A Conceptual Framework for Designing a Computer-based Dyslexia Screening Test


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ABSTRACT

Dyslexia is a type of specific learning disability that affects people of all backgrounds globally without prejudice. Most learning institutions applied paper-based screening tools to identify dyslexic children before they are referred to psychologists for further tests to identify the students’ disabilities. The advantages of computer based applications in healthcare have been well established. Moreover, previous researches in computer-based screening tests are limited and innovations are poorly designed to be used by dyslexics. This paper is a conceptual framework for the development of a Computer-based Dyslexia Screening Test (CDST). The framework consists of assessment modules (for the purpose of screening dyslexia) and proposed design guidelines specifically for dyslexic children. The assessment modules and design guidelines were specially formulated to detect dyslexia at an early stage. CDST is expected to act as an early detection dyslexia screening tool without the children knowing that they are being screened.

KEYWORDS


1 INTRODUCTION

Dyslexia is a learning disability specifically characterized by the unexpected difficulties in reading and writing despite adequate intelligence, normal senses, education and social environment [1]. 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 [2]. These unique phenomena are attributed as the cause of dyslexics’ reading impedence.

A Computer-based Screening Test 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. Moreover, Information and Computer Technology (ICT) are being used in almost all levels of education in the areas of diagnostic testing, teaching, remedial teaching, psychological testing, evaluation, development of virtual laboratory, instructional material development, development of reasoning & thinking, and online tutoring [9]. Singleton agreed that there are various advantages of computer-based assessments over conventional assessments including being reportedly more efficient and cost effective to administer [8].

2 RELATED WORKS

The disability can be identified either by performing tests, through examinations, or other presumptive detection procedures of unrecognized afflictions. Further action will then be taken by psychologists upon positive or suspicious results for advanced diagnosis and/or necessary treatments [10]. Although
research in dyslexia is prolific, many were not comprehensive as there is a shortage of early detection screening for dyslexic children.

Previous studies in early detection screening tools of dyslexia will be used in this study for comparison purposes. The first research is by Hawa Mohd Ekhsan et. al on an interactive multimedia computer-based screening tool for dyslexic students called Smart Lexic [10]. The application consists of three modules using three key learning skills which are identifying letters, identifying numbers and identifying directions.

The second tool is Lucid Rapid that is widely used to detect dyslexia among children in the UK and around the world [8]. Through this application, the test were measured based on the phonological deficit model of dyslexia and comprised of phonological processing, auditory sequential memory, and visual-verbal integration memory/phonic decoding.

In another research, Zapirain et. al have prepared a set of games as a screening tool for detection of dyslexia [18]. This games set was made up of six modules that evaluate the childrens’ word production, syllabic memory capacity, verbal work memory, auditory memory, syllable and word reading capacity.

Despite the wide spread research into the use of computer-based screening tests for detection of dyslexia, there are still a number of limitations. One limitation in the previous work was that there were no storage of details such as personal information and results for further reporting. In addition, a previous work by Hawa Ekhsan et.al has yet to be tested [10].

3 PROPOSED CONCEPTUAL FRAMEWORK

The conceptual framework of this Computer-based Dyslexia Screening Test (CDST) application consists of five modules (as figure 1).

4 ASSESSMENT MODULES

The 5 assessment modules for CDST will be Reading, Mathematics, Hearing, Spelling, and IQ, that are fun, easy, and non-intrusive. Each module is scored individually and the result is displayed at the end of activity.

4.1 Reading Module

One important assessment is by screening the reading ability. Studies have shown that reading difficulties is one of the symptoms of dyslexia. Fakhrul Anuar Aziz et.al showed that dyslexics have difficulties in their phonological decoding process, which causes phonological deficit [2]. Reading disability is one of the symptoms in dyslexia [16].

This module will test reading skills among students where the score will be shown at the end of the activity. Testing reading abilities is
an accepted approach in many countries around the world as a screening test for dyslexia detection.

4.2 Mathematics Module

Children that have difficulties in mathematics may also be dyslexic [17]. A report from previous researches showed that 60% of dyslexic students would typically face difficulties in learning mathematics.

A mathematics module will be developed for CDST with the aim of providing further evidence that the difficulties faced by dyslexics in learning mathematics compared to normal students were due to their disabilities. CDST will be able to screen dyslexics’ mathematics disability at an early stage so that comprehensive treatments can be administered.

4.3 Hearing Module

Reports from previous researches proved that dyslexics' reading difficulties were due to visual and auditory deficits [2] [5]. Auditory Processing Disorder is widely diagnosed in the USA and Australia with more reports from the UK and elsewhere [15]. This clearly shows that problems regarding auditory deficit is serious. Thus, a hearing module is proposed to be developed for CDST. Through this module, students will have to identify the words they hear by clicking buttons provided. Scores will be shown at the end of the activity.

4.4 Spelling Module

Studies have found that dyslexics have difficulties in identifying phonemes which occurs during the spelling process due to exchanging of letters such as the letters ‘b-d’, ‘u-n’, ‘m- w’, ‘g-q’, ‘p-q’, and ‘b-p’ [13]. The main feature of dyslexia is a problem with word decoding, where it impacts the development of reading fluency and spelling performance [14].

A module will be implemented in CDST to test spelling ability.

4.5 IQ Module

One of the characteristics of dyslexia is memory loss among dyslexics [7] [12]. Previous studies have found that individuals with dyslexia may suffer from memory loss which is related to and categorized as neurological deficit [5].

It is important to develop an IQ module to screen memory characteristics of children detected with dyslexia. This module will test IQ skills among students where the score will be shown at the end of the activity.

5 PROPOSED DESIGN GUIDELINES

An attractive design can motivate children to actively participate in the assessment module activities. However, for CDST to be effective, the development must follow dyslexia specific guidelines. This paper discusses special guidelines used to design CDST.

5.1 Typography

Typography is the key element to convey a clear message in order to attract children. It consists out of several elements including font type, and size.

The most suitable textual font styles are in the sans-serif font group such as Arial, Comic Sans, Verdana, Tahoma, Century Gothic, Trebuchet, Helvetica, and Sassoon [2] since these typefaces are very clear, straightforward, and easy for users to read through; enhances the readability of texts and the reading accuracy of dyslexic [7].

Another key problem experienced by dyslexics is finding the text too small. Thus, British Dyslexia Association and The Higher Education Academy recommended that font
sizes of 12 to 14 points as suitable, although some dyslexics may request a larger font [2] [4].

Standardizing the font size used in CDST (12 and 14 points) will help them read easier and quicker for optimal reading. More research shall be done to find the optimum font size preferred by dyslexic users.

5.2 Colours

Research reviews showed that poor color combinations are one of the key problems encountered by dyslexics while reading the web [4]. Fakhrul, et.al agreed to use the background colour as suggested by dyslexia experts and avoid using red and green colour since they lead to distraction (especially to those who are colour blind) [2]. Rozita & Azizah recommended the use of dark blue or black text on pale blue or yellow screen [5].

Many dyslexics are sensitive to brightness that causes the words appear to swirl or blur together [3]. A contrasting combination of text and background color such as yellow on dark green is considered good and suitable [16].

Realizing this fact, we need to understand cognitive demands placed on dyslexic children upon the design of the application. Hence, CDST will be developed following the suggested color guidelines according to specific dyslexic requirements.

5.3 Layout

Text layout for dyslexics should be justified to the left with ragged right edges while avoiding narrow columns such as used in newspapers. Fakhrul added that the lines should not: be too long (60 to 70 characters), be using and cramping long materials, have a start of a sentence at the end, and spaced into dense paragraphs (space it out) [2]. Besides that, a preferable line spacing is 1.5 point. He also suggested the use of bullet points or numbering rather than continuous process.

CDST will be developed in accordance with recommendations of previous researches to achieve an effective screening process. It must be enjoyable to the children without disturbing their concentration, thus producing reliable results.

5.4 Metaphor

Metaphorical concepts will be used to create the user interface for CDST to make interactions more intuitive and easier to comprehend [11]. Metaphors used however, must relate to existing experience [6].

CDST is proposed to have a classroom inspired design to make it more attractive to children.

6 CONCLUSIONS

This research will create the fundamental components in developing the Computer-based Dyslexia Screening Test. All the assessment modules will be developed with the involvement of teachers and parents.

Previous studies have proven that computer-based screening tests are beneficial. This application is expected to encourage children to participate in the activities without them knowing they are being screened for dyslexia.

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9 REFERENCES


