Number Skills Conceptual Framework for Down Syndrome Children

By
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CERTIFICATION OF APPROVAL

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ABSTRACT

This project explores what are the learning theory/s that can be used in developing the Number Skill Conceptual Framework for Down Syndrome Children. The framework will be used as a guideline in developing a mathematic computer application with the purpose to help the Down Syndrome children to recognize numbers. The methodology used for this project is the Rapid Application Development (RAD), and the data gathering process draws on Mix Method data gathering that were done through interview, survey, observation and literature review analysis. From that, few things were identified; the findings suggested that Cognitive Learning theory is one of the most relevant theories that can be used in developing the conceptual framework, and children with learning difficulties learn better when they are using computer applications. An application to help children with Down Syndrome to recognize numbers were developed by using the conceptual framework as a guideline. The application is named as "**SynMax**" and it was developed so that it can be used in 2 languages which are English and Malay Language. There are three modules in the **SynMax** which are the "Learning", a module that introduce numbers to children, "Matching", a module that helps the children to recognize the shape of the numbers and finally "Counting" that teaches the children the amount for each of the numbers. User acceptance test was done to 3 children with Down Syndrome aged between 13. The testing served 2 objectives which are; 1) To test users' acceptance to the application and 2) To test whether users can connect their prior knowledge with the activities in the application. Observation checklist was prepared prior to the testing. The result showed that the children can accept the application with the assistance of their teacher and they can connect what they have learned in the class with the activities in **SynMax**. The project is ended with recommendations and conclusion. Recommendation is a section where all the related recommendations and some improvements that can be done for the future of this project are listed and elaborated. Finally, the conclusion section concludes the project as a whole.

Keywords *Down Syndrome; framework; mathematics; computer;*

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"With the Name of Allah the Most Merciful and the Most Gracious"

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ABBREVIATIONS AND NOMENCLATURES

DS	Down Syndrome
NKRA	National Key Result Areas
LINUS	Literacy and Numeracy
PEMANDU	Performance Management and Delivery Unit
RAD	Rapid Application Development
KDSC	Kiwanis Down Syndrome Center

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

In the year 2009, Malaysia's Government has announced six short term targets concerning the people of the country through the National Key Result Areas (NKRA). One of it is to broaden the access to affordable and quality education (The Star, 2009). In accordance with the announcement, a program called Literacy and Numeracy (LINUS) had been implemented with the objective to ensure every child will be able to acquire basic literacy and numeracy skills after 3 years of mainstream primary education by the end of 2012. Based on the figure provided by Performance Management and Delivery Unit (PEMANDU), the dropout rate for Malaysia in 2008 was 31,939 at primary and secondary levels. The causes of the dropout are varied and one of them is because of learning disabilities such as Down Syndrome and Dyslexic (Literacy and Numeracy, 2010).

According to the National Down Syndrome Society, Down Syndrome (DS) is a common chromosomal abnormality. Studies done by experts have shown that as women getting older, the chance of having a baby with a chromosome problem such as Down Syndrome increases. Table 1 shows the statistics of Down Syndrome born in certain maternal age range (BC Prenatal Screening, 2009).

Table 1: Risk of Down Syndrome and other chromosome abnormality in live birth by maternal age

Maternal Age (At Term)	Risk	
	Down Syndrome	Total Chromosome Abnormality
25	1 in 1250	1 in 476
30	1 in 840	1 in 385
35	1 in 356	1 in 179
40	1 in 94	1 in 63
≥45	≥1 in 24	≥1 in 19

People with DS experience cognitive delays that causes them to take longer time to learn to sit, walk, talk and do most other activities later than their peers without DS. The best way to help DS children in learning is using the right teaching methods to establish essential foundation that can assist them in their daily life. One of the basic skills that they need to have is number skills, but unfortunately, the achievements of children with DS in number are lower compared to their achievements in literacy ("Developing Numeracy Skills," 2011). Therefore, in planning mathematics curriculum for children with Down syndrome, the learning outcomes should be significant to their capabilities, realistic and provide them with the appropriate skills that can support independent functioning and be useful in real life.

Specific teaching techniques have been shown to give positive results in helping DS children to learn. Suggested teaching approach is by using computer based application, which the children can interact with multimedia material that have the integration of visual information and auditory. Computer-assisted teaching especially animated material, allow the children to extend their attention span a little bit more than learning through traditional ways. For example, just writing or listening to the instructions from their instructors might not be as effective as an animated and colourful learning material since DS people usually have better visual skill than the listening skill.

1.2 Problem Statement

The problem statements for this project are:

1. There is limited theory to guide mathematics learning for Down Syndrome children.
2. There is no personalized mathematics learning application for Down Syndrome children.

A lot of studies have been conducted in many areas of DS with language taking a large part of the study but relatively there are few studies about numerical skill of DS children (Geary, 2005). Existing studies stated that children with DS, showed lower achievements in numbers compared to their language skill (Abdelhameed & Porter, 2006; Leech, 2006; Nye, et al. 2001). Experts indicated that the causes for these problems are typically because people with DS born with cognitive disabilities. According Down Syndrome Ireland (2011), delayed motor-skills, auditory and visual impairment, postponement in speech and language, short-term auditory memory, limited concentration span, difficulties with thinking and reasoning, and applying knowledge are the most common cognitive difficulties that faced by people with DS. Therefore, they need more personalized way of learning to suit their learning needs. Unfortunately, due to the lack of study in the area of mathematics education, there is limited theory to guide mathematics learning for DS children. Because of that, sometimes teachers do not notice that they are using teaching method that does not fit the learning need of children with DS. It resulted to the children do not understand the lesson taught (Abdelhameed & Porter, 2006). Thus, it is crucial to develop a proper framework that can cater most of the requirements of DS children in learning mathematics, so that they can learn mathematics in a more effective way.

Moving to the second problem statement, a study conducted by Feng, Lazar, Kumin, and Ozok, (2008) have indicated that children with DS started to use computer as early as 3 years old and 80% of them use computer for educational purposes. This research showed that people with DS are being exposed to computer and using computer might help them

in their learning. For instance, Ortega-Tudela & Gomez-Arizaw (2006), proved that Down syndrome learn basic counting and cardinality skills more quickly when taught using computer application than when spending the same amount of time on similar pencil and paper tasks. It shows that computer software have a great potential in assisting DS with their learning. Unfortunately, most of the applications, games, and web sites found were designed without considering the special needs of DS people, thus making the applications less effective or completely inaccessible (Feng & Lazar, 2010). Therefore, from the above-mentioned reasons, it is crucial to develop an application that is align with the framework and take into account the special needs of children with DS in learning mathematics.

1.3 Objectives of study

The objectives of this project are:

i. To identify suitable learning theory(s) to be used in developing numeracy conceptual framework for Down Syndrome children.
ii. To propose or produce a conceptual framework for designing effective numeric skill content for Down syndrome children.
iii. To develop application on learning the basic of numbers for Down Syndrome children.
iv. To conduct a user acceptance test on the developed application.

Research will be conducted to identify the suitable learning theories to be used in deriving the numeracy conceptual framework for DS children. The study begins with detail analyzing of existing learning theories, find out what are the characteristics of DS children, investigating the level of their numeracy skill and their educational needs and requirement.

A conceptual framework will be developed in accordance to the result of the research. It will be validated by experts from selected Down Syndrome association named Kiwanis Down Syndrome Center. Following the conceptual framework, an application on learning

the basic numbers for DS children will be developed. The application is planned to be developed with animation and using features that are accessible to DS children. With the help of Adobe Flash and its Actionscript 3.0, both of the essential requirements are made possible. One of the purposes of developing this application is to prove the framework that had been developed.

Finally, user acceptance test will be conducted to the target users. The test will be done to determine whether the application can be used in the exact real world. With this, the project is expected to be completed within 8 months, from the initial requirements finding, development, testing until the final delivery of the prototype.

1.4 Project Feasibility

The benefit from this project is DS children in Malaysia will have a personalized application on learning numbers. Through this application, they can have interactive learning medium. Interactivity in learning is essential to ensure that they can focus longer in their learning.

Other than benefiting the children, the conceptual framework also can assist the teachers in using the appropriate methods to teach children with DS. Some teachers used methods that are not suitable in teaching them and it resulted to the children can't capture what their teachers are trying to teach them. It will create frustration for both the teachers and students.

Within eight months, this project can be completed at least to the minimum requirements. It also depends on the amount of scope creep that would be encountered which is inevitable. Due to the scope creep and testing difficulties, it is also difficult to gauge how perfect the system can be within the time frame.

CHAPTER 2
LITERATURE REVIEW

2.1 Children and Learning Disabilities

Learning disabilities is a term used referring to a group of variety learning disorders. It is a neurological disorder that affects the brain's ability to receive and process the information. In addition, the term is also used to describe the difficulty that a person at of a least average intelligence faced in acquiring basic intellectual skills. These skills are the fundamental for success at school and work, and for coping with life in general. There are a number of specific types of learning disabilities such as Down Syndrome, Dyslexic and Autism. These learning disabilities have always resulted children not being able to follow the mainstream education systems as they need customized learning methods that can suit their learning styles (Learning Disabilities, 2009). The focus of this project is on numerical skills of children with Down Syndrome and the topic will be discussed more throughout the Literature Review.

2.2 Understanding Down Syndrome

2.2.1 Down Syndrome

Down syndrome is one of the most frequently occurring chromosomal abnormalities that happen before birth. Down syndrome can affect people from all walks of life regardless the age, race or economic levels. Statistic shows that DS is occurring once in every 800 to 1,000 live births and it is estimated that there are 50,000 people with DS in Malaysia.

For hundreds years, people with Down syndrome have indirect reference to art, literature and science. It wasn't until 1866 a physician named John Langdon Down published an accurate description of a person with DS. Although other people had previously recognized the characteristics of the syndrome, it was Down who described the characteristics as a distinct and separate entity ("What is Down Syndrome?" 2012).

2.2.2 Causes of Down Syndrome

Down Syndrome is usually caused by an error in cell division called nondisjunction. There are 3 common types of DS which are Trisomy 21, Mosaicism and Translocation. Regardless of the type of DS a person may have, all people with DS have an extra, critical portion of chromosome 21 present in all or some of their cells. This additional genetic material alters the course of development and causes the characteristics associated with the syndrome.

Most of the DS cases fall under Trisomy 21. About 95% of people with DS have this. This type of DS occurs because there is a pair of the 21st chromosomes in either the egg or the sperm do not separate properly that happen either prior to or at conception. This extra chromosome is then found in every cell in the body, thereby causing the characteristics of DS in the child ("What is Down Syndrome?" 2012).

Mosaicism occurs in about one to two percent of all people with DS. In this type of DS the nondisjunction of the 21st chromosome occurs in one of the initial cell division after fertilization. This causes the fetus to have a mixture of two types of cells, some cells with 46 chromosomes and some with 47. Those cells with 47 chromosomes have one extra 21st chromosome. Because of the "mosaic" pattern of the cells, the term mosaicism is used. In Addition, researchers have found out that individual with mosaic DS may be less affected by the physical and mental characteristics of DS than those with Trisomy 21 or translocation ("About Down Syndrome", 2006).

Translocation is responsible for three to four percent of all cases of DS. In translocation, a part of chromosome number 21 breaks off and attaches itself to another chromosome. When this happens it causes the characteristics of DS. When a child is born with Translocation, it could mean that one parent is carrying chromosomal material that is unusually arranged. Genetic counseling can help in determining the origin of Translocation. ("What is Down Syndrome?" 2012).

2.2.3 Characteristics of Down Syndrome

People with DS are typically associated with delay in cognitive activities and some physical symptoms. Among the most common physical traits are muscle hypotonia, hyper-flexibility, flat facial profile, oblique palpebral fissures, large tongue in relation to size of mouth, dysplastic ear, single palmar crease, curvature of the fifth finger, excessive space between first and second toe epicanthal folds ("About Down Syndrome", 2006).

Figure 2.1: Characteristics of a child with Down Syndrome

Apart from that, researchers have found out that the physical symptoms may affect their learning processes. For example, ear canals of children with DS tend to be much smaller, narrower and often have blockage caused by ear wax. These blockages of the external ear canal can cause hearing deficits. This is the reason why DS children prefer visual learning style compared to audio (Waldowski, n.d.). Typically, children with DS have some anatomical differences that can be seen including a small and narrow upper jaw, and a high palatal arch. This affects their usage of mouth including feeding, cup drinking, chewing and swallowing solid foods, and especially speech. Their speech is not clear and can be difficult to understand. As the result, the children will face speech and language delay. In addition, children with DS show problems with working memory functions, as well as a limited use of strategies for memorization, which causes difficulty in learning and having short attention span (Jarrold & Baddeley 2001).

Regardless of their unique features, children with DS have a great diversity in term of personality, intelligence, learning style and attitude. Therefore, they must get the same care, attention, inclusion in the community and opportunities for education which are needed in order to develop their social and academic skills needed in life. Different types

of specialized therapies, counseling, and training can help them to learn the necessary skills and manage emotional issues.

2.3 Learning Theories

Learning theories is described as how an individual absorb, process and retain information during learning. Learning theories is very helpful for educators since they are able to know how knowledge is acquired and therefore they can use appropriate teaching and learning methods in the classroom (Alzaghoul, 2011; Hammond et al. 2001). There are few types of learning theories that widely being used such as cognitive, behavior and constructive.

Cognitive learning theory has provided foundation in understanding the learning process of people with DS. From a cognitive learning perspective, learning happened when the information in the environment is transformed into knowledge that is stored in the mind. One of the major issues in this type of learning is memory and a researcher had recognized that students construct knowledge based on their experiences (Hammond et al. 2001).

In addition, there are some learning methods favoured by people with DS. In general, they prefer direct manipulation of objects, colours, pictures and animations and any verbal content must be presented in a simple format (Bruno et al, 2003). From their preferences, few cognitive theories can be applied when teaching them. For instance, Dual Coding Theory suggests that we remember better when two processes are used together ("Cognitive Learning Theory", 2011). For example, verbally explain to the students with the help of visual aid materials. While Schema Theory recommended that our former understanding is essential for the grasp of new information ("Cognitive Learning Theory", 2011). Figure 2.2 shows the Information Processing Model of a human being.

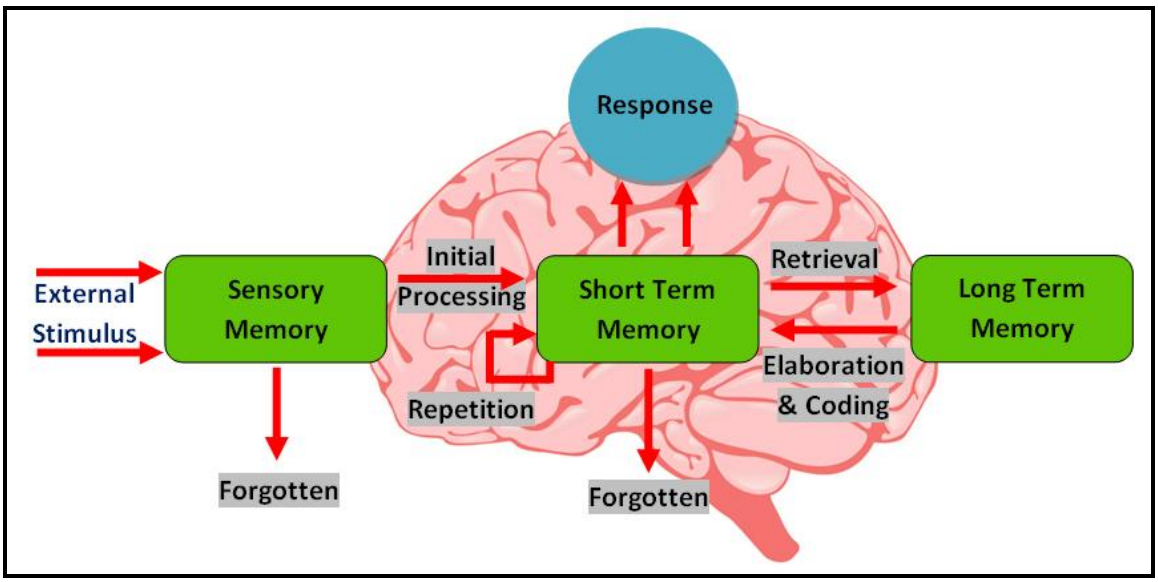

Figure 2.2: Information Processing Model

2.4 Down Syndrome and Mathematics

Children with disabilities tend to have cognitive delay, lacking capability to listen, think, read or to perform mathematical calculations. There are some examples of cognitive skill usage in calculation, for example the ability to represent, store and retrieve information for long term memory. Poor skill in this area will result to slow and often inaccurate recall of number facts. In addition, lack of skills in procedural knowledge and executive functions will result to incorrect selection and use of algorithm and strategies. In addition, according to Amy Dunaway (2010) the ability to acquire mathematics skills of children with DS are poor compared to their functioning in other areas. This is mainly because they are lacking in cognitive areas.

A number of researches have been done to study about how to enhance the cognitive ability so that it will be easier for them to grasp the mathematics skills. Ortega-Tudela and Gomez-Ariza (2006) have conducted a research on the relationship between teaching mathematics to DS children using multimedia materials and pencil-paper based task. The result from this research has shown that DS children who learned mathematics using multimedia showed a higher performance compared to the other group. From this research, we can see the teaching method and the mathematical learning preferences of the DS children.

Among the significant research that had been done is “Teaching Mathematics to Children with Down´s Syndrome”. The scope of this study was to design a learning tool for teaching basic mathematics concepts, such as the addition operation, to the children with DS. This study indicates the essential software characteristics for teaching mathematics in children with learning difficulties. Some of the crucial characteristics are; avoid using excessive textual interface of instructions and more focus on pictures and animations, feedback which explain the causes of errors and operations, and verbal content must be presented in a simple format so that it is accessible for lower level users (Bruno et al. 2003). The research showed that using computer application can enhance the children’s cognitive ability and allow them to learn mathematics more easily.

Apart from computer applications developed during the research, there is a number of learning modules for individuals with learning disabilities including DS. The modules have been presented in various medium such as in books, computers and handheld devices and some of them were being transformed to a kind of thing or object such as NUMICON. These are the examples of the current mathematics teaching methods for DS children.

“Teaching Math to People With Down Syndrome and Other Hands-On Learners: Basic Survival Skills (Topics in Down Syndrome)” authored by DeAnna Horstmeier is one of the well-known book used to teach children with learning difficulties. This book is focusing on teaching essential basic mathematics such as addition and subtraction, concepts about time and money, measuring and counting. Without doubt, the content of this book is good to equip DS and other children with learning difficulties with daily living skill. Unfortunately the drawback of using book is it is difficult to retain the attention span since it lack of elements that can attract children’s interest such as multimedia element.

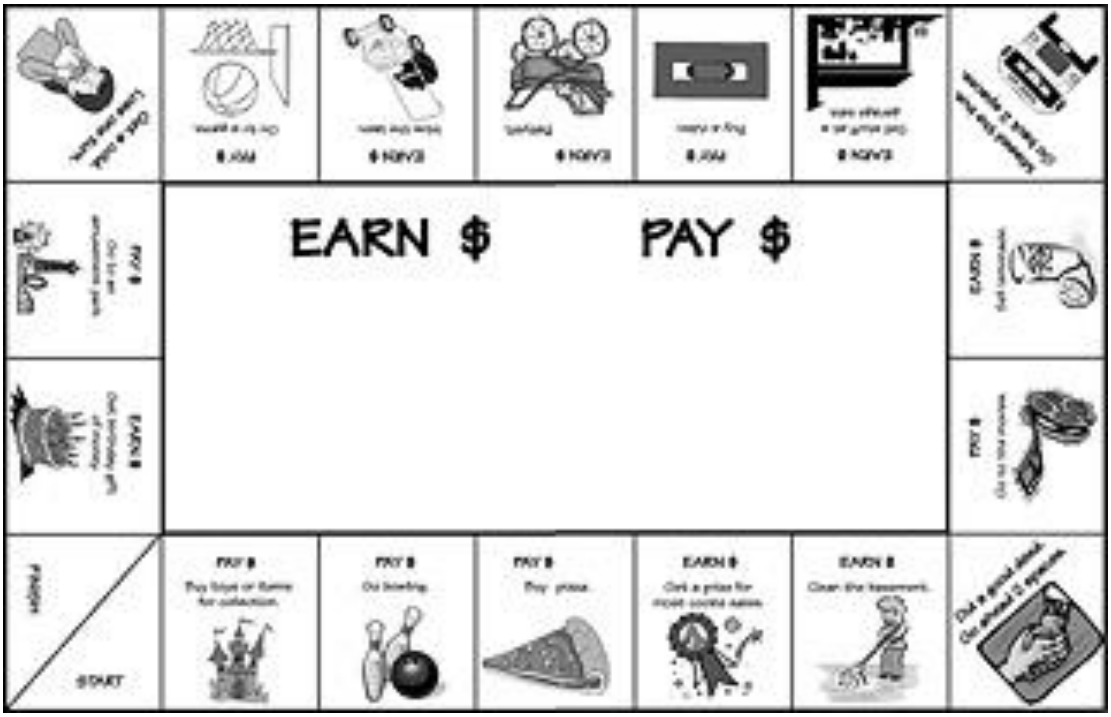

Figure 2.3: One of the games in the book

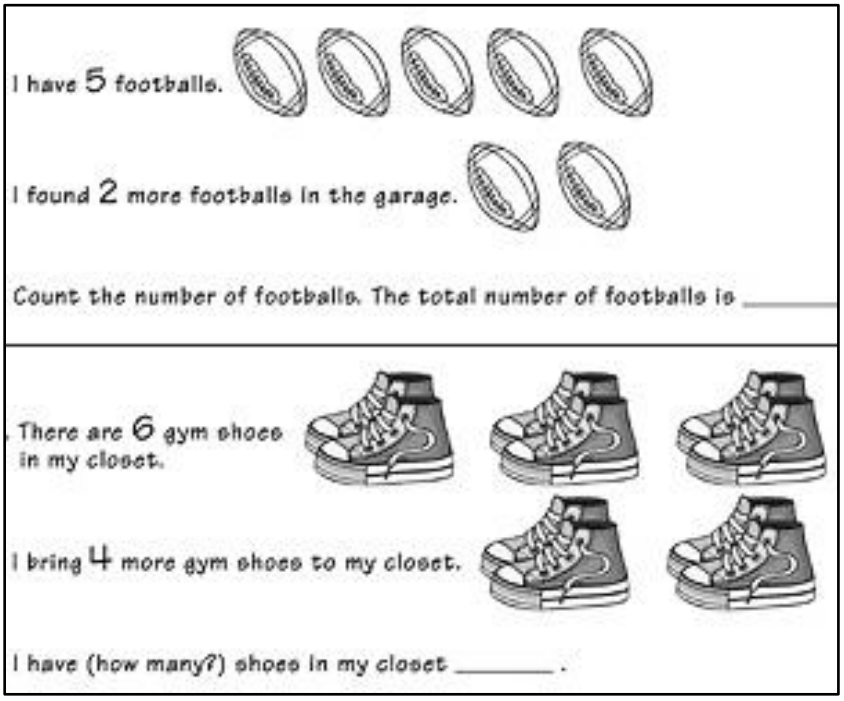

Figure 2.4: Problem solving with drawings

Other than books, there are also a lot of mathemathical games that have been developed and can be easily downloaded from the Internet. Besides, there are also websites which provide free mathematical games and programs for kids. The example of those websites and games are KidsNumbers, LDonline and Monkey Math School Sunshine. However, some of the games are not customized to fit the learning profile of DS children and it might get the children becoming less engrossed to play with the game.

Figure 2.5: An example of mathematical game for children

Due to the fact that children with learning disabilities need to use direct manipulation of objects which are graphically represented because they require a simpler and more immediate interface, a multisensory teaching tool has been invented and named as NUMICON. It is a set of object using special ‘number shapes’ that is used in teaching activities. The shapes help children to understand number more easily, as it uses visual concrete stimuli. This method has said to be helpful for children struggling with number, no matter how old they are. In spite of the advantages that NUMICON offers, one of NUMICON’s weaknesses is that it cannot retain the children’s interest for a long period as compared to multimedia learning assistance.

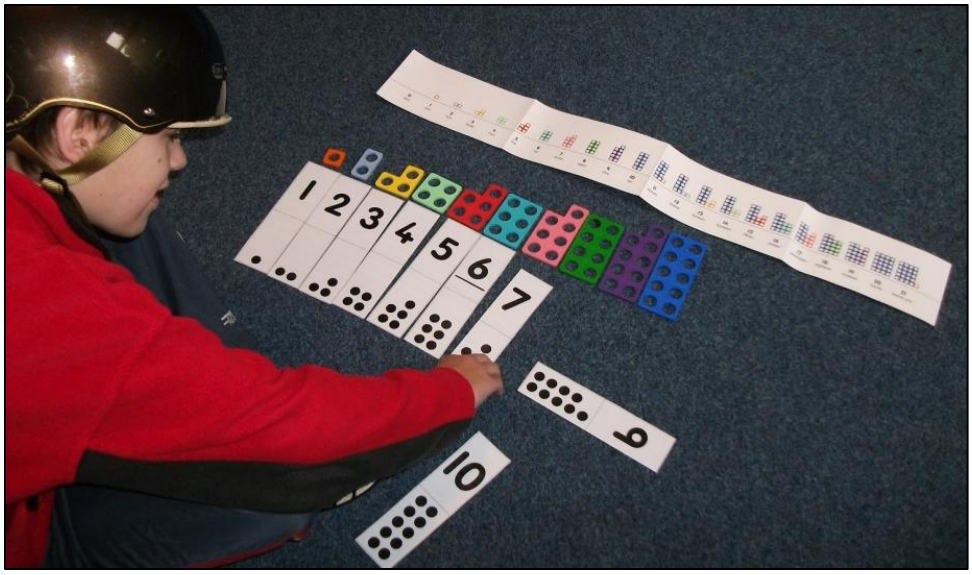

Figure 2.6: A Down syndrome child is learning numbers by using NUMICON

Although there are numbers of researches and learning tools that have been developed to further assist the children with learning difficulties, there is still lack of studies focuses on the numeracy abilities and achievements of children with DS especially the skills in money, time measurement and other basic mathematical functions that can assist them in becoming a more independent individual in their daily life. This opens a great opportunity for researchers to explore more on the DS and mathematics.

CHAPTER 3
METHODOLOGY

3.1 Introduction

In designing the end product which is the application of learning the basic of numbers for DS children, the methodology used is Rapid Application Development (RAD). RAD is used to adapt with the agile developing processes due to the time constraints. It is possible to achieve a suitable release of the end product by using this type of development model. Thus it is certain that the application developed using this method is likely to meet the current user needs. Phases involved in RAD are; Requirements Planning, User Design, Construction, and Cutover. Figure 3.1 shows the diagram of RAD.

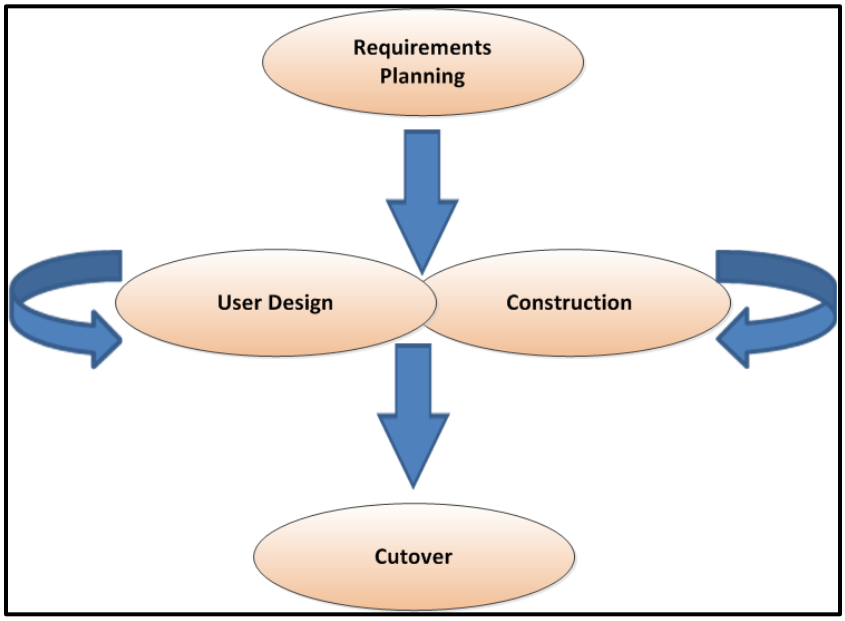

Figure 3.1: Rapid Application Development (RAD) Diagram

3.2 Project Activities

3.2.1 Requirements Planning

This is where the research to develop number skill conceptual framework for DS children will be done. The research will be conducted in three phases. In Phase 1, the research is done to determine the need assessment on learning mathematics of DS, their instructors and parents at a selected DS center. While Phase 2 will be is focusing on identifying the essential requirement of the prototype that will be developed. Finally, Phase 3 involves derivation and validation of the proposed numeracy skill framework.

To gather the entire requirement needed, various methods are used for example, detail examines on previous research papers, interview and survey. In this phase is where the interview session with Ms. Suzilina Meor Abdul Aziz and Mr. Christopher from Kiwanis Down Syndrome Center (KDSC) had been done. The objective of this interview is to specify areas of the research, determine the requirements and the types of leaning tools used. The results of the interview will be discussed in the Chapter 4.

In addition, a survey using a set questionnaire was done to gather data from parents and teacher at KDSC. Two observation checklists were prepared: one will be answered by the teacher-in-charge and the other by the mothers of the DS children. In the teacher's checklist (Appendix C1) are 34 items which are classified as cognitive, affective, psychomotor and observable behavior problems. The parent's checklist (Appendix C2) contains Part A which contains the same item as teacher's checklist and addition Part B questions concerning their DS child's activities at home. The purpose of the questionnaire is to have a basic understanding about the children by observing the activities performed by the children during the session and their behavior of the children at the center and at home.

3.2.2 User Design

During this time, the instructors of the DS children and the developer participate in discussion, where those involved used integrated tools to support the rapid prototyping of system design. Instructors will give some opinion on how the application should work to ensure that it will successfully assist DS children in learning mathematics. Instructors and developer will work closely and quickly to create prototypes that capture systems requirements and that become the basis for the physical design of the system being developed. At the end of user design, the outcome should be as below:

- Diagrams defining the interactions between process and data
- Preliminary draft of the interface

3.2.3 Construction

During this phase, the developer will start to develop the prototype code using the Adobe Flash CS5.5. Instructors also will participate to validate screens and other aspects of the design as the application system is being built. When developing small systems, construction and user design are combined together. The outcomes from this activity are:

- Finalized number skill conceptual framework.
- Finalized design of the prototype.
- The system builds using the Adobe Flash CS5

3.2.4 Cutover

Cutover is the delivery of the application to its end users. Planning for cutover must begin early in the RAD process because the RAD approach is so fast. Cutover involves many of the traditional activities of implementation, including testing the system, user acceptance testing and training users. The outcome from this activity is that the new application will be implemented.

3.3 Tools

There are a number of essential tools needed in developing this. Below are the minimum requirement and tools required:

- Personal computers with Windows platform, 1 GB RAM (minimum), 80 GB hard-disk space, including 115 MB of available space on the hard disk that contains the operating system.
- Adobe Flash CS5.5 to develop the application.
- Action Script 2.0
- Photo editing website such as clker.com
- Sound Recorder

CHAPTER 4
RESULTS & DISCUSSION

4.1 Literature Review Findings

From the literature review, the findings are as below:

- DS children learn like normal kids but at slower pace ("What is Down Syndrome?" 2012).
- Delay in Mathematics compared to language ("Developing Numeracy Skills," 2011).
- They need personalized learning especially in numbers (Feng & Lazar, 2010).
- Interactivity has always been something to strive for to keep children's interests going (Ortega-Tudela & Gomez-Ariza (2006).
- Need repetition in learning (Abdelhameed & Porter, 2006; Buckley, 2007; Leech, 2006).
- Love direct manipulation of objects (Bruno et al, 2003).
- Cognitive Learning Theory is one of the relevant theory in developing the numeracy conceptual framework for the DS children ("Cognitive Learning Theory", 2011).

4.2 Interview Findings

Most of the findings through interview are the same with literature findings. Below are the additional findings gathered from the interview:

- Attention span is longer when using computers.
- Like colours, sound and direct manipulation of objects in learning.
- Language used: Malay and English.

4.3 Survey Findings

Nineteen (19) DS children between aged 1 to 13 years old were observed. They are brought to the KDSC by their parents for a two hour session conducted by the teachers. The respondents of the questionnaire consist of 10 mothers and 1 teacher from KDSC. In the questionnaire, mean is used to determine the occurrence of:

- Activities listed in the questionnaire performed by the children during the session.
- Behavior of the children at the center and at home.

The mean responded by the teacher in Table 2 are according to age range of DS children which are 10 to 13, 7 to 9, 4 to 6 and 1 to 3 years old. Column 1 shows the item numbers for each category. For the age 10-13 the mean responses for the learning domain are greater than 3 (75%) where the highest is Psychomotor 3.35 (83.75%) which is about the proper eating, sitting, pencil holding, coloring, dressing up and putting things in order. Followed by Affective is 3.19 (79.75%) which is about confidence, happiness, relating to others, attention and cleanliness. Finally, Cognitive 3.14 (78.5%) which is about recognition, remembering, conversing, counting, doing task with simple instruction. For the age 7-9, Affective is the highest 2.0 (50%), this is about confidence, happiness, relating to others, attention and cleanliness, followed by 1.9 (47.5%), Psychomotor and Cognitive is only 1.45 (36.25%). For age bracket 4-6, Affective is the highest 3.02 (75.5%), Cognitive 2.61 (65.25%) and Psychomotor, 2.43 (60.75%). For age bracket 1-3, Affective 2.54 (63.5%), Cognitive 1.74 (43.5%) and Psychomotor 1.7 (42.5%).

From the teacher's view, occurrence of behavioral problems is between 1.29 (32.25%) to 2 (50%). From the parents' views, (Table 2) is between 1.67 (41.75%) to 2.7 (67.5%) which is higher compared to the teacher's response. The reason could be the DS children only stay 2 to 5 hours per week at the center as compared to staying longer at home. It means that DS children do show their anxiety (nervous) with repetitive behavior, and withdraw from peers or family members.

Table 2: Teacher's responses

Category (Item No)	Age 10-13	Age 7-9	Age 4-6	Age 1-3
Cognitive (1-11)	3.14	1.45	2.61	1.74
Affective (12-19)	3.19	2	3.02	2.54
Psychomotor (21-22,27-34)	3.35	1.9	2.43	1.7
Behavioral Problem (20, 23-26)	1.8	2	1.75	1.29
N=19	n=2	n=2	n=8	n=7

Table 3: Parents' responses

Category (Item No.)	Age 10-13	Age 7-9	Age 4-6	Age 1-3
Cognitive (1-9, 19)		2.65	1.68	2.03
Affective (10-17, 20)		2.66	2.82	2.56
Psychomotor (25-34)		2.4	2.67	2.27
Behavioral Problem (18, 21-24)		2.7	1.88	1.67
N=10	n=0	n=2	n=5	n=3

Table 3 shows mean responses of the parents. For the age 10-13, checklist was not returned. While for the age 7-9, the mean for Affective is 2.66 (66.5%), Cognitive 2.65 (66.25%) and Psychomotor 2.4 (60%). For this group of age, the means are very near to each other. For the age of 4-6, the highest mean is Affective, followed by Psychomotor and Cognitive with the following values of 2.82 (70.5%), 2.67 (66.75%) and 1.68 (42%).

It could be seen that, DS children have many intellectual challenges and it is necessary for the teacher to find strategies so that they will progressively move up and never assume that the child is not capable of doing things. They could be helped using the right tools that are appropriate for their learning capabilities. It is hoped that the application that is being developed will help them in learning Mathematics more effectively.

4.4 Conceptual Framework

According to Ludy Mae Naizaro (2012) conceptual framework is described as the a set of organized structure consist of ideas and elements that guide the development of the study or project. Typically frameworks are based on the identification of key concepts as the elements in the framework and the relationship among these concepts.

Figure 4.1 shows the conceptual framework that had been developed. It consists of 4 elements which are “Cognitive Theories”. “Language”, “Multimedia Elements” and finally “Development”. Each of these elements serves as a guideline for developing the Mathematics application for Down Syndrome children in Malaysia.

The first element which is the Cognitive Theory elements is a basic that should be included in the application. For example in the application that had been developed, audio and visual aid is being used and it is in line with the Dual Coding Learning theory. While Multimedia elements are needed in order to ensure that the application will be able to grasp the students’ attention and make their attention span a little bit longer. On the other hand, it is essential to have language element in the application. The language structure used should be simple and understandable by the users. Finally, the development of the application will integrate and implement all of the other elements into the application and make them accessible by the users.

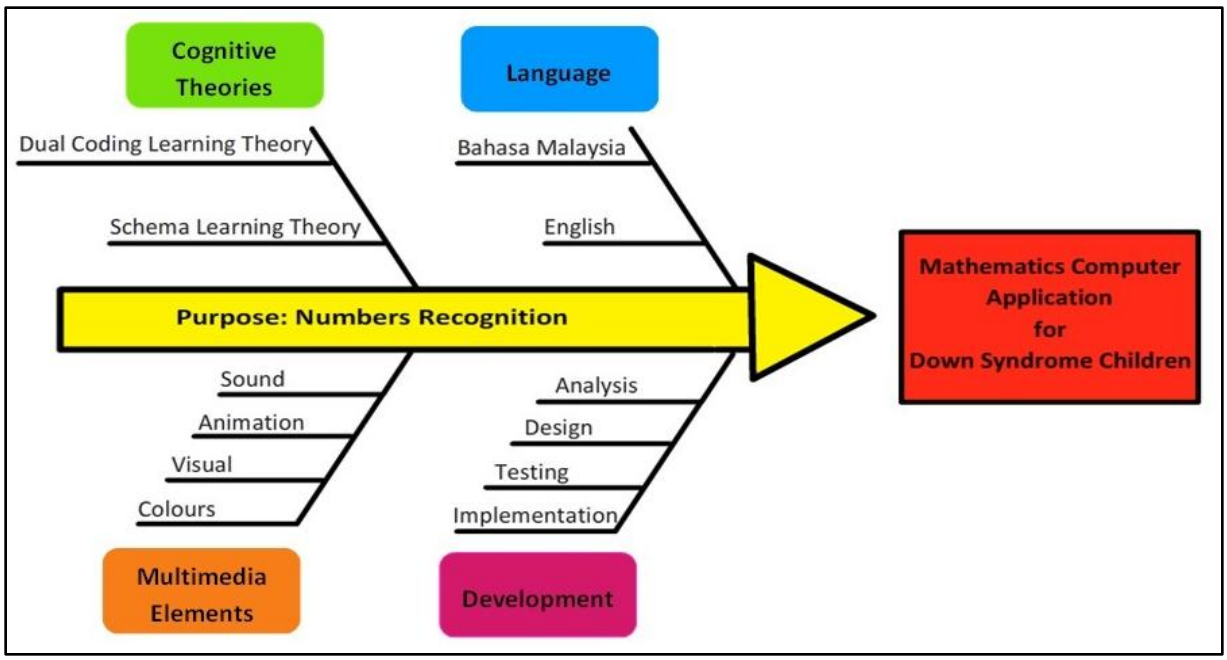

Figure 4.1: Conceptual Framework

4.5 Prototype

The user interface had undergone preliminary development prior to the completion of the storyboard design. This user interface was developed using Adobe Flash CS5.5 and it is designed to be as friendly as possible for usage of the DS children. The application was developed to accommodate Bahasa Melayu and English Language users. The main idea is to teach children with DS to recognize number from 1 to 10 by using this application. There are mainly 3 activities which are “Learning”, “Counting” and “Matching” and users can choose whether to do the activities starting from 1 until 5 or 1 to 10. In addition, the application was coded using ActionScript 2.0 and some of the codes will be shown in the Appendices subtopic.

Figure 4.2 shows the first page of the application. In this page, users will be able to choose whether they want to do the activities in English or Malay Language by clicking either one of the buttons. On the other hand, Figure 4.3 shows the screenshot of the level page. At this page users can choose to do the activities from umber 1 to 5 or from number 1 to number 10.

Figure 4.2: Screenshot of Main page

Figure 7: Screenshot of the level page

Figure 4.4 shows the "Menu" page that the users will be directed to after they have chosen the level that they want. In this page users can choose to between 3 modules which are the "Learn" Module, "Match" Module and "Count" Module. Other than that, the "Learn" page as shown is Figure 4.5 will teach students to recognize numbers.

Figure 8: Menu Page

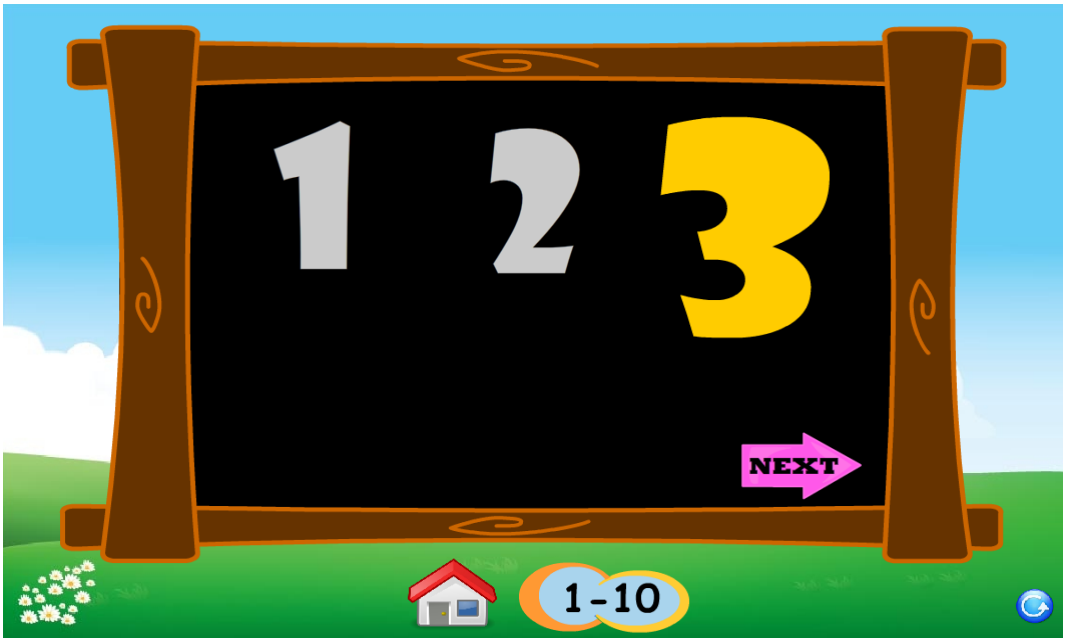

Figure 9: "Learn" Module page

Figure 4.6 shows the Match" module screenshot. This module will allow the children to match the numbers and their shape. On the other hand, the "Count" Module in Figure 4.7 will teach the children about the value or amount for each of the number.

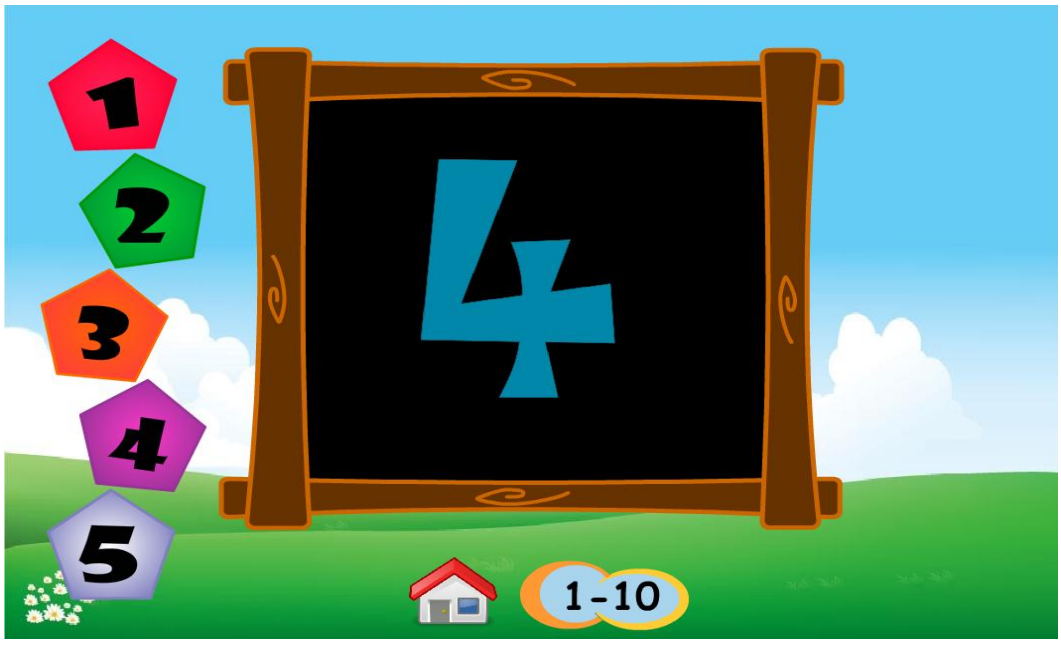

Figure 10: The "Match" Module Screenshot

Figure 11: The screenshot of "Count" Module

4.6 User Acceptance Test

Three (3) children with Down Syndrome aged between 8-13 were participated in the testing process. They were chosen because they fulfilled the basic requirement which is at least they can respond to instructions that is given by their teachers.

Listed below are the objectives for the test:

1) To test users' acceptance to the application.
2) To test whether users can connect their prior knowledge with the information in the application.

In order to achieve the objectives, observation checklist (Appendices E) was prepared prior to the testing. There are few elements listed in the checklist. The elements from number 1 until number 6 were listed to observe about the users' acceptance towards the developed application. While element 7 and 8 were listed in order to test whether the children can connect their existing knowledge with the information in the application.

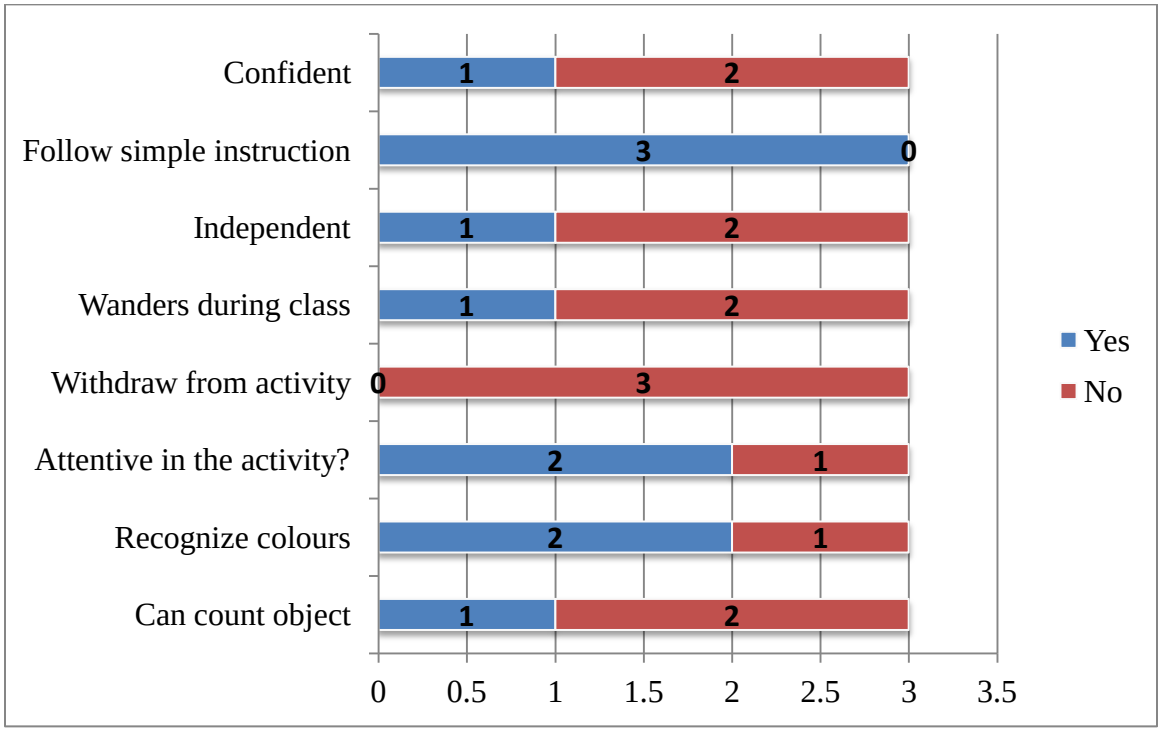

Figure 12: Testing Result

Based on the observation made, it can be concluded that the children can use and accept the application based on the children participation in the activity. The children can follow simple instruction given by their teacher and none of them withdraw from the activity. Eventhough there was a child that always wanders during the activity, he will continue to do the activity once instructed by the teacher. In addition, one of the children was eager to use the computer. The reason is maybe because he has been exposed to computer at home. On the other hand, the result also showed that the children can connect the existing information with new things.

CHAPTER 5
RECOMMENDATIONS & CONCLUSION

5.1 Recommendations

There are several recommendations that can be made to this prototype in the future. The recommendations are not meant to change this project wholly, but to allow improvements in certain aspects and make this application better.

One of the major recommendations is the content of the current modules in the application should be deepened since the current module is just giving the children a very basic exposure to numbers. Adding variety to the module is a must because once the children have mastered with a level of knowledge, for example he have recognized all the numbers he/she may proceed with the more difficult level of mathematics. It will allow them to expand their mathematics skills. In addition, the font also should be changed from funky fonts to standard fonts such as the Arial and Comic Sans MS since the children might get confuse with the design of numbers when funky fonts are being used.

The second recommendation is, there should be more animation and interactivity added in this application since children with DS are very fond of interactivity in their learning. Interactivity will allow them to explore the knowledge by themselves and it can expand their attention span. Extending their attention span is very crucial since they will be able to learn more if they can focus longer.

Lastly, it is recommended that this application should be developed so that it can be used with handheld devices such as smart phones and tablets so that it will be easier for

students with motor control problem to use this application. To allow that thing to happen, this application should be modified so that it is compatible with many platforms such as Android and iOS.

As conclusion, it is hoped that the application could further support Down Syndrome children in learning mathematics especially for the children in Malaysia. By the end of the stage, the system should work fine as it is intended for and the objectives of this project shall be achieved successfully.

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APPENDICES

Appendix A1: Key Milestones

Key milestones are the events marking significant stages in application development.

FYP 1

Activities	Week
Selection of Project Title	2
Submission of Proposal for Research	3
Submission of Extended Proposal	6
Proposal Defense and Progress Evaluation	13
Submission of Interim Report	14

FYP 2

Activities	Week
Project Work Continues	1 – 10
Submission of Progress Report	4
Pre-SEDEX	10
Submission of Dissertation	13
Oral Presentation (VIVA)	15
Submission of Project Dissertation (Hard Bound)	17

Appendix B1: Gantt Chart (FYP 1)

No.	Project Activities	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Selection of Project Title**														
	Search for Project Title														
	Project Title Approval														
2	**Submission of Proposal for Research**														
	Writing Project Proposal														
	Submit Proposal and Approval														
3	**Submission of Extended Proposal**														
	Perform Literature Review Research														
	Identify Project Methodology														
	Design Project Flow and Gantt Chart														
	Submit Extended Proposal														
4	**Proposal Defense/Progress Evaluation**														
	Prepare Presentation Slide														
	Proposal Defense & Progress Evaluation														
5	**Submission of Interim Report**														
	Project Works Continue														
	Submission of Interim Report														

Process
Suggested Milestone

Appendix B2: Gantt Chart (FYP 2)

No	Project Activities	Week																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	**System Construction**										■							
	Development Phase																	
	System Implementation																	
2	**Progress report Submission**				■													
	Writing of Progress Report																	
	Submission of Progress report																	
3	**Pre-SEDEX Presentation**										■							
	Prepare Presentation Slide																	
	Present for Pre-SEDEX																	
4	**Submission of Dissertation**													■				
	Writing Dissertation																	
	Submit Dissertation																	
5	**Viva : Oral Presentation**															■		
	Project Works Finished																	
	Prepare Presentation Slide																	
	Present for Viva															■		
6	**Submission of Final Dissertation**																	■
	Writing Final Dissertation																	
	Submit Final Dissertation																	

Process

■ Suggested Milestone

Appendix C1: Students and Teachers from Kiwanis Down Syndrome Center

Figure 13: Teacher Chris with the students

Figure 14: One of the students was doing the in class activity.

Appendix D1: Observation Checklist for Teacher

Observation Checklist (Teacher)

Name : _____ Age : _____

Gender : ☐Female ☐Male

Part A: Based on your observation, tick (/) the appropriate scale that will describe the child in each item.

No.	Items	1	2	3	4
1	Talks or converses to others.				
2	Follows simple instructions.				
3	Wanders during class.				
4	Eyes focused during conversation.				
5	Can count objects.				
6	Recognizes familiar persons.				
7	Remembers names of familiar persons.				
8	Interested in class activity.				
9	Recognizes colors.				
10	Does tasks given by teacher.				
11	Can write.				
12	Relates to others.				
13	Confident.				
14	Happy.				
15	Plays with others.				
16	Well mannered				
17	Looks clean.				
18	Voice loud enough to hear.				
19	Attentive during class activity.				
20	Shows aggression.				
21	Less assistance needed (Independent).				
22	Dresses appropriately.				
23	Appears nervous /anxious.				
24	Withdraws from classmates/persons.				
25	Do repetitive behavior/actions.				
26	Talks to self (seems to have his/her own world).				
27	Walks independently.				
28	Unsteady walks (loses balance).				
29	Sits properly.				
30	Put things/toys in order				
31	Uses toilet with less assistance.				
32	Holds pencil appropriately.				
33	Can color by crayons appropriately.				
34	Eats without assistance (not assisted in getting his/her snacks).				

1 = Never 3 = Often 2 = Sometimes 4= Always

Appendix D2: Observation Checklist for Parents

Observation Checklist (Parents)

Name : _____ Age : _____

Gender : ☐ Female ☐ Male

Part A: Based on your observation, tick (/) the appropriate scale that will describe the child in each item.

No.	Items	1	2	3	4
1	Talks or converses to others.				
2	Follows simple instructions.				
3	Wanders during class.				
4	Eyes focused during conversation.				
5	Can count objects.				
6	Recognizes familiar persons.				
7	Remembers names of familiar persons.				
8	Interested in class activity.				
9	Recognizes colors.				
10	Does tasks given by teacher.				
11	Can write.				
12	Relates to others.				
13	Confident.				
14	Happy.				
15	Plays with others.				
16	Well mannered				
17	Looks clean.				
18	Voice loud enough to hear.				
19	Attentive during class activity.				
20	Shows aggression.				
21	Less assistance needed (Independent).				
22	Dresses appropriately.				
23	Appears nervous /anxious.				
24	Withdraws from classmates/persons.				
25	Do repetitive behavior/actions.				
26	Talks to self (seems to have his/her own world).				
27	Walks independently.				
28	Unsteady walks (loses balance).				
29	Sits properly.				
30	Put things/toys in order				
31	Uses toilet with less assistance.				
32	Holds pencil appropriately.				
33	Can color by crayons appropriately.				
34	Eats without assistance (not assisted in getting his/her snacks).				

1 = Never 2 = Sometimes 3 = Often 4= Always

Part B: Please answer the following questions.

1. Number of children in the family: _____
2. Your age when giving birth to DS child: _____
3. What is your wish for your DS child?

   _____

4. How siblings and other members of the family treat the DS child?

   _____

5. Number of times the DS child throw tantrums in a week: _____
6. Usually, what are the causes of the tantrums?

   _____

7. If there's any gathering being held in the community, do you bring your DS child to join the gathering?

   _____

Appendix E: Observation Checklist for the Testing

Testing Observation Checklist

Name : _____ Age : _____

Gender : ☐Female ☐Male

Based on your observation, tick (/) the appropriate scale that will describe the child in each item.

No.	Items	Yes	No
1	Follows simple instructions		
2	Confident		
3	Wanders during class.		
4	Attentive during class activity		
5	Withdraws from the activity		
6	Independent when using the application		
7	Recognizes colors		
8	Can count objects		

Appendix F: ActionScript 2.0 Codes

1. Example of Codes for Buttons

```
stop();
EnglishMenu.onRelease = function()
{    gotoAndStop("Scene2_MenuNum", 1); }

MalayMenu.onRelease = function()
{   gotoAndStop("Scene7_MenuNumBM", 1); }
```

2. Codes for Match Module

```
stop();
selecao = "";
randomico = 1;
xinitial = "";
yinitial = "";

//Function for generating random number
function sorteia(){
_root.randomico = random(6);
if(_root.randomico == 0){
        _root.randomico = 1; }
_root.permainan2.keputusan.gotoAndStop(_root.randomico); }
sorteia();

//Function for drag and drop
permainan2.b1BM.onPress = function(){
_root.selecao = 1;
_root.xinitial = this._x;
_root.yinitial = this._y;
this.startDrag(); }

permainan2.b1BM.onRelease = function(){
if(this.hitTest(_root.permainan2.container)){
if(_root.selecao == _root.randomico){
        _root.permainan2.keputusan.gotoAndStop(11); }

else{ _root.permainan2.keputusan.gotoAndStop(12); }}

this.stopDrag();
this._x = _root.xinitial;
this._y = _root.yinitial; }

permainan2.b2BM.onPress = function(){
_root.selecao = 2;
_root.xinitial = this._x;
_root.yinitial = this._y;
this.startDrag(); }
permainan2.b2BM.onRelease = function(){
if(this.hitTest(_root.permainan2.container)){
if(_root.selecao == _root.randomico){
        _root.permainan2.keputusan.gotoAndStop(11); }

else{ _root.permainan2.keputusan.gotoAndStop(12); } }

this.stopDrag();
this._x = _root.xinitial;
this._y = _root.yinitial; }
```

```
permainan2.b3BM.onPress = function(){
_root.selecao = 3;
_root.xinitial = this._x;
_root.yinitial = this._y;
this.startDrag(); }

permainan2.b3BM.onRelease = function(){
if(this.hitTest(_root.permainan2.container)){
if(_root.selecao == _root.randomico){
        _root.permainan2.keputusan.gotoAndStop(11);
}
else{ _root.permainan2.keputusan.gotoAndStop(12); } }

this.stopDrag();
this._x = _root.xinitial;
this._y = _root.yinitial; }

permainan2.b4BM.onPress = function(){
_root.selecao = 4;
_root.xinitial = this._x;
_root.yinitial = this._y;
this.startDrag(); }

permainan2.b4BM.onRelease = function(){
if(this.hitTest(_root.permainan2.container)){
if(_root.selecao == _root.randomico){
        _root.permainan2.keputusan.gotoAndStop(11); }
else{ _root.permainan2.keputusan.gotoAndStop(12); }}

this.stopDrag();
this._x = _root.xinitial;
this._y = _root.yinitial; }

permainan2.b5BM.onPress = function(){
_root.selecao = 5;
_root.xinitial = this._x;
_root.yinitial = this._y;
this.startDrag(); }

permainan2.b5BM.onRelease = function(){
if(this.hitTest(_root.permainan2.container)){
if(_root.selecao == _root.randomico){
        _root.permainan2.keputusan.gotoAndStop(11); }

else{
        _root.permainan2.keputusan.gotoAndStop(12); }}

this.stopDrag();
this._x = _root.xinitial;
this._y = _root.yinitial; }

permainan2.b6BM._visible=false;
permainan2.b7BM._visible=false;
permainan2.b8BM._visible=false;
permainan2.b9BM._visible=false;
permainan2.b10BM._visible=false;
```

3. Codes for Count Module

```
//Function to delay the visibility of the balloons
stop();
```

```
rawak = 1;

bttn_goCount5.onRelease = function(){
_root.rawak = random(6)
if(_root.rawak == 0){
		_root.rawak = 1;}
		gotoAndStop(_root.rawak);}

var delayTime = 1500;
var step = 1; // Index variable that's used to step thru the array
var clipArray = ["red0", "blue0", "green0", "purple0"];

blue0._visible = false; // Turn visibility off clips
green0._visible = false;

var interval = setInterval(showClip, delayTime);
function showClip()
{		var clip:MovieClip = clipArray[step];
					_root[clip]._visible = true;

			step++;

		if(step == clipArray.length)
			clearInterval(interval); }}

//Function to increase the counter upon clicking of the balloons
stop();

red1.onRelease = function():Void
{ red1.unloadMovie();
_root.tekan = _root.tekan+1;
_root.keputusan5.gotoAndStop(_root.tekan+1);
if (_root.tekan == 1){
gotoAndStop(7); }}

blue1.onRelease = function():Void
{ blue1.unloadMovie();
_root.tekan = _root.tekan+1;
_root.keputusan5.gotoAndStop(_root.tekan+1);
if (_root.tekan == 1){
gotoAndStop(7);  }}

orange1.onRelease = function():Void
{ orange1.unloadMovie();
_root.tekan = _root.tekan+1;
_root.keputusan5.gotoAndStop(_root.tekan+1);
if (_root.tekan == 1){
gotoAndStop(7); }}

purple1.onRelease = function():Void
{ purple1.unloadMovie();
_root.tekan = _root.tekan+1;
_root.keputusan5.gotoAndStop(_root.tekan+1);
if (_root.tekan == 1){
gotoAndStop(7); }}

green1.onRelease = function():Void
{ green1.unloadMovie();
_root.tekan = _root.tekan+1;
_root.keputusan5.gotoAndStop(_root.tekan+1);
if (_root.tekan == 1){
gotoAndStop(7); }}
```