

A MULTISENSORY MULTIMEDIA MODEL TO SUPPORT DYSLEXIC CHILDREN IN LEARNING

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Abstract: Multimedia has benefited many areas in education and users including disable ones. In this paper we proposed a new courseware development model specifically for dyslexic children. The model could be used for developing courwares for dyslexic children. Five essential features are identified to support this model namely interaction, activities, background colour customization, directional for text reading (left-right) identification and detail instructions. A prototype courseware was developed and tested with a small sample size of dyslexic children (selected schools in Malaysia) based on the proposed model. The evaluation showed positive results in terms of performance whereby 60% of the users showed better improvement in their performance, 30% unchanged result and 10% with decrement in performance.

1 INTRODUCTION

Dyslexia is associated with difficulty or problem with words specifically in reading, spelling and expressing thoughts on paper (Greene, 2006). Dyslexic children are physically and mentally normal but have unusual difficulties in reading, spelling and writing. According to a local press the New Straits Times (2009), it is estimated about 5% of school going children in Malaysia are dyslexic.

The word dyslexia is derived from the Greek word “dys” meaning poor or inadequate and “lexis” means words or language (British Dyslexia Association, 2008). Along with the difficulties mentioned above, dyslexia also affects memory, concentration, sometimes mathematics, music and self-organization (Hornsby, 1995). According to some psychologists dyslexia is not a disease (Vicari et al, 2005; Shaywitz, 2003; Berninger et al., 2008). This is supported by Sariah Amirin (The Berita Harian Press, 2009), the President of Dyslexia Association, Malaysia in the quotation below:

“Dyslexia is not a disease it occurs in children with normal vision and nothing to do with the hearing, sight and brain damage. It happens because the brain lacks of a function to translate the image seen or heard into something meaningful.”

Recently, there have been a number of researchers looking at the benefits of multimedia educational courseware and addressing various educational issues in the market. This indicates that multimedia applications are widely used within the educational domain. Among others, the use of multimedia as secondary learning tool could play an important role to motivate students’ interest hence improving their performance in learning.

The main objective of this research was to study the problems faced by dyslexic children and to evaluate the effectiveness of using multimedia application as an alternative solution in order to overcome the problems faced by them.

2 CURRENT STATE OF EDUCATION FOR DYSLEXIC CHILDREN IN MALAYSIA

In Malaysia, the dyslexia program was initiated by the Education Ministry in 2004 where “*Sekolah Kebangsaan Taman Tun Dr. Ismail*” was the first school. At present, it is estimated around 5% or 314,000 of school going children in Malaysia are dyslexic (New Straits Times, 2009). Even though the figure is fairly high, the number of schools and trained personnel addressing the problems are relatively small; there are only about 30 schools that

offer special programs for the dyslexic and 100 trained teachers in this field (Devaraj & Roslan, 2006; New Straits Times, 2009). Moreover, due to the lack of knowledge, dyslexic children are left behind and often misjudged as being lazy and slow learners (low ability children with low IQ).

Based on the above-mentioned limitations, a study was conducted on the problems faced by dyslexic children and also the awareness level of this problem in Malaysia. Based on the results gathered from readings (journals and articles) and also interviews (Dyslexic program teachers), it can be concluded that Malaysia still lacks materials and experts in the field (Lee, 2008; Devaraj and Roslan, 2006; Gomez, 2004). In a recent work, the causes and symptoms of dyslexia have been defined (Eze, 2010).

2.1 Problems Faced by Dyslexic Children

Dyslexia as mentioned earlier is a specific learning disability that leads to certain difficulties in the child's learning process. It is important for the people around them (parents, teacher, siblings and friends) to understand their problems so that they can get the necessary help. Among those difficulties as noted by Gross and Voegeli (2007) include: difficulties in forming associations between letters and sounds; remembering sequences of letters for spelling; difficulties in recognizing or confusion between letters or familiar words; mispronunciations; difficulty in carrying out instructions; directional confusion between left and right; math activities; problems with sequencing; difficulty organizing work.

All the above-mentioned difficulties have an impact on the children's ability to read, write, navigate, comprehend and recall relevant information (Rainger, 2003). On the other hand, the difficulty with visual processing leads to the problems of delay in visual object recognition and problems with visual concentration and over sensitive to light (Rainger, 2003). Additionally, dyslexic children sometimes see words juggle in a paragraph or rivers of white space. This problem is referred to as a scotopic sensitivity (visual perceptual disorder that affects primarily reading and writing activities) or also known as Meares Irlen syndrome (Irlen, 1991) where they might find that the high contrast is difficult to read, for example black text on white background (Rainger, 2003). Besides that, they also have problems called Mirror opposites or reversal of word and letter (Heymans, 2007). For example, they see letter "p" instead of

letter "q" and the word "saw" instead of the word "was".

2.2 The Courseware

The courseware developed for this research is based on teaching and pronouncing words using the national language (Bahasa Melayu / Malay language) and targeted for beginners aged between 5 – 12 years old (teachers and parents may also use as an additional teaching aid). The courseware covers the following modules:

- Bahasa Melayu reading for beginners.
- Uses the eclectic-Express reading approach (e-Xra) a technique that combines the two reading methods that are *phonics* and *whole word* method (as such we used the reading method i.e. one of the phonetic reading for Bahasa Melayu).
- 12 syllables that are divided into 6 modules i.e. *module 1: 'a' and 'ba', module 2: 'ca' and 'da', module 3: 'fa' and 'ga', module 4: 'ha' and 'ja', module 5: 'ka' and 'la', module 6: 'na' and 'ma'.*
- Each sub-module is supported with audio and visual elements as well as hands on practice.

2.3 Learning Styles

In this research we also took into account the learning styles of the children. Learning styles is defined as individual's preferences of acquiring and using information when learning (Herod, 2002). Thus the definition shows that different individual has different learning style. There are three basic types of learning styles that are very simple and suitable for children namely visual, auditory, and kinesthetic (Beatrice, 1994). However each individual can have more than one learning styles or preferences because most people learn through a mixture of all three styles (James, 2009). It is very important for teachers to deliver their teaching with the combinations of these three learning styles to accommodate different learning styles of each student. This is supported by Reid (2005) where he suggested that when students are taught using techniques consistent with their learning styles, they will learn more easily and efficiently.

Visual learners learn best using images, pictures, colors, and maps. They can easily visualize objects (Douglass, 2008). In addition, visual learners prefer to write things down and they have to see to be able to understand better. They like to imagine the information given. This will make them process and understand information better (Tannahill, 2009). On

the other hand, auditory learner would prefer to listen for information. They usually enjoy talking, talk and read aloud and like explaining things to others (The Penn State York Nittany Success Center, 2009). Apart from that, they are easily distracted by background noise and having difficulties following written instruction (Hutton, 2009). In contrast, kinesthetic learner is basically a student who learns most effectively from movement-based or motion-oriented activities. They love to do hands on tasks, physical activities and motor skills (Fleming, 2009). Further discussion is given by Manjit (2007) on learning styles.

It is very important to identify students learning style in order to accommodate the right teaching method to enhance their learning performance (Silver et al., 2000; Cutter, 2009). The learning styles can be identified through observation or by answering few questions related to learning styles (Reid, 1987). There are many questionnaires designed to identify children’s learning styles such as:

- Accelerated Learning by Dr. Colin Rose (Grammatis, 1998).
- Memletics learning styles inventory (Advanogy.com).
- A Learning Style Survey for College by Catherine Jester (Jester, 2000)
- Learning style inventory by Jonelle A. Beatrice. (Union University, 2009).

For this research, we selected the questionnaire “Learning styles inventory” designed by Jonelle Beatrice (Union University, 2009) as the questions provided are simple, straight forward and easy for the lower primary school students (standard one to standard 3) to understand.

2.4 The Teaching Technique

The suggested technique to teach dyslexic is by applying the multisensory method in teaching (Learning Disabilities Association America, 1998). This method is proven to be effective method to teach dyslexic children because it can accommodate different learning styles (Logsdon, 2008). It is used in many Special Needs schools and Dyslexia centers, for example Dyslexia Association Singapore, British Dyslexic Association, etc. Research by the National Institute of Child Health and Human Development (NICHD) reported that, dyslexic children who were trained in multisensory intervention program made significant achievement in their learning skills (International Dyslexia Association, 2000).

Multisensory teaching involves a simultaneous links between visual, auditory and kinaesthetic-tactile pathways to enhance learning and memory (Marcia, 1998; Logsdon, 2008). In this technique, children are taught to link the sounds of the letters with the written symbol. They also have to link the sound and symbol with how it feels to form the letter/letters by tracing, copying or writing the letter while saying the corresponding sound. Further guidelines of what should be taught in multisensory method can be found in Dyslexia Association Singapore (2006) and Cecilia (2004).

2.5 The Malay Language Reading Method

The first method of teaching beginners or children to read Malay language is by using the alphabet method (‘kaedah abjad / alphabet method’ or ‘mengeja / read’). In this method, children have to spell out the letter names of segmented syllables followed by sounding out the syllables then blending up the syllables to form words. For example to read the word ‘bola’ (which means ball), children have to say the letter name of the first syllable (b + o) and sound out as ‘bo’ and followed with the second syllable (l + a) sound out as ‘la’. Finally they will combine the sounds of those two syllables as ‘bola’ (Elias, 1998). To be able to use this method, children have to remember the name of all letters and the sound of combined letters. However it will take much longer duration for children to read fluently (Ahmad, 2004). Figure 1 illustrates the step by step process in reading using the Alphabet Method.

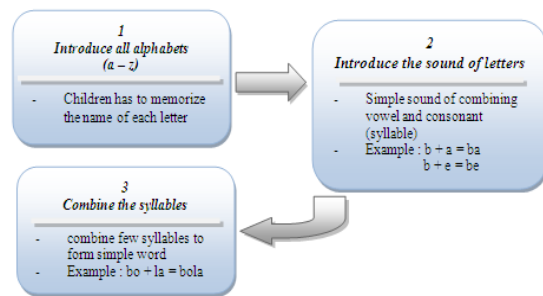


Figure 1: Reading strategy using the alphabet method.

The second method is the whole word or sight word method. This method is similar to the look and sees method. In this method, children will be introduced to meaningful words using flashcards with picture and associated word representing the picture.

The third method is the phonics method. This method concentrates on the sound of letter and sound of combined letters. Recently, the use of phonics approach has been increasing especially in pre-school. It shows significant improvement in reading ability not only of the normal children but also of dyslexic children (Ahmad, 2004). Due to its benefit for dyslexic children as reported by Hollowell (2009), Blevins (2003) and Ahmad (2004), the phonics method was selected to be the reading method in this research. Figure 2 shows the steps in teaching Bahasa Melayu reading using phonics method.

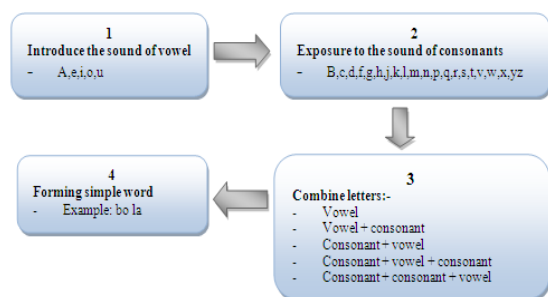


Figure 2: Phonic method in teaching Bahasa Melayu / Malay language reading.

2.6 Dyslexia and Multimedia

With the problems faced by dyslexic children as stated earlier, it is clear that dyslexic children need additional aids as compared to normal children (Shaywitz, 2005). In addition to the traditional supervisory learning environment, dyslexic children should be given the opportunity to explore reading on their own, as it is indeed a good way to improve their reading skills (Devaraju et al., 2006). Adopting a computer aided learning (CAL) environment would be an alternative as it could give flexibility to the dyslexic children in terms of what to study and when to study. Multimedia as mentioned by Singleton (2006) is one of the aids to promote a CAL environment since it has the potential to reduce most of the problems faced by dyslexic children. For example, Beacham (2007) in his article has mentioned that learning materials containing text can be supplemented with graphical and auditory forms as dyslexic children are able to comprehend meaning better in that format.

Multimedia has the potential to improve reading ability as it provides large amounts of practice that promotes the drill and practice concepts (Lundberg, 1992.). This is supported by Karsh (1992) in his report where substantial gains were made by dyslexic children in word reading fluency using

'Construct a Word' program. This program provided drill and practice in forming real words by matching consonants with word endings.

Lundberg (1992) in his research noted that students who enjoyed the benefits of computer training with speech feedback gained more in reading and spelling performance compared to students who had access to conventional special education.

Singleton (2006) reported five principle advantages of computer assisted instruction for dyslexic children as following:

- *Increase motivational value*
- *Individualized instruction*
- *Informative feedback*
- Promotes active learning environment.
- *Customization feature*

With all the benefits stated above, multimedia has opened up a completely new world to dyslexic students, one that could help them in their learning process.

Multimedia presentation techniques do have a potential in providing outstanding support for dyslexic children (Heymans, 2007).

Based on the details discussed earlier, a courseware was developed to assist dyslexic children in reading Bahasa Melayu. The method of teaching that was integrated into the courseware is the multisensory method as it has been recommended as the best method to teach dyslexic children (International Dyslexia Association, 2000; Marcia, 2000) at present. Besides the multisensory method, the phonetics method was also used as a reading technique in this research.

The courseware developed was tested to evaluate its effectiveness as well as to identify the best features or elements that should be incorporated into the courseware to ensure that it will give full benefit to dyslexic children. As a result a new courseware development model especially for dyslexic children was proposed. This is discussed in the next section.

3 DYSLEXIA COURSEWARE DEVELOPMENT

This section briefly describes the courseware developed to help dyslexic children in their learning. The multisensory method as discussed earlier suggests that the subject or course to be divided or structured into modules and the organization of the materials should follow the logical order of

language. The content structure was based on these guidelines. The content covers twelve sub modules selected from a book (see sample content structure in Figure 3 below).



Figure 3: Content structure of the courseware.

Each of the sub modules contains five pages where the first two pages introduce the user to the new syllable together with the previous syllables. As an example, in sub module ‘ba’, the first two pages will show the ‘ba’ syllable with the associate sound of ‘ba’ together with the previous syllable (‘a’) that has been introduced before. The ‘ba’ (new syllable) is represented in blue colored text while the previous syllable (‘a’) is represented in black colored text. The third page shows the word or sentence that can be made by combining the current syllable (‘ba’) and syllables from previous sub modules. The fourth page is where the student can see the associated pictures of animals, things or people where the first syllable starts with the current syllable (‘ba’) for example ‘basikal’ (bicycle). The associated picture with sound is to help children remember the sound of the syllable better. The last page is where the user can practice writing the letters using the mouse. This gives the user the feeling of how to write the letter and further on, easier for them to remember the letters.

For ease of interaction with all the modules, the courseware is equipped with a menu that allows the user to access any module that they want. Based on the structure of the content as shown in Figure 3, the navigational structure for the courseware was designed. The navigational structure summarizes the overall flow of the courseware. There are several navigational structures such as linear, hierarchical, non-linear and composite (Vaughan, 1996). The navigational structure for this courseware is based on the composite structure that combines the three

navigational structures that are linear, hierarchical and non-linear structure. Figures 4 and 5 illustrate the navigational structure for this courseware.

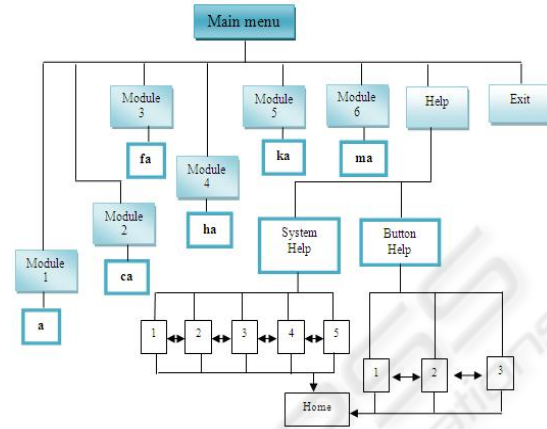


Figure 4: Courseware navigational structure.

From the main menu, the user can choose any module(s) that they wish to explore. Figure 4 shows the courseware navigational structure where from the main menu, the user can click on any of the module(s) button, i.e. the help button or the exit button to exit from the courseware.

The navigational structure within each module as illustrated in Figure 5 was designed to give flexibility to the user in exploring the content and at the same time bonded to certain limitation or constraint. The limitation or constraint was that the user had to wait till the whole contents of each page were presented before the user could navigate to the next page, previous page or repeating the same page. The implementation of this concept was targeted to force user to finish the module without clicking unnecessary icons and be lost in the modules. In addition, the user could also try to read the content of each page their self. In a condition where they are not sure with the sound associated with the syllable, they can click on the syllable to listen to its pronunciation. This feature is available once the whole contents of the current page had been displayed.

On the last page of each sub module, the user can click on the pencil icon which directs them to the page where they can practice writing up the letters/syllable while watching the animation on how to write those letters/syllable. Once they had finished this module, they can go back to the current sub modules and later advance to the next sub modules or go back to main menu to choose other module.

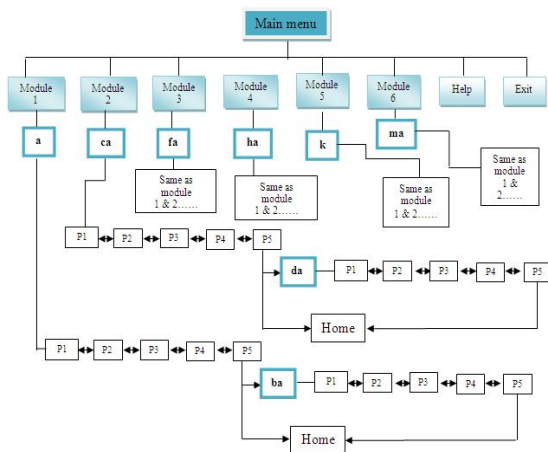


Figure 5: Navigation within module.

Careful consideration was also taken in designing the user interface design. We considered the following six principles in designing the user interface design: 1. Sufficient contrast between foreground and background; 2. User control button or navigation; 3. Provide sufficient white space so that the information can be absorbed properly (Hutton, 2009); 4. Fonts should be easy to read and have clear spacing between letters; 5. Avoid using blinking or moving text as this is hard for dyslexic user to read and it will distract them; 6. Provide the audio feature (narration) as this will help dyslexic user.

The interface design for this courseware can be divided into: Main page, Help page, Content/module page and Writing Page. The main page was design as simple and straight forward as possible appropriate with its function as the first page of the courseware. The page acts as an interactive table of content or index page for the courseware. It has menu buttons that will direct user to the modules in the courseware. “Lady Bugs” were chosen as the icons for the modules. The use of these icons was to attract the user and make the page livelier. When the user moves the mouse over the button, the ‘lady bugs’ will stretch its wings. Tool tips are provided for all the buttons together with the narration when the mouse is moved over the button. This will help dyslexic children understand the use of buttons better. In total, there are six ‘lady bugs’ in this courseware. Each ‘lady bug’ represents two sub modules. Figure 6 shows the screen snap for main menu.



Figure 6: Screen snap for the main menu.

As mentioned earlier, the content of this courseware was adopted from the e-Xra technique. With reference to the e-Xra book, we divided each syllable as a sub module for example ‘a’, ‘ba’, ‘ca’ and others. Each module contains a combination of two sub modules. All the sub-modules have the same design in terms of the arrangement of buttons/icons, colors and layout. This was to avoid confusion and aligned with the interface design’s principal that suggested a consistent design. Also mentioned earlier, there is a directional confusion among dyslexic children. The conventional way of solving the directional confusion was by wearing a bracelet on the left hand so the children will remember that the hand with bracelet is the left hand (Dyslexia Association of Scotland, 2008). In order to cater this problem, the courseware is also equipped with a left marker throughout the content page as shown in Figure 7 label (a).

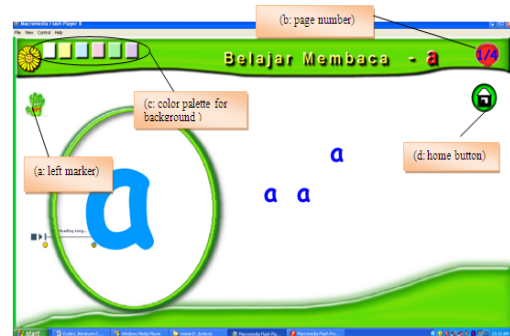


Figure 7: Screen snap for content page for sub-module ‘a’.

The left marker is represented using the hand image which is located at the upper left corner of the page. The use of the left marker is to assist dyslexic children on identifying the left side of the page as they always confused between left and right and sometimes ends up reading from the right (Gross & Voegeli, 2007). Besides the use of the marker, another method was applied to help dyslexic

children to overcome the directional confusion. The method was implemented by showing the syllables one by one from left on the screen. This means, at the beginning of each content page, the letters or syllables will be displayed one by one from left to right. The process will continue on each new page. This will indirectly help dyslexic children to read from left. All screen for the alphabets have the same design and layout. On the upper right corner of each content page, the page number for example page 1 out of 4 pages as illustrated in Figure 7 label (b). Page numbers will help user keep tracks of his/her visited page.

Additionally, the courseware also offers a background customization feature that will give flexibility for the dyslexic children to choose the background color that best suited them. The choices of colors are represented with a color palette on the top left corner of the courseware as shown in Figure 7 label (c). The main intention of this feature was to lessen the scotopic sensitivity or Meares-Irlen syndrome.

Besides the text and icons that represent the visual features of the courseware, the courseware was also equipped with pictures to support the learning process. These pictures were used to signify the syllables. Example is the use of “chicken picture” that symbolizes the syllable ‘a’ in the Malay language as shown in Figure 8.

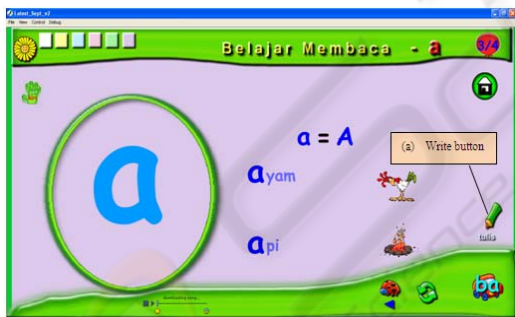


Figure 8: Screen snap for content page for sub-module ‘a’.

On top of the visual layout of the content, the courseware also offers the audio feature in term of narration or the sound of each syllable. The sound of syllable can be heard when the syllable appears on the screen. The feature is tally with the multisensory guidelines that has been discussed earlier. Moreover, the user can also click on the syllable if they are not sure of the sound. This can only be done when the whole content of the current page has appeared. This facility is hoped to help dyslexic children remember the sound associated with each syllable better.

At the end of each sub module, the courseware is equipped with the pencil button that will direct the user to the writing page. The button is shown in Figure 8 label (a) while Figure 9 shows the writing page. This page is to compliment the kinaesthetic feature suggested in multisensory method. The user can try or practice to write the syllable as many times as they wish and can click on the erase button as shown Figure 9 label (a) to erase the writing and try again. At the beginning of this page there will be a voice narration that explains the steps that should be taken for the activity (writing). On completion of the text, the user could do some exercises provided in the courseware to gauge their understanding.

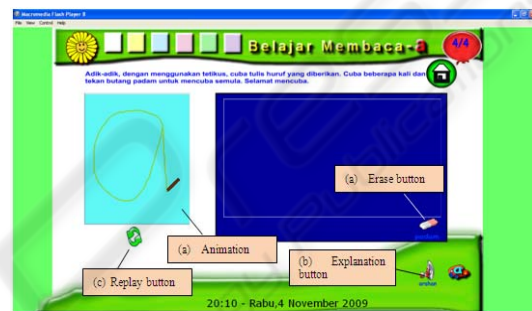


Figure 9: Screen snap for writing page.

4 THE COURSEWARE MODEL

Based on the current structure and contents of the courseware, a model is proposed (Figure 10) that can be used as guidelines for the development of multimedia courseware for dyslexic children.

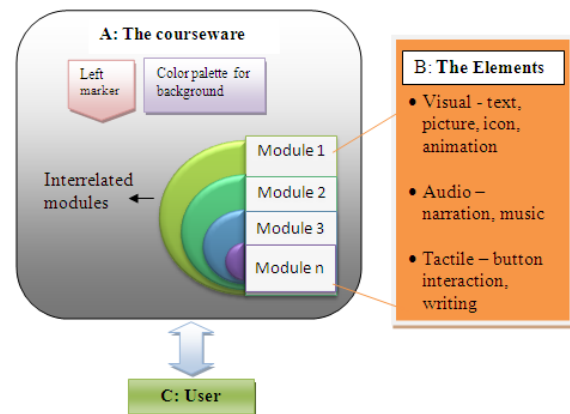


Figure 10: Courseware development model.

According to Figure 10, there are three components that represent the overall courseware model as in the box labelled A. These components

are the interrelated modules, i.e. the left marker and the color palette for background.

The left marker was used to indicate the left side of the courseware. The idea of having the left marker was to reduce the problem faced by dyslexic children who always gets confused between right and left. This confusion may result in reading from right. As such it was significant to have the left marker displayed on the screen as this was found to be suitable for a more advance courseware such as for reading and comprehension. Besides that the user can customize the background color using an in-built color palette. This customization feature is essential especially to reduce the scotopic sensitivity or Meares-Irlen syndrome as explained earlier in the literature.

Besides the three components explained above, the courseware is bounded to the elements that support the multisensory teaching as depicted in Figure 10, box 'B: The Elements'. These elements are visual, audio and kinaesthetic content. These elements are aligned with the multisensory concept that has been discussed earlier. The kinaesthetic elements for this courseware include the two way interaction between the user and the courseware where user can click the buttons, the syllable and also changing the background color. In addition to the above, the user can also practice writing the syllable using the mouse.

The box labelled C: in Figure 10 represents the interaction between the user and the courseware. The two headed arrow symbolizes the two ways or interactive communication between the user and the courseware. The interactive communication between user and the courseware was possible with the used of buttons where user can control the flow of the courseware that suited them.

5 COURSEWARE EVALUATION

In this research two evaluations were conducted namely formative evaluation and summative evaluation.

- a. The formative evaluation was done among normal children ages from 6 to 10. There were six children involved in this evaluation. The result from this evaluation is further discussed in section 5.1.
- b. The summative evaluations were conducted in few schools that offer dyslexia intervention class such as "Sekolah Kebangsaan Taman Tun Dr. Ismail (2)" and also "Sekolah Kebangsaan Taman Maluri." This evaluation involved

dyslexic children and also teachers who are teaching dyslexic children. However in this paper only the overall performance statistical experimental results are shown and discussed. Complete results on pre and post test, observation and interviews are discussed in details in (Eze, 2010).

5.1 Results and Discussion

The overall performance statistical experimental results are shown in Figure 11. The Figure shows that 60% of the students who participated in the experiment demonstrated a slight improvement in their result. Another 30% of the students got the same score for both pre-test and post-test. Most of the students with the same result are in fact those with a good score or the students who scored full marks. Hence the use of the courseware did not actually affect their performance for the reason that they do not actually have problems in reading basic Bahasa Melayu / Malay language. Figure 11 also shows that 10% of the students had a slight drop in their score. This might be due to carelessness or difficulty to stay focus during the session.

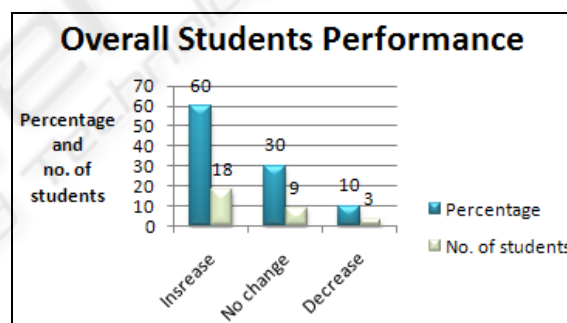


Figure 11: Overall students performance.

Referring to the result and analysis discussed in this section, it can be concluded that the courseware developed based on the proposed model discussed in section 4, benefited the dyslexic children especially for those who are still in the beginning stage of learning to read. It can be envisaged that the performance might increase significantly if the students were given more time to use the courseware as their learning aid.

6 CONCLUSIONS

There are limited teaching and learning resources for dyslexic children especially for Malay language. In

this paper, a preliminary courseware model that could assist the courseware developer in developing effective courseware for dyslexic children was proposed. A prototype courseware was developed and tested. In general the evaluation results showed positive results whereby the students reading performance of the Bahasa Melayu / Malay language improved. It is believed that the courseware is being well received by the children who took part in the evaluation process. However further work is in progress to revise and improve the proposed model further.

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