E-learning for Disability : Creation, Assessment, and Implementation

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Abstract: This paper presents the design and delivery of X-leksia: a multimedia courseware to aid basic reading skills in Malay language among the pre-school dyslexics. The courseware has been developed based on multi-sensory teaching approach. It supports the visual, auditory, kinaesthetic elements via multimedia and "learn by doing" exercises that will reinforce each other for optimal learning. The courseware has undergone both formative and summative evaluation with dyslexics and subject matter experts from Dyslexia Association of Wilayah Persekutuan, Kuala Lumpur. The evaluation procedure, criteria and results are presented in this paper. As a result of completing the evaluation procedure, the author found that X-leksia's approach was well received by the children and teachers alike although there is still room for improvement. The courseware is hoped to contribute a significant idea to the development of technology in Malay language education for pre-school dyslexics in Malaysia.

Introduction

Interactive multimedia occurs when the user can control 'what', 'when' and 'how' elements such as text, audio, video, graphics and animations are presented. It has the capacity to deliver learning materials in multiple forms which can motivate learners with specific learning difficulties. It should be noted that dyslexia is a condition that affects more than 300,000 or 10 percent of schoolchildren, in both primary and secondary schools in Malaysia [6]. These undiagnosed and misunderstood schoolchildren with reading and writing disorder can end up being ridiculed and have low self esteem. Despite being a lifelong condition; most dyslexics learn to read and write well through appropriate training. The paper presents the design and implementation results of an assistive multimedia courseware, named X-leksia, to aid the basic reading in Malay language among pre-school dyslexics.

The Motivation

The motivation to come up with X-leksia is due to the weaknesses in the current traditional teaching practice which has been addressed by the Subject Matter Expert (SME), from Dyslexia Association of Wilayah Persekutuan, Kuala Lumpur. The traditional teaching method is via book series do not attract the dyslexics' attention. Moreover, the learner needs someone's guidance to follow the lessons. Next, the common teaching method used in Malaysian schools when handling dyslexics is using the reading skills used by their non-dyslexic counterparts. Furthermore, there is lack of educational software in the market that teaches dyslexics to learn to read in Malay in ways dyslexics can learn compared to the amount of materials available in English.

Teaching Principles for Reading Disability

The following teaching principles formed the basis for designing the methodology for our study.

Multi-sensory Teaching. “Studies from the National Institutes of Child Health and Human Development have shown that for children with difficulties learning to read, a *multi-sensory* teaching method is the most effective approach or treatment” (Bradford, 2000). This teaching employs all pathways of learning at the same time, seeing, hearing, touching, writing and speaking. It helps to develop links between what a word looks like, sounds like and means.

Orton-Gillingham. The Orton-Gillingham approach is language-based, multi-sensory, structured, sequential, cumulative, cognitive, and flexible. The approach teaches how sounds and letters are related and how they act in words. Reading and writing sounds are done in isolation in the beginning. Next, sounds are blended into syllables and words. Dyslexics will learn language elements, e.g., consonants, vowels, digraphs, blends, and diphthongs, in an orderly fashion. They then proceed to advanced structural elements such as syllable types, roots, and affixes [1]. Language Tune-Up Kit [8] and Phonics Tutor [10] are currently available softwares that use this approach.

Design, Development and Implementation

The courseware structure, material design and development guidelines followed in the X-Leksia development will be explained in this section. The learning materials included in the courseware are from a book series [2], which is currently used as material for teaching in the Dyslexia Association of Kuala Lumpur (DAKL).

User Interface Design Guidelines

The materials design and development guidelines set out in this courseware are based on Bradford, J. (2000), Rainger, P. (2003) and Pickard, J. (2005) whom have outlined principles of usability and accessibility of electronic educational content for dyslexics. Please refer to our initial paper [11] that indicates the user interface guidelines implemented in our courseware.

Courseware Structure

Figure 1 shows the major components in X-leksia which are *Laman Utama* (Main Screen), *Aktiviti* (Activity), *Latihan* (Exercise), *Bank Perkataan* (Word Bank) and *Bantuan* (Help).

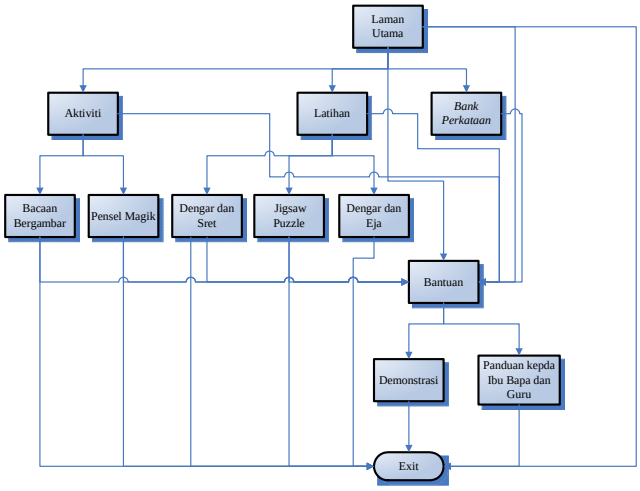

Figure 1: X-Leksia Courseware Structure

The accommodations to enhance successful interactive instructional learning in the courseware are described according to each component as follows. The *Aktiviti* and *Latihan* components are cumulative as it leads on to the next and the child can be confident that he is only expected to do work for which he has been well prepared for.

i. Main Screen

Figure 2 shows the welcoming page with the navigation buttons linking to the other major components such as *Aktiviti*, *Latihan*, *Bank Perkataan*, and *Bantuan*. Voice over for the navigation buttons and instructions are provided. All the other components have a link back to the main screen.

Figure 2 : Main Screen

ii. Activity

Aktiviti component gives the dyslexics the foundations of reading and writing. It has two modules which are *Bacaan Bergambar* and *Pensel Magik.*

Pensel Magik as shown in Figure 3 will teach dyslexics to write letters using 2D animation. Letters have been categorized into four different categories according to the way a letter is written i.e. *from the right, from the left, from top to bottom, left to right and from the middle*. Dyslexics can then follow the 2D animation on screen by placing their fingers on screen. Here, the visual and kinaesthetic elements used will reinforce each other for optimal learning. This involves a creative, participatory act by dyslexics.

Figure 3: Pensel Magik

Bacaan Bergambar as in Figure 4 uses images, text and audio to teach dyslexics to read. Here, the learner will first figure out the story content from the pictures. This is an example of exploratory driven based learning. The learner will make the transition to learn the syllables that make up the word. Each word contains two

Figure 4: Bacaan Bergambar

syllables represented in two standard colours used in the Dyslexia Association. The dyslexic learner will then watch a simple animation of the syllables appearing as it is pronounced by the voiceover. Once the learner understands the material, words become more meaningful. This is an example of inquiry based learning which will help dyslexics retain more information.

iii. Exercises

Latihan component functions as a 'learn by doing' exercise to apply or test the knowledge learnt in the previous *Aktiviti* unit. It has three modules with varied and interesting activities i.e. *Dengar dan Seret* (Listen and Drag), Jigsaw Puzzle and *Dengar dan Eja* (Listen and Spell). All the instructions will be read out and there will be an immediate positive computer based feedback when the user completes each practice exercise. *A Dengar dan Seret* exercise requires dyslexics to listen to the pronunciation of different words and match it with the correct picture.

Jigsaw Puzzle module as shown is Figure 5 requires dyslexics to complete a jigsaw puzzle which consists of an image and its word. In *Dengar dan Eja*, dyslexics will listen to each word and pick the correct letters from an onscreen QWERTY keyboard to spell the word. A unique feature here is the keys on the onscreen keyboard has been already categorised according to the four ways letters are written in the *Pensel Magik* module using four different colours.

Figure 5. Jigsaw Puzzle

Figure 6: Word Bank

iv. Word Bank

Bank Perkataan component functions as a word bank to increase the dyslexics' vocabulary. Here, dyslexics will learn more four lettered – two syllables words from a category, for example parts of the body. According to the SME, dyslexics learn words better when they are categorized. In addition, there will be a printable worksheet available in this unit.

v. Help tool

Bantuan, the help tool, has a step by step video demonstration on how to use each screen. It also contains the learning objectives of each module be used as parental guide. In particular, this is also unique from other text based help modules found in other e-learning tools.

Courseware Evaluation

The courseware evaluation consisted of both *formative* and *summative* evaluation which had been customized from the Dick and Carey model [5]. The formative evaluation is conducted during the development stage of the instructional design process, while the summative evaluation is conducted after the courseware has been implemented. The strategy for evaluating *X-leksia* had the following goals: to report on the usability of *X-leksia* and the effectiveness of *X-leksia* as a teaching material. The effectiveness of *X-leksia* depends on whether it achieves its learning objectives. Usability refers to the ease of learning and ease of use.

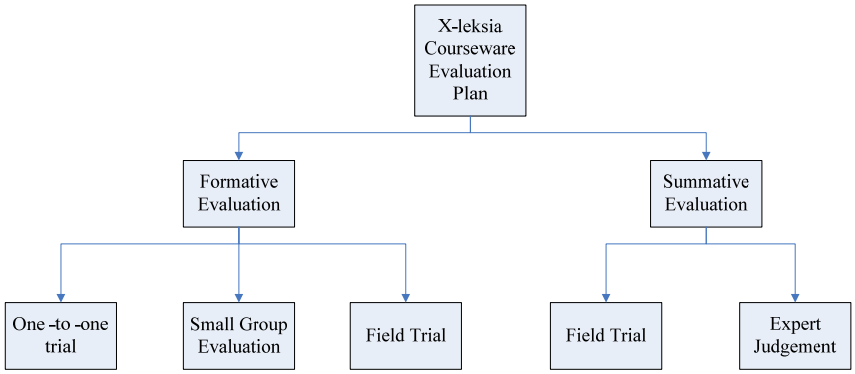

Figure 7: Courseware Evaluation Strategy

Evaluation Strategy

Primarily qualitative in nature, the formative evaluation was conducted through interviews and open-ended questionnaires at selected Dyslexia association. Please refer to the Table 1 for the evaluation criteria. There were three basic phases of formative evaluation. The first is *one-to-one* evaluation. In this initial phase, the author worked with 3 dyslexics to obtain data to revise the materials. The second stage was a *small-group* evaluation. Here, a group of 15 dyslexics aged between 6 – 12 were tested to collect the required data. The third stage of formative evaluation was a field trial conducted with 15 dyslexics aged between 6 – 12. Only 15 dyslexics were chosen due to the small number of students at the Dyslexia Association. The emphasis in the field trial is on the testing of the procedures required for the installation of X-leksia in a situation as close to the "real world" as possible. Subsequently, the summative evaluation which was quantitative in nature, investigated the goals and the objectives of X-leksia as a learning tool that implemented multi-sensory approach. It had two phases: *expert judgment* and *field trial* which were conducted with the subject matter experts and instructors from the Dyslexia association.

Evaluation Guidelines

The Table 1 lists the courseware evaluation guidelines on X-leksia's usability which is based on evaluation framework by (Elissavet, et al., 2003).

Table 1: Courseware Evaluation Guidelines

Area of Evaluation	Evaluation guideline
Content	Correct use of grammar Current and error-free information

	Concepts and vocabulary relevant to dyslexics' abilities Information relevant to age group curriculum Information of sufficient scope and depth Logical progression of topics Variety of activities
Curriculum & Structure	Can be used by dyslexics alone, without the need of other instructional objects (i.e. book) The content is structured in a clear and understandable manner The structure of courseware permits dyslexics to advance, repeat the unit, or escape to explore another unit.
Learners Control	Learner's control corresponds to dyslexics' age Learner's control corresponds to dyslexics' cognitive capabilities The quantity of learner's control corresponds with the feedback given from the courseware.
Interactivity	The interactivity of the courseware is according to the maturity of the students. Courseware provides opportunities for interaction at least every three or four screens. The content is chunked into small segments. Courseware asks students to apply what they have learnt in the activities rather than memorize it. Courseware allows dyslexics to discover information through active exploration
Navigation	Help key to get procedural information Check/Submit key for answering a question Objective key for reviewing the course's objectives. Content page for seeing a list of options available Main Menu key for returning to the main page Exit key, for exiting the program Key for moving forward or backward in a lesson Key for accessing the next lesson in a sequence.
Feedback	Courseware provides feedback immediately after a response. Courseware provides feedback to verify the correctness of a response. For incorrect responses, information is given to the student about how to correct their answers, or hints to try again. Courseware allows students to print out materials.
Screen Design	Screens are designed in a clear and understandable manner The presentation of information can captivate the attention of students. The presentation of information can stimulate recall. The design does not overload student's memory. The use of space is according to the principles of screen design. The design uses proper fonts in terms of style and size. The use of text follows the principles of readability The colour of the text follows the principles of readability. The number of colours in each screen is no more than six There is consistency in the functional use of colours The quality of the text, images, graphics and animation is good Presented pictures are relevant to the information included in the text The use of graphics support meaningfully the text provided A high contrast between graphics and background is retained. There is only one moving image (animation and/or video) each time on the same screen Animations enhance the presentation of information. Sound is of good quality and enhances the presentation of information. Sound is an alternative means of presenting information and is a necessity. The integration of presentation means is well coordinated. Courseware in general has a distinct and easily recognized character. The information is organized into small and functional units. Each learning unit is presented under the same design principles (consistency).
Learning process	Courseware is easy to learn Courseware is efficient to use

	Courseware is easy to remember; the casual user is able to return to using it after some period without having to learn everything all over. The structure of courseware is comprehensive and the average performance dyslexics can easily follow it. Users do not make many errors during the use of courseware or if they do so they can easily recover them. Users are subjectively satisfied by using courseware. Users find courseware interesting.

Result and Analysis

Figure 8 is the graph based on the summative evaluation results using the criteria in Table 1. The results showed that the feedback to X-leksia is encouraging. However, the result is only rated based on a small number of the respondents due to the limited number of dyslexics learning in the Dyslexia Association Kuala Lumpur. Therefore, testing involving adequate number of respondents will be conducted in future with other Dyslexia associations.

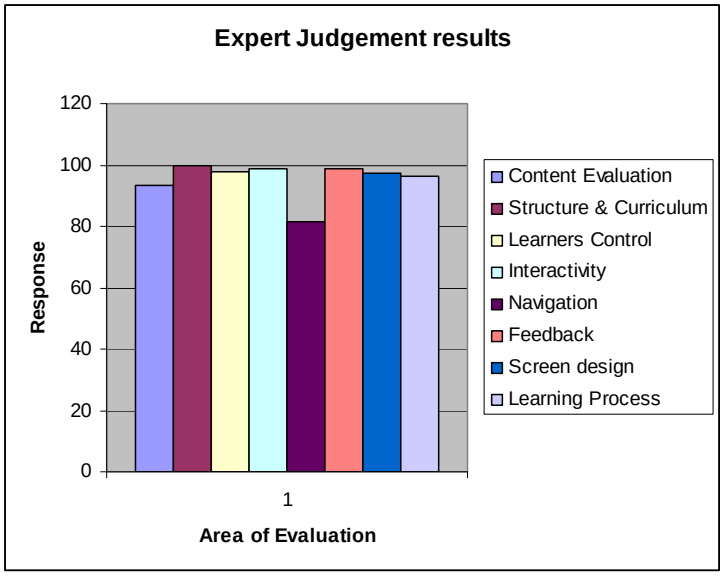

Figure 8: Courseware Evaluation Results

Conclusion and Future Works

Overall, there are a number of future works that might be pursued. The first suggestion by parents and teachers was to add a video showing how to pronounce each word used in the *Bacaan Bergambar* module so that the learners can follow the spoken words with the shape of the mouth, facial expressions and gestures. Next, an animated character may be designed to be the narrator in the courseware instead of just using the narrator's voice for voice over to retain the interest of the learners. In addition, the authors plans to develop own fonts to overcome some irregularities produced by the *Lexia Readable font* used throughout *X-leksia*. Finally, the developer also plans to conduct a wider courseware evaluation with a bigger population of dyslexics.

To sum up, the biggest contribution of this project towards the education of dyslexia is the implementation of the multi-sensory teaching approach while adhering to general design guidelines for educating Dyslexia via interactive multimedia technology. The courseware helps dyslexics to enrich their learning experience, and it has given them better control of their learning pace which is self motivating. *X-leksia* is an early intervention product to complement other teaching aids to help students with the highest risk of reading failure and early enough to prevent it.

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