Heuristic Evaluation Of i-Dyslex Tool for Dyslexia Screening

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***Abstract*—Early detection for dyslexia is crucial in order for children to receive early as well as proper treatment. There are various studies that have focused on early detection of dyslexia, however the results remain limited. Therefore, an easy and user-friendly dyslexia screening tool called i-Dyslex was developed. In order to make sure the tool is free from design and interface problems, heuristic evaluation has been carried out. This paper discusses the heuristic evaluation of i-Dyslex tool for dyslexia screening among expert evaluators. This study adopted ten Usability Heuristics to be included in the questionnaire. Overall result derived from the evaluation is above average mean score, which are neutral (3.00) in one domain. Several comments and feedback from the experts. Both the experts' evaluation and the feedback were essentials for further improvement of the i-Dyslex tool to ensure meets the user requirement and expectation.**

***Index Terms*—Dyslexia Screening Tool, Heuristic Evaluation, Computer Based Assessments.**

I. INTRODUCTION

Dyslexia is one of the specific learning disability characterized by unexpected difficulty in reading and writing despite adequate intelligence, normal senses, education and social environment [1]. Referring to International Dyslexia Association (2012) it is a language-based learning disability and refers to a cluster of symptoms [2]. Prof. Rudolf Berlin (specialist and ophthalmologist) in 1887 introduced the word dyslexia that came from a Greek word which "dys" means difficulties and "lexia" means word. Studies using Functional Magnetic Resonance Imaging (fMRI) has shown that dyslexics use a different part of their brain to process information compared to non-dyslexics, causing either one of these deficits: visual, auditory, or visual-auditory, impeding phoneme awareness that causes phonological deficit [3]. Recently, this disorder has been reported in all countries including USA, France and Czech.

Mostly, schools in Malaysia applied paper-based screening tool and the test are performed manually which handled by the teachers. Then, if the children are found to be dyslexic, they are referred to the psychologist for further test to confirm the students' disabilities. By using paper-based screening test it is time consuming and less attractive. Children tend to be bored and did not complete the activities due to the lengthy period of time [4]. Either conventional or computerized screening tools, the screening test are available to assist the identification of children at the risk of dyslexia. However, the use of computer-based assessments (CBA) for the identification of children with specific learning difficulties has currently been a growing trend [5]. A computer- based screening tool can gives a more precise result from the participants, time saving, more objective and reproducible [4]. Singleton agreed that there are various advantages of computer-based assessments over conventional assessments including being reportedly more efficient and cost effective to administer [6].There are various studies which focused on early detection of Dyslexia, although results remain limited as discuss in Section 2.

As a result, an easy and user-friendly dyslexia screening tool called i-Dyslex was developed. The aim of this paper is to conduct a heuristic evaluation on i-Dyslex. This evaluation is important to obtain feedback and usability from expert. This paper is organized as follows: Section 2 presents related works includes dyslexia screening tools. This is followed by Section 3 that describe the usability and heuristic evaluation. Section 4 discusses the methodology used in this study. Then, Section 5 presents the result from the evaluation. Lastly, Section 6 concludes this paper with conclusion and future work.

II. DYSLEXIA SCREENING TOOL

Recently, various research projects have been carried out focusing on screening dyslexia among children. Screening is the presumptive detection of unrecognized disease defect by examinations, performing tests, or other procedures. Children with positive or suspicious result are not intended to be diagnostic and should be referred to professionals such as psychologist for further diagnosis and necessary treatment [4]. Due to rapid expansion of computer technology, many researches use this technology to develop screening tool.

A computer-based screening tool should be designed in such a way that is more attractive, efficient, fun and interesting so as to motivate and promote positive feeling of the user. [4] introduce a screening tool called Smart Lexic. It was implemented using an interactive multimedia approach as an alternative for traditional approach. The application consist of three modules focuses on three key learning skills; identifying letter, number and direction. The result from the study indicates that multimedia elements can influence the performance of a dyslexic student.

Another tool which is widely used to detect dyslexia among children in the UK and around the world is Lucid Rapid [5]. Through this application, the measurement are based on the phonological deficit model of dyslexia and comprised of phonological processing, auditory sequential memory, and visual verbal integration memory/phonic decoding. The researchers have conducted a test among Singapore children to investigate the applicability of Lucid Rapid. The outcome showed it is useful to identify children at the risk of dyslexia if some misclassifications like false positive and false negative can be overcome.

Another research by [7] has done a set of games a screening tool for detection of dyslexia. The focus of the games is to improve and facilitate the task of diagnosis by implementing traditional tests in a set of games, so that the child loses the notion of being under evaluation.This games are web based platform and was made up of six modules that evaluates the children's' word production, syllabic memory capacity, verbal work memory, auditory memory, syllable and word reading capacity.

Despite the wide spread effects of research into the use of computer based for detection of dyslexia, there are still a number of limitations. One limitation of the previous work is that there are no personal information details and results stored for reports. The computerised-based Lucid Rapid Dyslexia Screening is using English Language as a main medium due to misunderstanding among dyslexic regarding the instructions given. This on-going research is focused on children in Malaysia and Malay Language. Besides, using internet connecting screening tools is not suitable for some school in Malaysia where internet facility is not available. Another limitation is that the previous work hasn't been testes with real users. Therefore, a new computer based application will be developed to improve on the existing screening tool for detection of dyslexia.

III. USABILITY EVALUATION

Usability evaluation is a technique frequently used in the field of Human-Computer Interaction. [8] has defines that usability evaluation are based on five constructs which are learnability, efficiency, memorability, error and satisfaction. Several other definition of usability include quality in use [9], the effectiveness, efficiency, and satisfaction with which specified users can achieve goals in particular environments [10] and the capability to be used by humans easily and effectively by [11]. Besides, International Organization for Standardization (ISO) defines the term of usability by "the extent to which the product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [10].

There are various techniques that can be used for usability evaluation including heuristic evaluation, measure performance, think aloud, observation, questionnaire and many more. The choice of the technique is depends on focus of the study. Table 1 shows the several techniques that can be implemented in usability evaluation.

A usability evaluation can reveal a system's usability problems and provide suggestions to refine the system. One of the most popular methods use for evaluating usability is Heuristic Evaluation (HE). It can be said as usability inspection evaluation techniques that are normally used by experts to determine usability problem in any application or product [13,14,15]. [13] has define HE as a usability engineering method for finding usability problem in user interface design by having a small set of evaluators examine the interface and judge its compliance with recognized usability principles.

Table 1
Usability evaluation technique [12]

Evaluation Method	Number of respondent	Advantages and Disadvantages
Heuristic	None	Advantages: Find the usability problem of individuals. Address the issues of expert users. Disadvantages: Dose not involved real user.
Think Aloud	3-5	Advantages: Can identify misunderstanding by user. Cheap test. Disadvantages: Un natural user. Difficult for expert to give opinions.
Observation	3 or more	Advantages: Ecological validity: revealing the actual service users. Suggest functions and features. Disadvantages: Difficult to make an appointment. Control experiments.
Questionnaire	At least 30	Advantages: Can reach many people with low resources. Disadvantages: Need a pilot study (to avoid misunderstanding)
Interview	5	Advantages: Flexible attitude, probing depth and experience. Disadvantages: Time consuming. Difficult to analysis.

IV. METHOD

Heuristic Evaluation is a type of inspection class methodology [18]. This study used Heuristic Evaluation as a research methodology which is adopted from usability engineering methodology. The objective of this study is to identify problems in the interface of i-Dyslex tool that had been developed. The result from the evaluation is used to improve the design. Hence, selected experts were involved by interacting with the tool to identify the usability problems. Methodology of the study is as follow:

A. Sample of Study

In this study, there are 4 experts involved for the evaluation process. They were selected based on the qualification and experience related to dyslexia. Table 2 shows the profile of expert evaluators.

Table 2
Profile of Expert Evaluators

Evaluator	Professional Role	Experience with Dyslexia Student
A	Lecturer	More than 10 years
B	President of Dyslexia Organisation	More than 10 years
C	Volunteer	4 to 6 years
D	Operation therapist	4 to 6 years

B. Research Instruments

The instruments use to conduct this study include:

a. Questionnaire

HE was used as a basis in the questionnaire for the evaluation of i-Dyslex. Neilsen Usability Heuristics (NUH) by [17] was used to evaluate the interface design. The questionnaire consists of two (2) sections: (A) Demographic and (B) Usability Heuristic for User Interface Design. In section A the information about professionals roles, education level, gender and years of experience with dyslexia student was collected. Meanwhile Section (B) contained questions about heuristic for user interface as shown in Table 3.

Table 3
Usability heuristic for user interface design

	Heuristic and subheuristic Interface (IN)
IN1	Visibility of system status
IN2	Match between system and real world
IN3	User control and freedom
IN4	Consistently and standards
IN5	Error prevention
IN6	Recognition rather than recall
IN7	Flexibility and efficiency of use
IN8	Aesthetic and minimalist design
IN9	Help users recognition, diagnose and recover from errors
IN10	Help and documentation

Likert scale was used in the questionnaire with the measurement score as Table 4 below:

Table 4
Likert Scale

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

b. Hardware and Software

Several hardware used for the development of this tool were notebook, graphic tablet and mouse. While, software used in developing the tool is Adobe Flash CS6 as a main authoring tool, Sound Forge for audio recording and editing and Adobe Photoshop CS6 for graphic editing.

c. i-Dyslex Tool

i-Dyslex tool is a computer based and stand-alone application. It consists of five modules which are "Mendengar", "Membaca", "Berfikir", "Mengeja" dan "Menyusun". Malay Language was used as a main language in this tool in order to avoid misinterpretation of the questions. Sample screenshots of the tool are shown in Figure 1 to 3.

Figure 1: Main menu of i-Dyslex tool

Figure 1 shows a screenshot for the main menu of i-Dyslex tool. The main menu displays the entire menu for each module available in this tool. The user can click on any module to begin the screening test and the application will display the module. Each of the module have 10 questions and total of question in this tool are 50.

Figure 2: "Menyusun" module

Figure 2 shows the screenshot for "Menyusun" module. In this module, user needs to arrange the numbers in ascending and descending trend. User must select the answer from options provided by click on it.

Figure 3: "Berfikir" module

The screenshot of "Berfikir" module is shown in Figure 3. In this module, user will hear the sound when the speaker icon in the interface is click on. User need to choose the right answer among three options given according to the sound.

C. Evaluation Process

Heuristic evaluation of i-Dyslex tool was conducted through offline activities where the tool was installed in the researcher laptop. The procedure of the evaluation consists of following steps as follows:

1. Offline invitation
   Researcher set a date with the experts for the evaluation and on that day the explanation of the evaluation purposes was given.
2. Demonstration of the tool
   The researcher demonstrates the operational of tool and after that the experts can use the tool. Next, the questionnaire was given to the experts.
3. Feedback
   The expert evaluated the tool based on the provided questionnaire. Then, the problems were identified and the expert gave suggestions to overcome the problems in order to improve the tool. Once the evaluation process completed, the data were analysed accordingly.

V. Result and Discussion

In this section, the result from heuristic evaluation is presented and discussed together with the feedback from experts.

A. Heuristic Evaluation Result

Figure 4 shows the mean score of the result from questionnaire analysis. Overall, the result indicate that the respondents agree and neutral on the heuristics criteria.

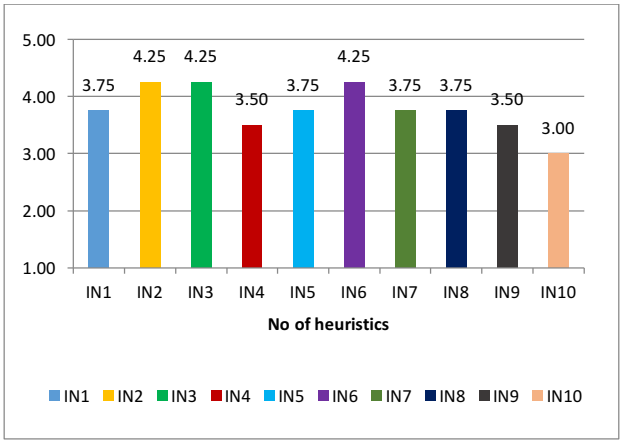

Figure 4: Means score of user interface heuristic

The results showed that, according to the respondents, the tool can fully meet users' need as measured by three heuristics, which are "IN2: Match between system and the real world", "IN3: User control and freedom" and "IN6: Recognition rather than recall". These 3 heuristics have 4.25 mean score, which means that users were between agree and strongly agree with these three usability heuristic of the tool.

Other four heuristic obtain mean score as 3.75 which are "IN1: Visibility of system status", "IN5: Error prevention", "IN7: Flexibility and efficiency of use" and "IN8: Aesthetic and minimalist design".

Meanwhile, heuristic for "IN4: Consistently and standards" and "IN9: Help users recognition, diagnose and recover from errors" had mean score 3.50 individually.

The "IN10: Help and documentation" obtained a score 3.00, which is neutral score of the heuristic. This tool already has its help documentation regarding tool's however some modification need to be done to improve it.

Overall, the findings from the questionnaire were positive even though some of heuristic received neutral score from the experts. Obviously, certain aspects of the i-Dyslex tool need to be improve based on the score of usability heuristic to ensure the tool is ready to be commercialized soon.

B. Feedback and Comments from Expert

Besides the Ten Usability Heuristic, few related feedback and comments were gathered from the expert. The comments are as follows:

1. This tool is new approach to detect dyslexia using computer based application and use multimedia elements (audio, graphic), which is very attractive to children.
2. In certain modules the number of the questions and animation need to be reduce because it may disrupt children attention.
3. The experts suggest that the proper time to implement the detection process for dyslexia among children is at the beginning or and of the year.

VI. Conclusion and Future Works

In this study, i-Dyslex tool was developed for dyslexia screening among children in Malaysia. It uses Malay Language as a main language in order to ensure the questions are well understood. It consists of five modules which are "Mendengar", "Membaca", "Berfikir", "Mengeja" dan "Menyusun". This study was conducted to determine the its usability via heuristic evaluation. The result showed that the evaluator rated majority of the questionnaires domains score as average and above average. Besides, the evaluators also provide a positive feedbacks and comments. Those evaluation and feedback from the experts are essentials to further improve the application in order to meets the user requirement and expectation. As a future work, the improvements of i-Dyslex tool will be carried out and usability testing will be conducted with dyslexic and non-dyslexic children in order to get real and reliable result. Once its' validity and reliability is tested in real population, i-Dyslex tool can be use as a dyslexia screening tool in Malaysia. These will be great historical improvement in this field which will lead to early detection and treatment for dyslexic children.

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