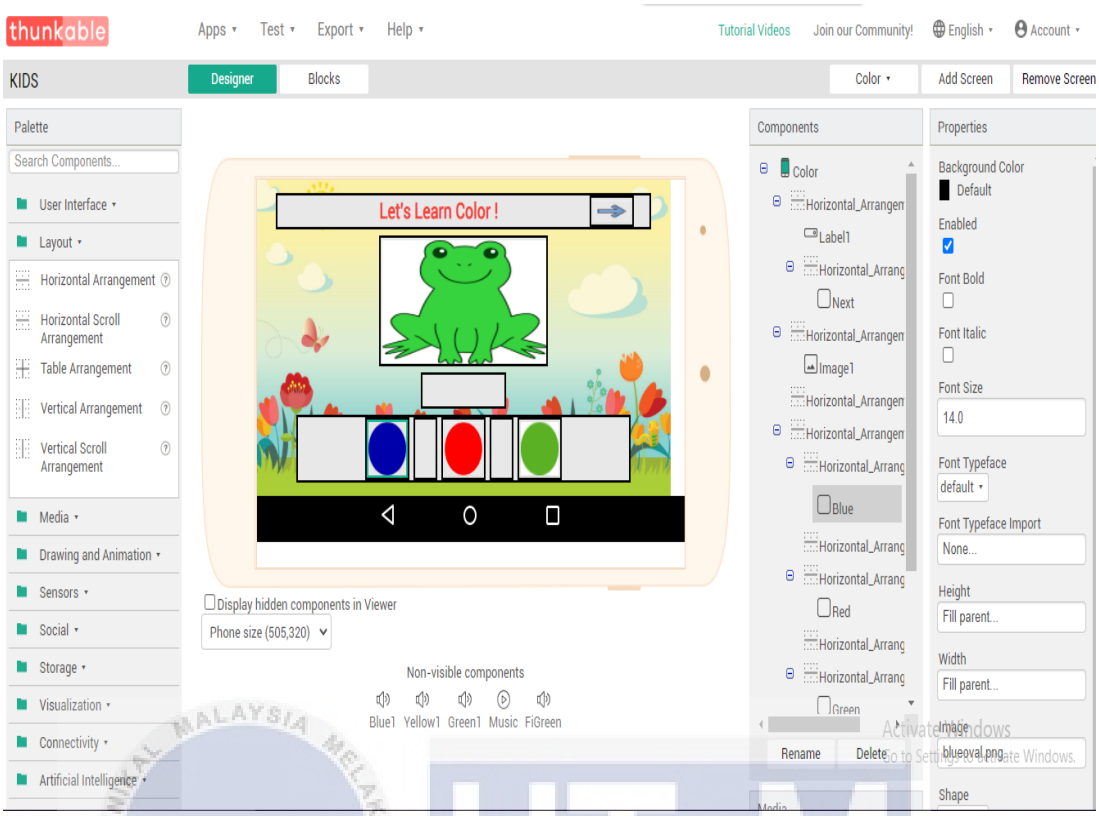

Figure 3.2.1.3: The page to learn color of the application

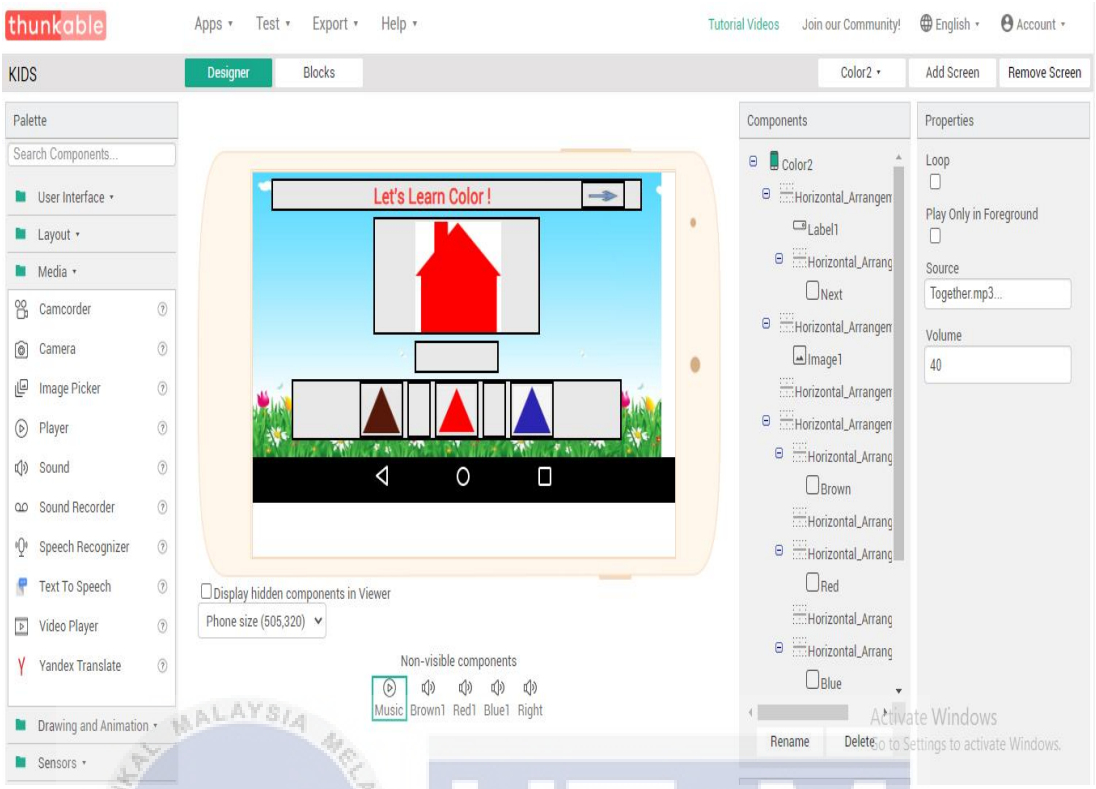

Figure 3.2.1.4: The page to learn color of the application

3.2.2 Software Flowchart

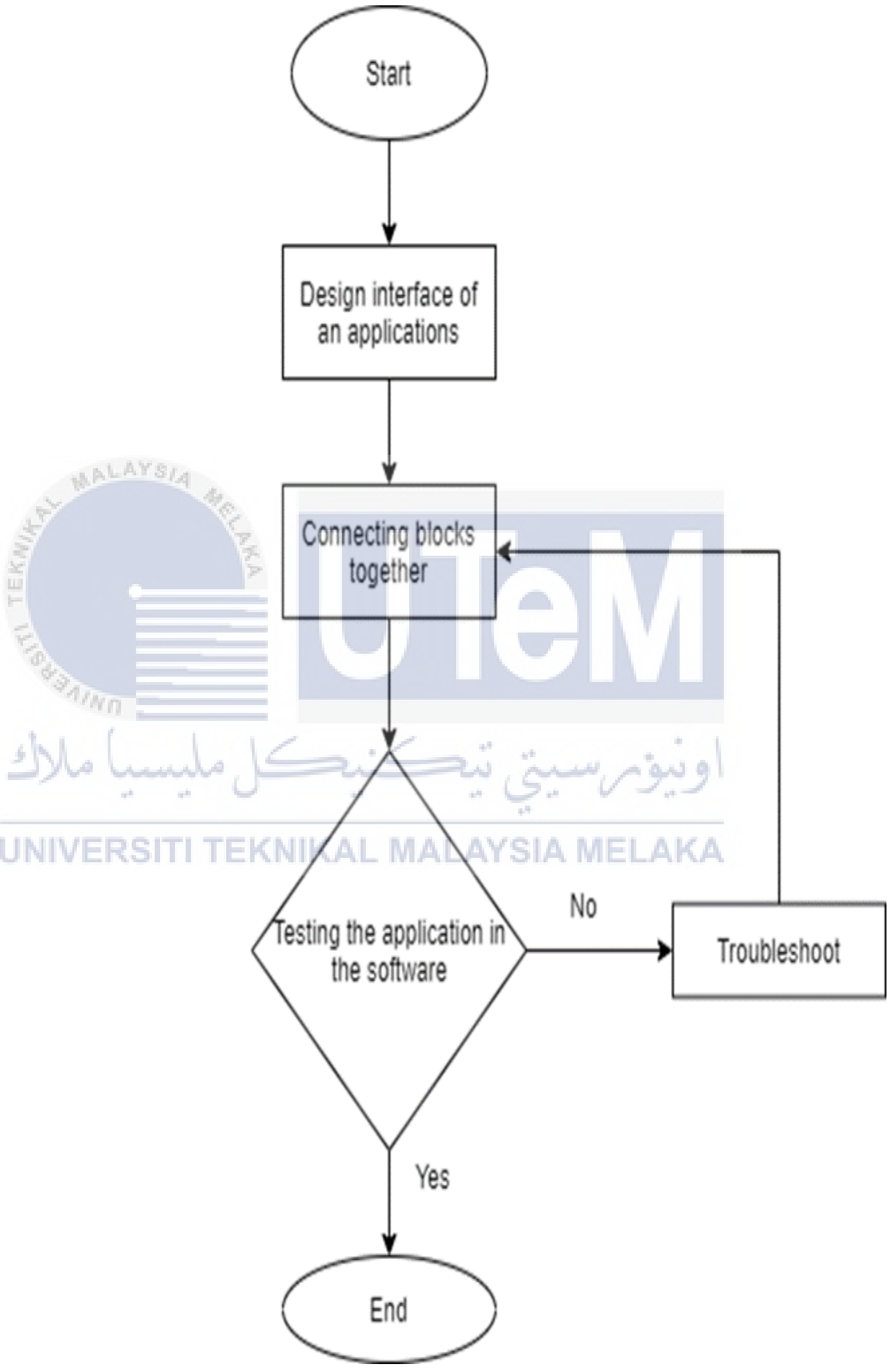

Figure 3.2.2.1: The flowchart of the software

3.3 Types of User Interface

There are many types of user interface to develop an applications, but in this project only two types of user interface is used to develop an applications.

3.3.1 Music

Children with autism have consistently shown sensitivity and responsiveness to music. A lot of autism spectrum disorder (ASD) literature state that children who do not respond to speech will often respond to music. Moreover, they respond more frequently and properly to music than any other sound stimulation [27].

3.3.2 Colors

Based on Dr Mary Barbera research [19], in order to teach children with autism spectrum disorder (ASD) colors, there are four main colors to be used which are orange, blue, red and green. Autism children are more attracted to four main colors than other colors.

3.4 Level of Autism

There are three level of autism spectrum disorder. In order to assess the level of autism, doctors take into consideration two aspects, including the ability of social communication, limited and repeated behavior. For this project, an application developed will focus on kids with autism level 1.

Table 3.4.1: Level of autism spectrum disorder

Level	Outlook	Symptoms
Level 1	Maintain a good standard of life on a daily basis with minimal assistance. Such assistance is typically given in the form of behavioral therapy or certain forms of therapy.	• Decreased participation in social contacts and activities. • Difficulty to facilitate social activities, such as talking to an individual. • Obvious symptoms of communicating problems. • Difficulty in arranging and coordinating.
Level 2	Usually, need more assistance than level 1 autism. Even with assistance, they could have a rough time responding to shifts in their environment.	• Difficulty coping with change of routine or surroundings. • Significant lack of verbal and nonverbal communication skills. • Behavior problems are severe enough to be noticeable to the ordinary observer. • Narrow, specific interests.
Level 3	Frequent, intensive therapy that focuses on a variety of issues, including communication and behavior, is often needed.	• Highly visible lack of verbal and nonverbal communication skills. • Have difficulty changing behavior. • Rather little ability to communicate socially or to partake in social activities. • Extreme distress or difficulties in shifting focus or attention.

3.5 Method used in Application

3.5.1 Participants

Five children with Autism Spectrum Disorder (ASD) between the ages of 3 until 5 years old were participated in this research. All of the participants diagnosis with level 1 autism.

3.5.2 Materials

Android devices are used to run an application during the application test. The child was given full control of the smartphone with the teachers' guide.

3.5.3 Procedure

Before the application test, the teachers provided guidance about how to use the application. The teachers also had to give a specifics instruction to the participants as some of the participants feel intimidated with new things.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter will explain and discuss the outcomes based on the objective that has been present in methodology section.

4.1 Interface Design

4.1.1 Colors

The program interface was built in this section. Starting with color selection, the chosen color is the four main color which is red, green, blue and orange. The main reason for these selection of colors is based on research by Dr Mary Barbera [19] autism children are more attracted to these four main colors than other color. Furthermore, unfavorable color may have an inhibitory effect on autism children. Past studies have shown that suitable colored materials may

improve task performance and reading capability. In this interface, yellow color is avoided because autism children are likely to avoid these color.

4.1.2 Music

Second interface in this applications is to added some music and sound. The sound that has been added to the applications is the fluctuating sound. As the sounds produces gradually exercise and tone of the ear muscles, teach the ear to respond and recognize the full spectrum of frequencies. Another reason to add music is that it can stimulate both hemispheres of our brain rather than just one. This means that the use of song or music is to enhance cognitive activity so that autism children can build self-awareness and improve relationships with others. Music also can encourages communicative behavior and may encourage interaction with others.

The interpretation of music, both in lyrics and in sound can greatly help autism children to communicate. For autism children, that may involve in discovering a new vocabulary from a song.

4.2 Software Interface

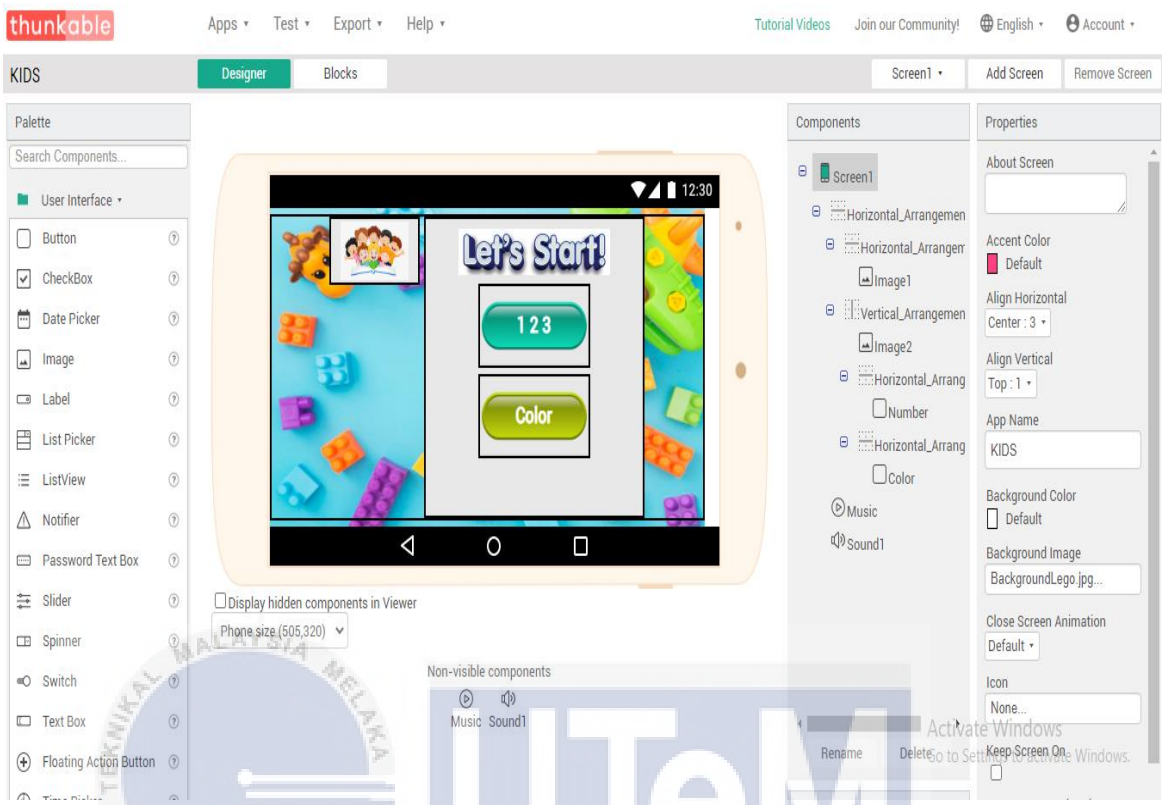

Figure 4.2.1: The interface for the first screen in Thunkable software

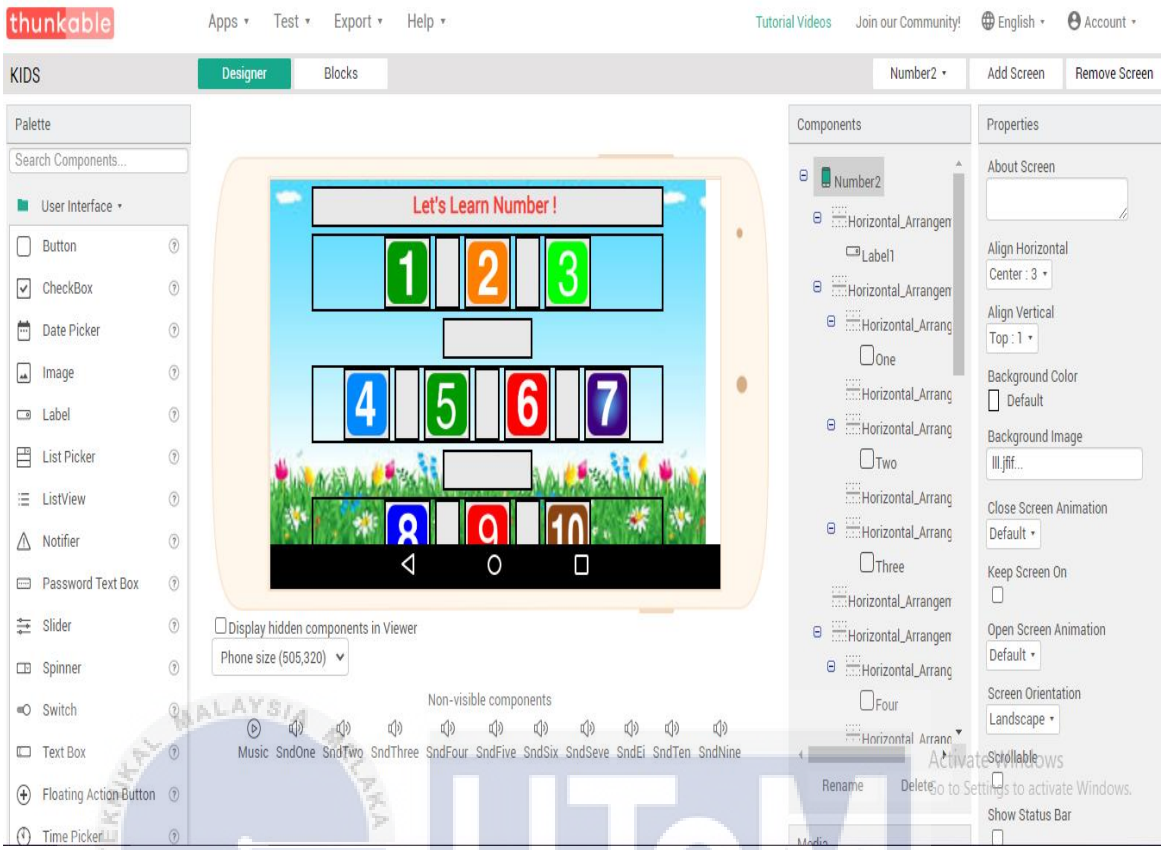

Figure 4.2.2: The interface for the number screen in Thunkable software

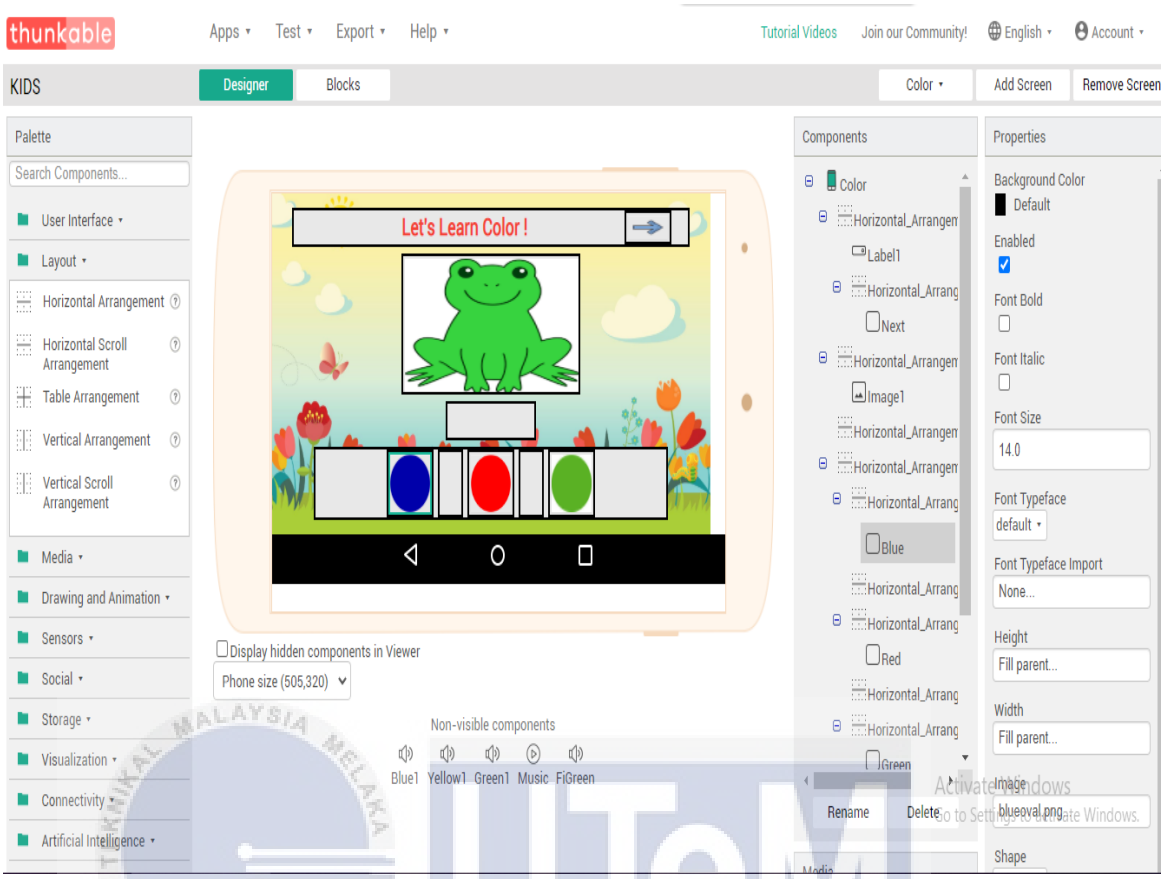

Figure 4.2.3: The interface for the first color screen in Thunkable software

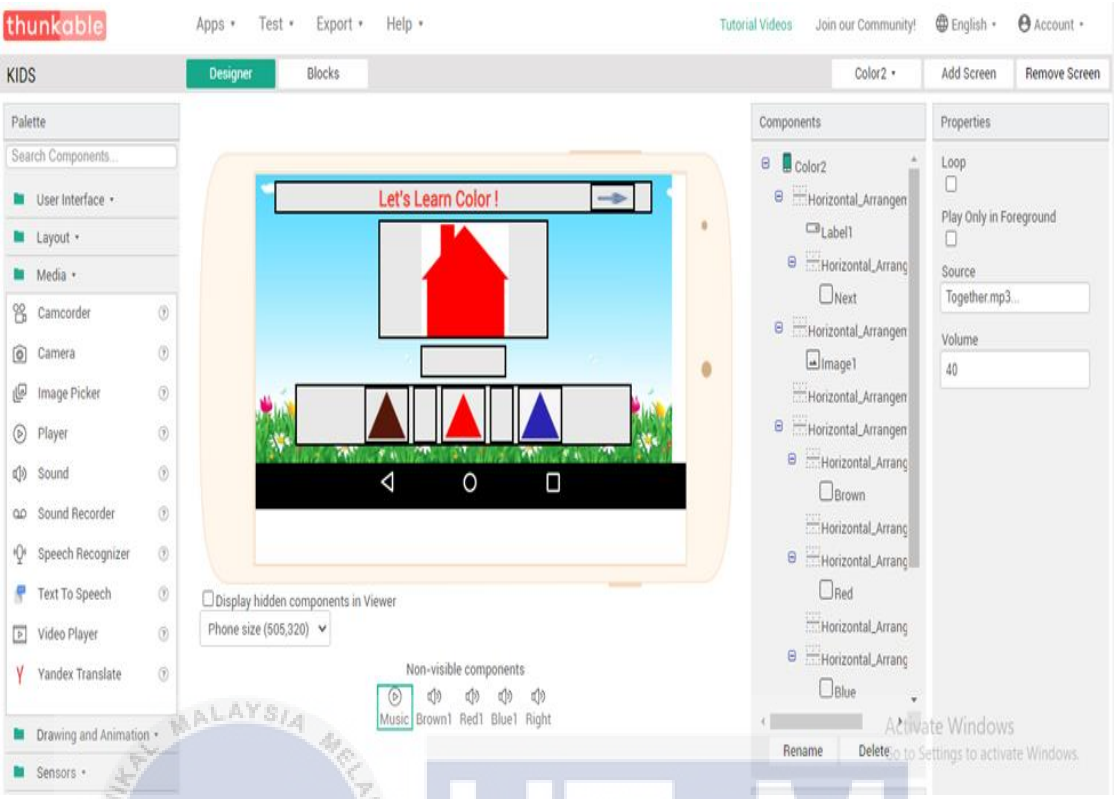

Figure 4.2.4: The interface for the second color screen in Thunkable software

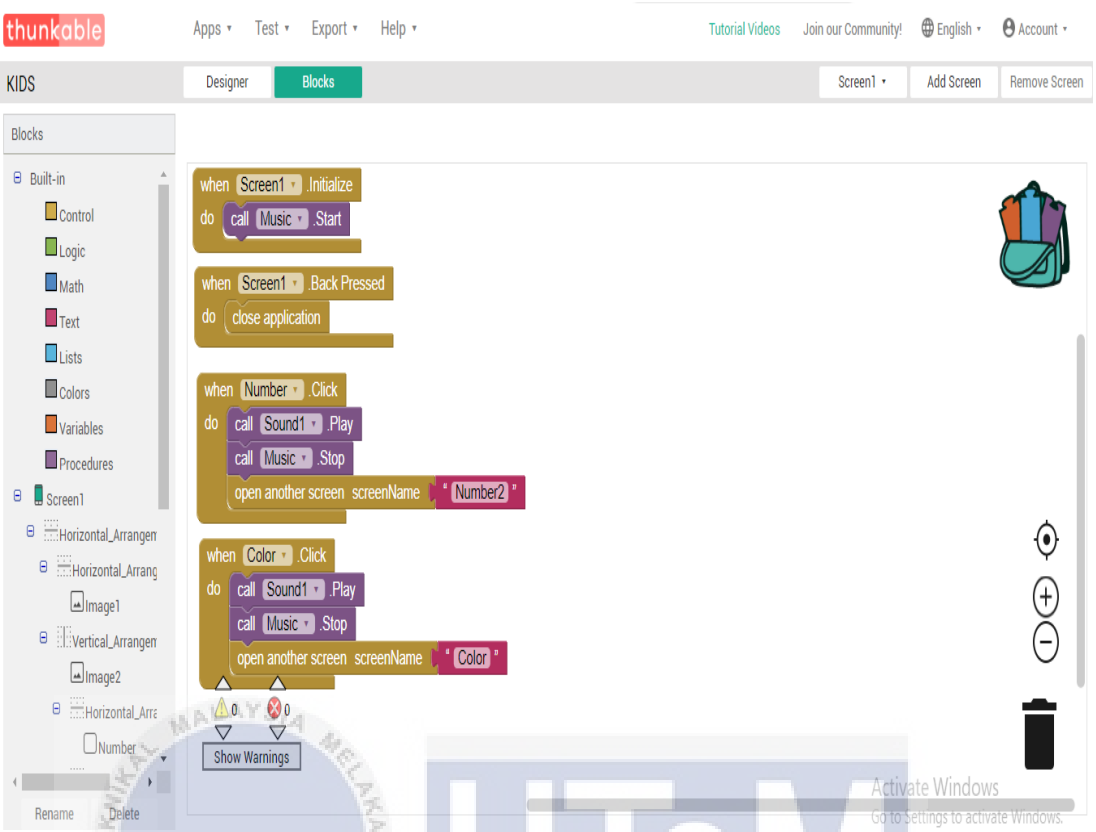

Figure 4.2.5: The blocks interface for front screen in Thunkable software

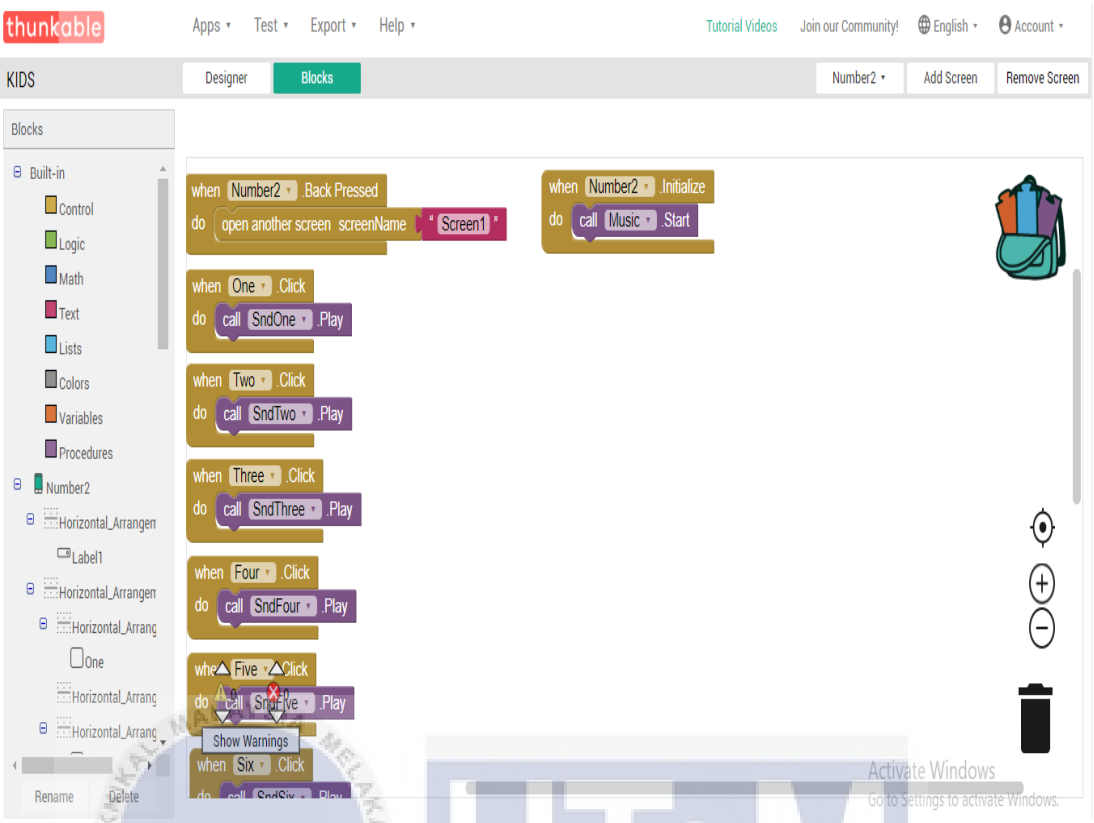

Figure 4.2.6: The blocks interface for number screen in Thunkable software

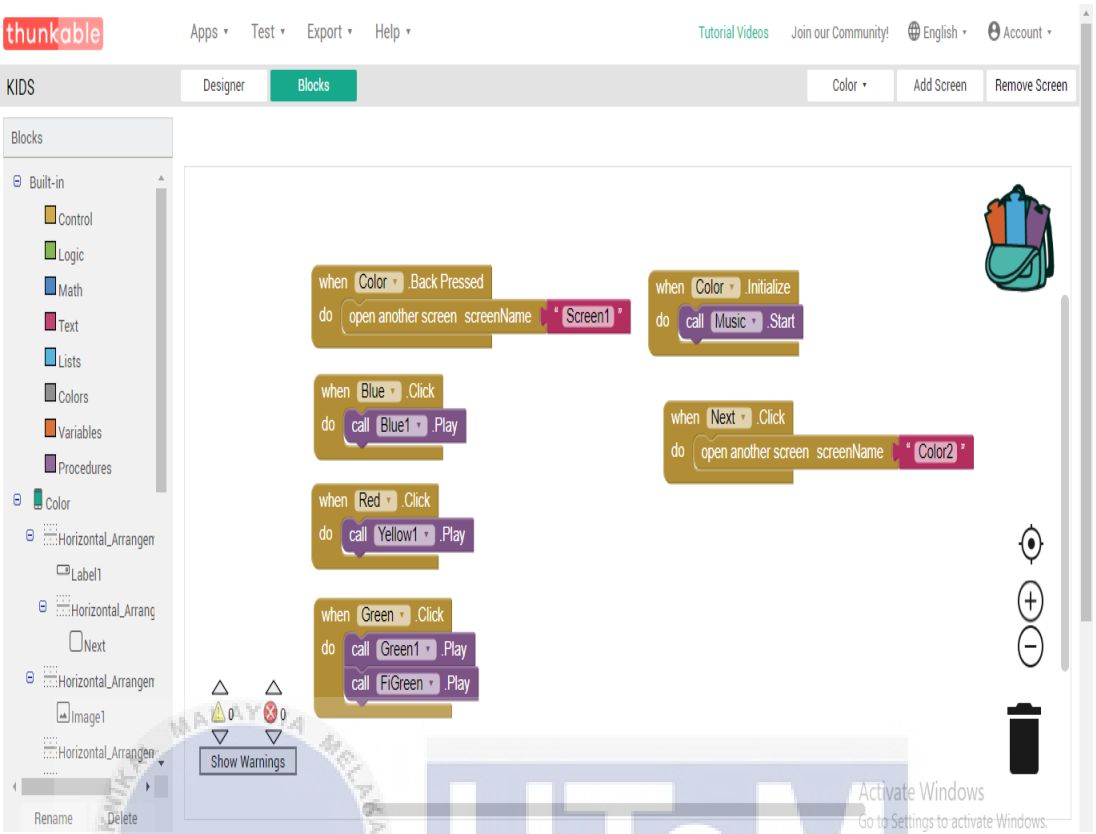

Figure 4.2.7: The blocks interface for color 1 screen in Thunkable software

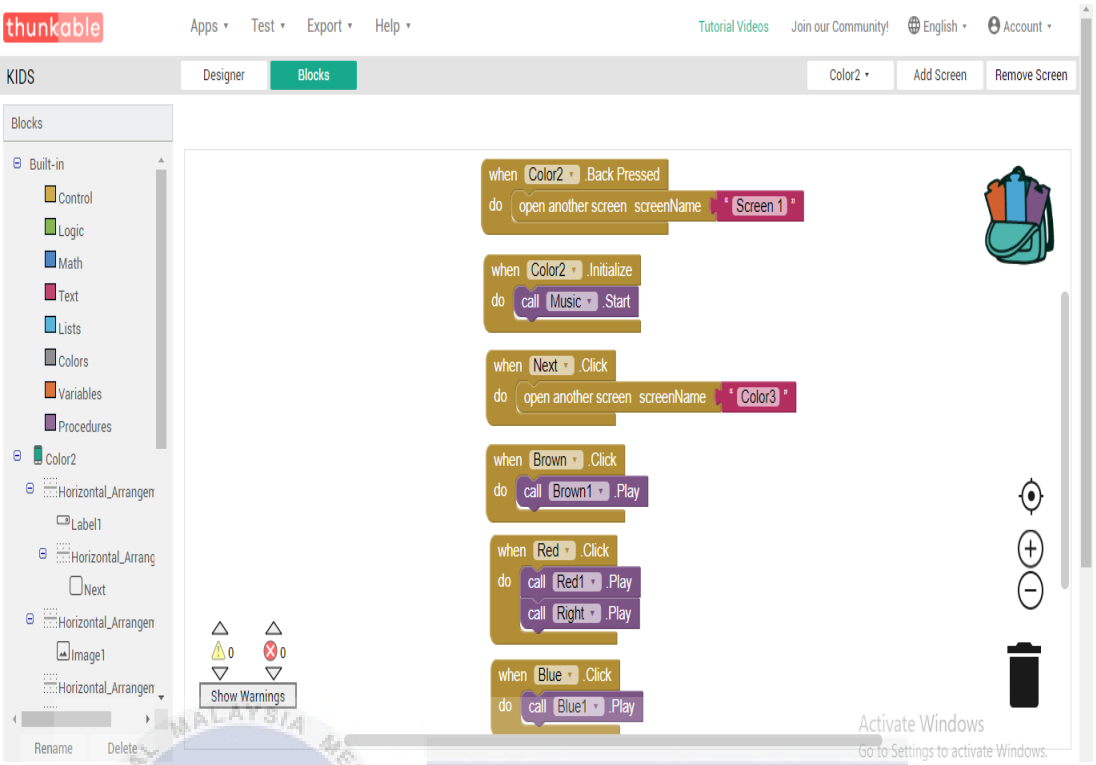

Figure 4.2.8: The blocks interface for color 2 screen in Thunkable software

4.3 Application Works

The way this applications operates is, when the application was launch the first screen will been shown as in Figure 4.3.1.In the first screen there will be music playing. After that the user can choose whether to start with learning number or color. If the number button was click, the screen will show as in Figure 4.3.2. To start learns number, the user can press any number in the box. When the number was press the number box will produce a sound for a pressed number. From there, the autism children can learn what number is it.

Next, when the user click the color button, the screen will show as in Figure 4.3.3. To start learn color, the user can choose what is the color for the showing picture. When, the user click the wrong color the box color will make a wrong sound to show that user choose the wrong color. Then, when user click the right color, the box color will produce a sound for the correct color. After that, when the user click the next button, the screen will lead the user to the next color screen.

Figure 4.3.1: The interface of the first screen in application

Figure 4.3.2: The interface of the number screen in application

Figure 4.3.3: The interface of the first color screen in application

Figure 4.3.4: The interface of the second color screen in application

4.4 First Initial Response of the Participants and Action when the Answer is wrong

Table 4.4.1 First Initial Response of The Participants and Action Taken when the Answer is wrong

Participants	Initial response to cue	Action when the answer is wrong
Child 1	He enjoyed using the application especially in the color section.	When he was aware of a wrong answer, he didn't pursue the particular option again.
Child 2	She enjoyed using the application in both color and number section.	She was trying to choose another option when the answer was wrong.
Child 3	She was interested in touching the number button as the button produced the sound.	When she was aware of a wrong answer, she didn't pursue the particular option again.
Child 4	He was not interested in responding to the cue given at the first meeting. After the second meeting, he only decided to pursue to the number section only.	He did not even bother to finding the correct answer when the chosen answer was wrong.

Child 5	He was not interested to try the application at the first meeting. After the second meeting, he interested to respond to the cue in the application.	He tried to choose another option when the answer was wrong.

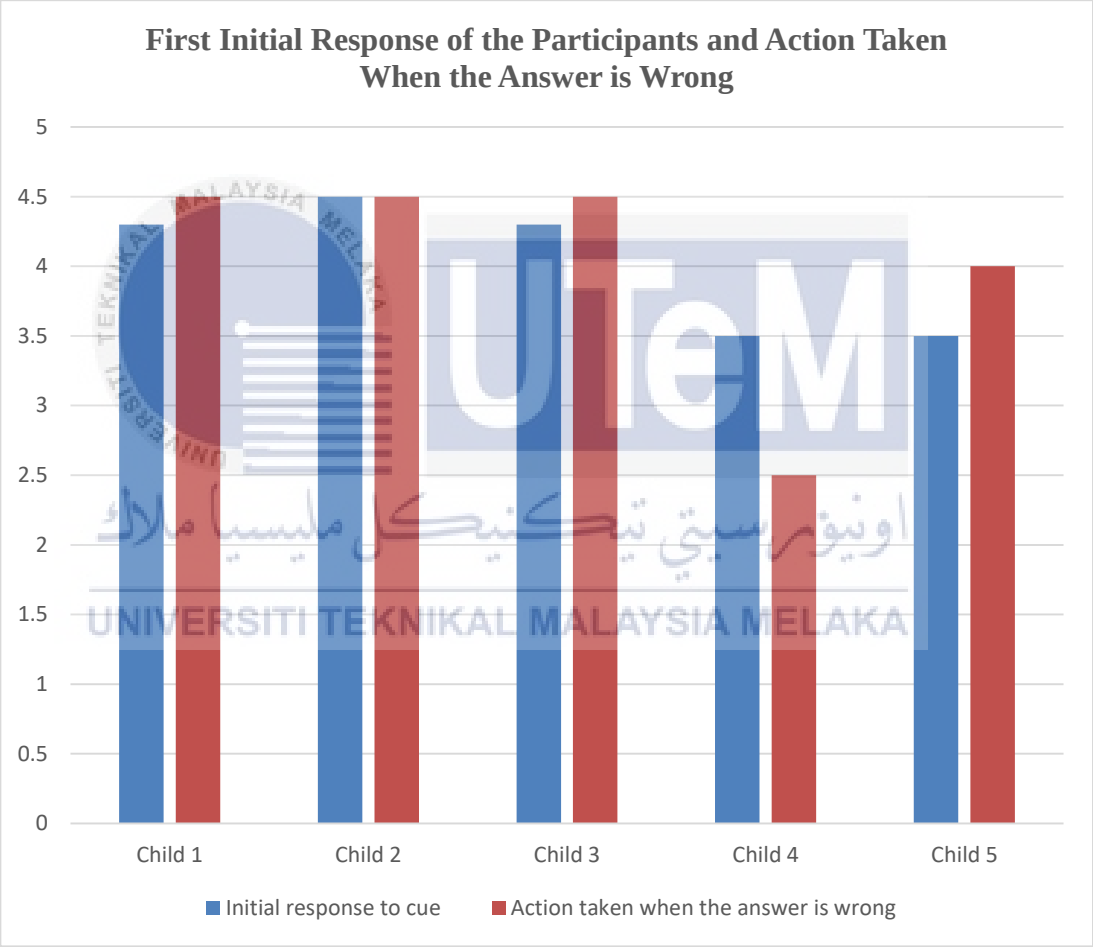

Figure 4.4.1: Graph for first initial response of the participants and action taken when the answer is wrong.

4.5 Analysis

The following Table 4.4.1 and Figure 4.4.1 summarizes the first initial response of the participants and action when the answer is wrong. The data in Table 4.4.1 is taken from the observations that were made during the application test session. All participants showed some improvement in basic numbers and colors. For the first few minutes of the meetings, two of the five participants were not interested to try the application. After the parents distracted them with other things, such as playing with other toys, the parents helped them to understand the cue of the applications. Not all participants understand the cue provided during the first session. After three sessions, all participants can identify the colors and numbers very well. These analysis showed that this application may lead to an improvement in multiple cue response skills for kids with autism spectrum disorder (ASD). This application is also suitable for home and school use.

Figure 4.5.1 One of the participants try the application

CHAPTER 5

CONCLUSION AND FUTURE WORKS

This chapter will discuss about the outcome of the applications and the suitable suggestions to improve this project in future works.

5.1 Conclusion

By using this application, the children with autism spectrum disorder (ASD) may be drawn to learning. In this application, the analysis focuses on two parameters. The first parameter focuses on the time the child responds to the cues and the second parameter is when the child has not been able to find the correct answer and has to try other options. This is to understand their learning requirements and preferences. This project proposes that new technologies allows children with ASD to take advantage of this advancement in a healthy and stable environment instead of undergoing

psychological therapy sessions. The user interface used to build this applications is by using color and music. Based on the previous studies, it shown that autism children attract with color and music. So, using these information, the applications build consists of color and music as its interface to attract autism children to learn. The autism children doing great in learns number and colors using this applications. But, some of the autism children do not interested at all to learn using the applications. Some of them are more interested on plays with puzzles, blocks, balls and books.

5.2 Future Works

The success of this project will contribute to the design and development of the application for kids with autism spectrum disorder (ASD). For the next future works the things that can be improve in this project is by adding animation into the applications, as it can appeal to autism children to learning using applications. Furthermore, we also can including appropriate components and simple cues to get connected with these special children. For future work, more participants and a longer timeframe to perform the test are suggested in order to obtain good data.

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