# Language Assessment and Training Support System (LATSS) for Down Syndrome Children Under 6 Years Old

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*Abstract:* - Theoretically and generally, Down syndrome children in this study are defined as children who are proven scientifically and medically of their impairment in mental health or developmental abilities. Although some of the limitations of Down syndrome children cannot be overcome, early childhood intervention is proven to be able to improve the quality of their lives. Early childhood intervention includes screening for common problems, and vocational training can improve the development of the Down syndrome children. The language ability is emphasized in this study as the speech and language skill of Down syndrome children are significantly delayed – more delayed than non-verbal abilities. Besides that, the speech and language skill underpin social and cognitive development, therefore affecting all aspects of development. In other words, improving the language ability of individuals with Down syndrome will improve all aspects of their development and quality of lives. In this study, the support system provides the most effective assessment and training method for language ability to the children. This software utilizes speech recognition technology, with modified internationally recognized curriculum, implemented in C sharp programming language. In conclusion, the result of this study is expected to be beneficial and able to assist parents and trainers on effective language training for Down syndrome children.

*Key-Words:* - Support system, Language training, Language assessment, Down syndrome children, Speech recognition, Early Intervention Program

## 1 Introduction

Theoretically, Down syndrome is a chromosomal disorder caused by the presence of all or part of an extra 21st chromosome which results in impairments and imperfections in developmental abilities and physical growth as compared to normal children. The Down Syndrome (DS) is an anomaly often associated with mental retardation, being the most common genetic cause of disability in development [1]. In other words, a Down syndrome child may take more time to learn to walk, to self-feed and to learn a particular new skill. Approximately one out of every 800-1,100 births results in an extra chromosome of the twenty-first group called Trisomy 21, or DS [2].

Although some of the limitations of DS cannot be overcome, early intervention program is proven to be able to improve quality of their lives. However it requires more time and patience from parents and trainers to train their special children on certain basic activities, as compared to normal children.

Early intervention program includes six main fields which are cognitive ability, language ability, gross motor ability, fine motor ability, social emotional, and self help ability.

Currently there are governmental and private bodies which provide education and care for Down syndrome children in order to improve the quality of lives of Down syndrome children. In those established Down syndrome centers, trainers have the responsibility and are being educated to assess the ability of each child and provide suitable training for him or her.

Assessment and training can be best defined as a continuous process in which one's achievement is judged using various methods and suitable exercises are provided to improve in the particular activity. The process of assessing and providing trainings are generally based on resources such as Hawaii Early Learning Profile (HELP), Vort curriculum, and so on. Table 1 shows the comparison between different products including their advantages and disadvantages.

Table 1
The comparison between different resources for EIP

| | **HELP** | **BCD** | **Child Laptop** |
|---|---|---|---|
| Functions | To assess and provide trainings | To assess and provide trainings | To provide interactive training |
| Price | High | High | Low |
| Advantage | Highly reliable and proven effective | Highly reliable and proven effective | Able to attract children's attention and lower cost |
| Limitation | Highly dependent on trainers' experience and hardly interpreted | Highly dependent on trainers' experience and hardly interpreted | Assessment not included, and no individual training given |
| Reliability | High | High | Medium |

In short, the current EIP in Malaysia is still done manually, in which it depends heavily on the experience of trainers and parents and the ability to interpret EIP as in books or website. Hence, the implementation of the EIP is still not effective.

One of the limitations in the current manual early intervention program is the lack of assessment instrument, as the current only way to assess the ability of the children is based on their individual interpretation on the available curriculum manually by experienced trainers. Secondly, the lack of individual curriculum for each child is also another problem in the current situation. Special children might have different ability though they are in the same age, and currently children in the same age are usually being allocated in the same classroom in Down syndrome centers and trained to do the same activities regardless of their difference in the ability obtained.

Next, the insufficient information and human resource limitation are also the limitations in the current early intervention program. Although some of the trainers are experienced, well trained and there are a lot of information about Down syndrome in the internet, parents and trainers in some countries or rural areas still find it hard to assess to the internet information and are less experienced to handle or train children with Down syndrome [15]

Therefore, there is a need to develop a new interactive support system, in other words, a network of professional available to a person or organization for practical or moral support when needed to train the children as well as to assist in the assessment and training for children from 0 to 6 years old, as that is the period when the brain develop the fastest and best in absorbing new knowledge obtained. Table 1.2 shows the comparison between the current methods of performing EIP and the support system developed. It is shown that the newly developed support system is well rounded and reliable in language assessment and training for special children.

This support system is innovative, as it provides a new method for effective assessment and training, besides making the learning and teaching process more interactive to the children. This new method and software is expected to improve the language ability of special children and enable the children to enjoy the teaching and learning process.

In this study, the language ability will be emphasized as the speech and language skill of DS children are significantly delayed – more delayed than non-verbal abilities Besides that, the speech and language skill underpin social and cognitive development, therefore affecting all aspects of development. In other words, improving the language ability of individuals with DS will improve all aspects of their development and quality of life [3].

# 2 Literature Review

## 2.1 Speech and Language

Beginning with the speech or language domain, six studies "claim favourable outcomes and four find little or no improvement" [4]. Studies by Brinkworth [5], Hayden & Dmitriev [6] and Aronsson & Fällström [7] are classified as showing "little or no improvement" for the speech/language domain. In the Brinkworth [5] study, the experimental group received a mean of 99.9, and the control group a mean of 69.7 on the hearing/speech scale of the Griffith developmental scales. The difference was statistically significant.

Considering the t-values, in contrast to the means, the difference in the hearing/speech measure is the second largest of the five domains investigated. In the Aronsson and Fällström [5] study, the training group showed an average increase of 7.9 months, as compared to 3.7 months for the control group, on the Griffith hearing/speech scale during the 18 months of training. No tests of significance are provided.

Nevertheless, in the absence of such a test, the reasonable conclusion would be that the training had a positive effect in the hearing/speech domain. Further, in both these studies, the differences on the hearing/speech scale were the largest in the follow-up testing. Hayden and Dmitriev [6] present different sets of data on language development. Gibson and Harris [4] choose to present the figure of 39-100 competency per age level in the early preschool section of the intervention program. These figures are, of course, hard to interpret. Nevertheless, in Hayden's and Dmitriev's [6] paper, another comparison is made between 14 preschool children, who had attended preschool for six to twelve months with five children who had just entered the program. The developmental lag on the Peabody Picture Vocabulary Test was 6.4 months for the former group and 21 months for the latter.

Consequently, the conclusion of "little or no improvement" does not seem reasonable although, admittedly, it is hard to draw any conclusion from these data. Following the line of reasoning by Gibson and Harris [4], the most reasonable conclusion seems to be that there is hardly any evidence against the hypothesis that early intervention programs are beneficial as regards the language/speech domain.

## 2.2 Learning to talk

Learning to talk is a complicated process, it involves few emerging skills, influenced by learning opportunities and it might take many years. The requirements in talking are as in Table 2. To express themselves through language, children need to know the words and grammar to express their thoughts in spoken language, they have to be able to make the sounds and words clearly so that their speech can be understood and then engaging someone effectively in conversation.

Table 2
The skills and knowledge needed for talking [8]

| **Interaction** | **Spoken language knowledge** | | **Speaking** |
|---|---|---|---|
| **Non-verbal** | **Vocabulary** | **Grammar** | **Speech motor skills** |
| smiling, eye-contact, taking turns, initiating a conversation, maintaining the topic (pragmatics, discourse skills) | building a dictionary of single words and their meanings (lexicon and semantics) | learning the word ending rules for plurals, tenses, word order rules for questions, negatives, (morphology and syntax) | learning to make speech sounds, produce clear words with correct stress and intonation (articulation, phonology and prosody) |

Table 3
An overview of language ability developmental progress for typically developing children, from birth to three years (for normal child) [9]

| | Birth | 1 year | 2 years | 3 years |
|---|---|---|---|---|
| Speech | Smiling, Cooing | Babbling, Words | Keyword phrases | |
| Reading | Experience of books and stories | | | |
| Memory | Attending | Copying | Choosing | Memorizing |

From birth to 3 years, children change from totally helpless infants to a person who is able to socialize with others, co-operate and communicate in spoken language. The development progress is as in Table 3. Apart from that, they begin to write, to count and to read. However, most children need supervision and supports for almost all those activities. Generally, DS children develop slower in speech, reading and memory skills compared to normal children. Thus more care required by parents on training on those skills. In order to assist parents and trainers or DS children, an effective support system for language ability is discussed here.

In this paper, we present an effective support system for language assessment and training for special children. Several aspects for example the age and ability of the children are considered while the assessment and training for language is being done. This support system does not only serves language as assessment and training system, but also important in managing the children data effectively and providing scientific information about DS to parents and trainers.

## 2.3 Early Intervention Program

An additional aspect of early intervention programs discussed by Gibson and Harris (1988) are the long-term benefits of early intervention. The reviewers report such data from eight studies [7], [5], [10], [11], [12], [13], [14]. The studies by Brinkworth [5], Aronsson and Fällström [7], Ludlow and Allen [10] and Cunningham [11] are taken as evidence of loss of gains at follow-up testing. While the Brinkworth [5] and the Cunningham [11] studies point in this direction, the Ludlow and Allen [10] study exhibits a narrowing of differences in IQ scores, but no such levelling for school placement.

In the Aronsson and Fällström study involving eight pairs of children with Down syndrome matched for chronological age, several changes took place between the intervention and the follow-up study. One pair of children was excluded, and 8 of the remaining 14 children had been moved to other institutions. Consequently, it is hard to draw any conclusions from this study with respect to long-term effects since we do not know what effects these new environments had on the development of the children. The study by Conolly et al. [11] supports long-term effects of early intervention. The evidence appears to be mixed. However, what would the conclusion be if long-terms effects are not substantiated?

No early intervention or continued intervention? Examples of such continuous intervention are characteristics of the intervention programs reported by Hudson and Clunies-Ross [12] and Pieterse and Center [13], especially the latter. Gibson and Harris [4] do not discuss the outcome of these studies with regard to some kind of control condition; that is, some kind of achievement of a comparable group of children with Down syndrome. Instead, the comparison is now made with non-Down syndrome "comparison" children. The argument turns from being concerned with effects of early intervention to possibilities of school integration. Nevertheless, the papers are not informative about long-term effects, understood as a comparison between treated and untreated groups of children with Down syndrome, at all.

To sum up, it does seem that early intervention in children with Down syndrome, given the methodological shortcomings of the field, provides support for reliable effects across different developmental domains. However, in agreement with Gibson and Harris [4], the question of long-term effects does seem to be an open issue. Even though the effectiveness of early intervention is still debated, it has become an accepted practice. While it is questionable if "early" is better in early intervention with children with Down syndrome [14], [4]. "Early" is accepted as better. One cannot on an a priori basis reject the hypothesis that early intervention is less based on scientific knowledge, than on deeply held cultural beliefs. Maybe the time is ripe to broaden the scientific interest in order to investigate the interplay of such beliefs with how early intervention is conceived.

As noted by Marfo and Cook [14], the "efficacy" issues seem to be a typical American preoccupation and early intervention can be considered legitimate on other grounds, such as in terms of humanistic values. As the "efficacy" issue has been tied to economical resources, the quest to prove the efficacy of early intervention programs has become vital. Nevertheless, in this way, more important research concerns might have become neglected, such as more specific questions concerning training methods. While the historical process seems to make the control-group design anachronistic, methods addressing the differential effectiveness of training methods do seem suitable, both from ethical and scientific standpoints.

## 2.4 Current related research

The latest related research published is the research entitled “Java Based Automatic Curriculum Generator for Children with Trisomy 21” [15] in World Academy of Science, Engineering and Technology 32, 2007. Also, the minor part of the researches above including research on “face tracking based camera motion control system” to observe the actions of children during training [16], cognitive assessment and training support system for special children to train the cognitive ability of the children [17] and the medical data security model for early intervention support system based on HIPAA for data management [18] are carried out simultaneously by researchers in Universiti Teknologi Malaysia.

Apart from Malaysia, researches in Slovakia also realizes the importance of interactive learning environment in learning process and has done a research on “E-learning Support for Computer Graphics Teaching and Testing” [19] in order to make the students’ learning process more fun and effective.

The researches were done to produce a helpful tool for assessment and training for special children. Data of the children is first inputted in the system, then being processed and the training is generated by the system. Assessments and trainings done by the tool includes the 6 main domain, including gross motor, fine motor,

social interaction, cognitive, language and self help abilities.

The product is related to this study as this study is also serves as an assessment and training tool, but only for language ability. However, this study concentrates more in the reliable of the system, by including the international recognized curriculum, in order to be more effective and reliable in assessment and training method.

# 3 Methodology

In this section, the procedure, and the methods used for language assessment and training support system will be described. This support system is divided into 3 main parts, namely the hardware devices, software, and content & database.

The hardware devices used is the microphone. It is existing technology and they will be integrated in this support system to train the language ability of special children.

The software used in this study is C Sharp programming. This programming language is used because it is established and contains libraries for different functions especially the speech recognition library which is crucial in this support system.

## 3.1 Hardware Implementation

The hardware used in this study is simple and available hardware. The purpose of utilization microphone is to perform reliable assessment and trainings to the children.

The microphone is used to record the voice of the children and as the input for assessment besides the manual input by users using keyboard. Also, the microphone is used as a training tool to train the speech ability of children. In short, the microphone is for speech recognition purpose.

The input of the support system is divided into 2 forms, which are the the input from keyboard and the input from microphone.

The outputs of the system are images and sound displayed in PC screen and speaker. The main process is done in the system. The software will be developed to interpret the input data sent into the system and to produces suitable outputs to the screen and speaker.

## 3.2 Software implementation

The software implementation is divided into 2 parts:

- The Graphical User Interface (GUI)
- The main program

The GUI is designed should be interactive and user friendly so that the program is easily used by the users.

A graphical user interface is a human-computer interface (i.e., a way for humans to interact with computers) that uses windows, icons, and menus which can be manipulated by a mouse or keyboard.

In this study, C Sharp is used to develop the GUI because of its open accessibility and availability. More details about GUI and functions of the buttons and slider will be explained in the next chapter.

## 3.3 Contents and database

To begin this project, big efforts were spent on data collection and regrouping of the sub-groups in language ability. Each sub-group is labeled and categorized so that there will be no conflicts between 2 sub-groups as in Table 4.

Table 4
The Assessment and Training System contains the following elements

| Assessment Group | Sub-groups |
|---|---|
| **Language** | Hearing, receptive language skills, expressive language skills, etc. |

The assessment method developed was adapted based on Hawaii Early Learning Profiles and Denver Developmental Scale to meet the prevalent local context. The differences between those in manual assessment and this assessment system are listed in Table 5.

Table 5
Differences between manual and Newly Developed Language Assessment and Training Support System

| | Manual Assessment | Language Assessment and Learning Support System |
|---|---|---|
| **Data management** | Manual data storing and analysis | Automatic data storing and analysis |
| **Assessment program** | Common or less precise | Individual and precise, based on priority and target |
| **Time to generate Training Schedule** | Longer time | Shorter time ( < 5 minute ) |
| **Teaching strategy** | Human limitation | No human limitation |

| | | |
|---|---|---|
| **Trainer requirement** | Special training for trainer required | Special training for trainer not required |
| **Environment** | Limited | Ubiquitous |

The flow of the system will go as below:

1. Personal Data of children is filled in.
2. Assessment of children's ability is being done.
3. Results of assessment is displayed
4. Training guidance is shown

Generally, the flow of the language support system is as below:

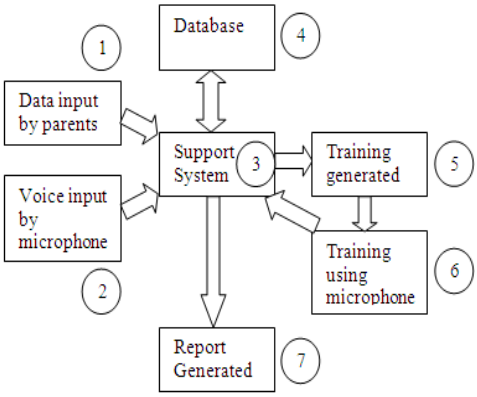


Fig. 1: Block diagram for language assessment and training support system.

First, the data is inputted into system after registration of the children. Then, the support system will save the assessment results in the database. Exclusive training guidance list and report of children assessment will be generated for a particular child specifically, and training is being done with the assistance of the parents or trainers.

# 4. Design and implementation

## 4.1 Computer Based-processing unit

By using computer-based processing unit, the language ability support system design is implemented using C sharp as the programming tool. The input of the system will be the user data and assessment by keyboard or microphone and the output will be graphical form of assessment and the guidance to trainings. The output will be displayed through computer's monitor. This support system can be described in Figure 3.

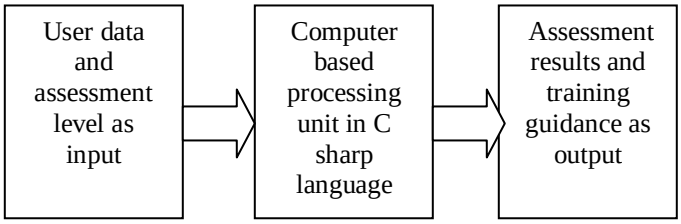


Fig. 2: Specification for computer-based processing unit

## 4.2 Development Tools

In software development, this support system is developed using C sharp programming language with the platform tool, Visual Studio. C sharp is used for data processing and implementation of algorithm.

Besides that, Microsoft Access and XML document is used for database management. Microsoft Access is applied to manage the children data and the assessment input in table form so that those data can be easily retrieved when they are in use. The software has been developed to receive input and record the user data, to process the user data in order to generate the results of assessment and graphical form, and then provide training guidance for users to train their children

Table 6
Development tools

| Function | Tool / Software |
|---|---|
| GUI application | C sharp |
| Software Platform | Visual Studio |
| Operating System | WINDOWS System |
| Database Management System | Microsoft Access and XML documents |

## 4.3 The design and functions of each part in the support system

There are 4 main parts in the support system:

1. <u>Children data acquisition and management</u>

The children data is obtained from the input of users. Then, all the inputted data is saved in the database in MS Access.

With the use of MS Access database, security measures can be implemented to protect the data and design. Besides that, the data can be retrieved easily in the later stage in result analyzing and language training generation stage.

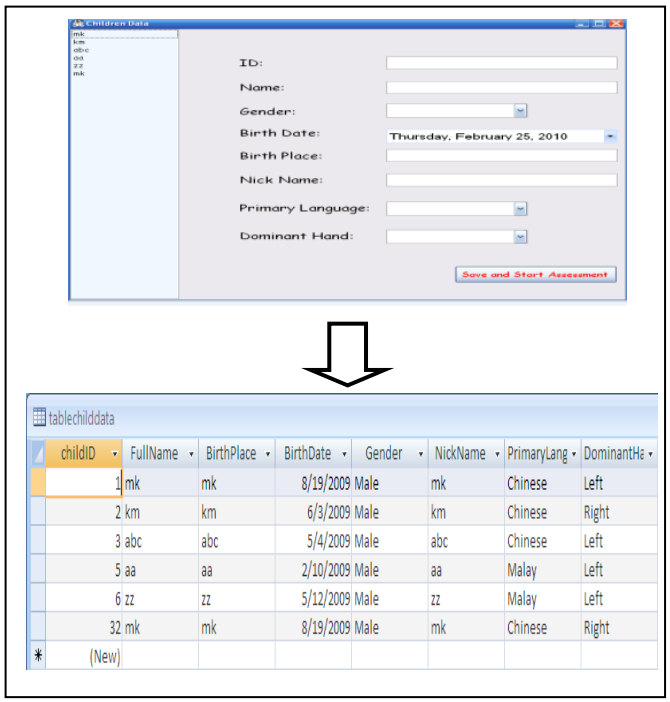


Fig. 3: Children data management for language assessment and training support system.

2. Language Assessment for children

The most effective assessment method in language ability requires the biological age of child, a simple formula in C sharp programming is able for user to obtain biological age of children from his/her birth date.

```
years = now.Year - childBirth.Year;
Months = now.Month -
childBirth.Month;
childAge = (years * 12) + Months;
                                    (1)
```

The calculated results will be the biological age of children in months. The effective age of language assessment includes assessment activities on biological age of children, 5 months before and after the biological age of the children. The assessment list is according to the world wide recognized curriculum – Hawaii Early Learning Profile (HELP) with some modifications to suit Malaysian children. The language activities are being divided into 4 groups, namely the vocalize ability, verbalize ability, expression of thoughts and feelings, communication, and understanding of communication.

Database of the assessment list is available in Extensible Markup Language (XML) format. The main advantage of XML is that the data is portable and it allows users to have nested entries. XML allows users to preserve document structure, supports document transactions and execute queries in an XML query language.

Native XML databases are designed especially to store XML documents. It enables users to retrieve data much faster than a relational database. One more reason to store data in a native XML database is to exploit XML specification capabilities, such as executing XML queries. C Sharp language allows users to save and retrieve data from the database in XML effectively and easily by creating a tree view and called in the part of the program programmers want to execute or utilize the database.

During the effective assessment process, users can insert the level of achievement of the children in particular activity in the language assessment list, level 0 is inserted if the children cannot do it at all and level 3 is given if the children can do it well. In order to create a more accurate assessment results, speech recognition is used in language assessment. There are some assessments which require the usage of microphone to test the language ability of children pronouncing certain words or producing certain sounds. The input from children through microphone is compared to the database in the speech library used in C sharp programming. The saved assessment levels are kept inside MS Access in the training result table.

3. Generation of Assessment Report

After the assessment, result from effective language assessment is used to construct a graph for each group in language ability to the level of achievement of children in all the language activities assessed overtime. For effective language assessment, users need to repeat the assessment from time to time to ensure the trainings given to the children are generating positive impacts on the children language ability improvement. This support system can show the improvements of children in language ability from time to time so that the users can observe the effectiveness of training and thus give the most effective trainings to their children.

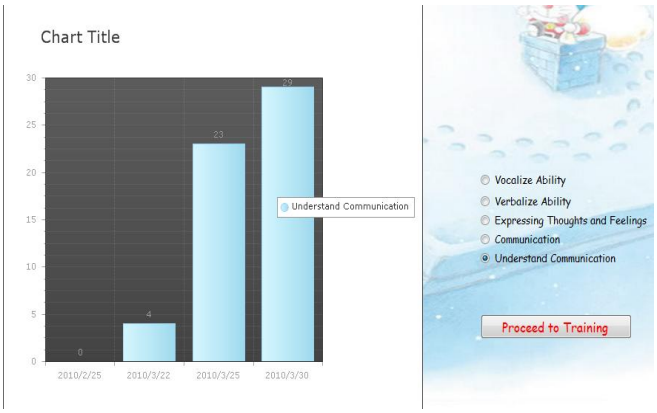


Fig. 4: Graphical form of the achievement of the children in different language groups

Also, the suggestions of children language training in the group that the children score the lowest will be given. By using that, the parents or trainers can use the guide to train their special children. The training generated for each child is different, depending on their achievement and ability in language. Unique and specific training suggestions are given to different children to ensure the best and most suitable trainings are given to a particular child.

4. Language Training for children

The training list is generated based on the assessment results of the children.

The tool used for training is microphone, the children needs to speak a word or phrases repeatedly until they can achieve good level in the particular activities with proper teaching and encouragements from the parents. Some other training activities which cannot be trained using microphone will be given training guidance and instructions so that the users can train the children well.

After the training is done, the whole process of effective assessment and training is finished.

5. Information and Help Topic

In order to carry out effective assessment and training for language ability, there is a button in the support system to call a Portable Document Format (PDF) file which contains the DS information. With this, parents are expected to know more about their children and understand their children's needs and characteristics.

Apart from that, this support system is also equipped with a user manual which provides step to step instructions on how to use this support system is provided.

# 5. Testing Results and Optimization

After the support system is developed, some testing has been conducted. Firstly, a testing is conducted for GUI application for language assessment and training. Then, user acceptability testing is carried out to find out the feedback of users including parents and teachers on this support system. Last but not least, an analysis on semi automatic screening and training for language ability as well as graphical generation and user database management testing are also has been done, in order to make this system reliable and trustable for the users.

## 5.1 GUI Application

The interface for language assessment and training has been tested in order to ensure that this is a user friendly support system for the users. This support system is run for hours and switched on and off repeatedly to test on this part. Table 7 shows the results for the GUI application testing.

Table 7
Testing on GUI application

| Events | Results |
|---|---|
| The GUI of support system fits the main application | Nothing is cut off when the counting menu is launched. |
| Same screen appears every time application is started | Same application appears every time the program is debugged |
| GUI features (e.g. buttons, dialogue boxes, checkbox) can be used | GUI features are working. Whenever and whatever the page is clicked, the system will go to the page with the related page. |
| Checking for spelling and grammar within the application | Checking on spelling and grammar has been checked and corrected. All the information is reliable and easily understood within the application. |
| Consistent and logical flow | The flow of the application has been tested and it is correctly according to the appropriate flow. For example, the application will go first to the children registration page, then to the assessment page, then to the results form and finally provide training guidance to the users. |
| Counting application can be closed | The counting menu application can be shutdown easily. |

### 5.2 User Ability Testing

Table 8
User feedback on the support system

| Events | User's Feedback |
|---|---|
| Color of the display | User's feedback: The display in was not interesting and attractive.<br>Solution : Animation display is used |
| Font size of the contents | User's feedback: The font size was too small<br>Solution: The font size had been adjusted. |
| Contents are stated clearly | User's feedback : The words used in the contents are stated clearly and visible to users |
| User-friendly application | User's feedback: The application is very user-friendly. There is a user manual to help parents to use this support system; user instructions from the first until the last step of this support system are clearly shown. |
| Language used are easily understood | User's feedback: The words and sentences used within the application are easily to be understood. Good selection of words |
| Graphical method used in this support system | User's feedback: Graphical method used for representation of assessment results is easily understood and acceptable. Users find it easy to interpret the results from the graphs of children development. |
| Information provided on Down syndrome | User's feedback: Information provided on Down syndrome is reliable and helpful for users to understand more about Down syndrome |
| Timer used in the support system | User's feedback : The timer used for support system is accurate and does help to improve the quality of assessment and training process |
| Sound display | User's feedback : Music displayed to attract children's attention is pleasant and able to attract children's attraction throughout the assessment and training process |

### 5.3 User Database Management

Table 9
Files and folders for user database management

| Data Management | Results |
|---|---|
| Children data and assessment results | Saved in Microsoft Access and able to retrieved easily |
| Assessment list | Saved as XML document and automatically retrieved when the program is run. |
| Information on Down syndrome and the user manual | Saved as PDF document and able to retrieved easily |

### Discussion

It is important to consider the ability of the children before begin the training for language ability. This is because every child has different ability although they might be in the same age. In this study, the diversity of the children's ability is taken into account. Besides, the database for assessment list is crucial in the support system. Thus, it is extracted from worldwide recognized assessment list. The assessment list in the database is also tested in various DS centers and proven to be effective to special children in Malaysia.

## 6. Conclusion

In conclusion, an effective support system for language assessment and training for special children has been developed. The level of achievement of special children in the activities under language ability is used as the input for the support system to generate graphs and suitable training to the particular child specifically. Besides that, the support system acts as a DS information provider and child data manager for parents and trainers. Help topic on step to step instructions on how to use the support system is also provided in order to ensure that parents and trainers are able to utilize the support system effectively. Results and findings show that the support system is effective and consistent in producing relevant results to the children. This support system can be developed in the algorithm for speech recognition system in the future in order to obtain more accurate and reliable voice input from childen

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