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Requirements Elicitation and System Design for a Dyslexia Online Assessment and Assistance

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ABSTRACT

In this paper, we discuss the requirements elicitation for a web-based system that provides a dyslexia early screening test and dyslexia information resources. Related works such as screening tool and websites were reviewed in order to highlight their key features and functionalities. This information was used to guide the suitable functional and non-functional requirements for the online assessment and assistance which would serve the interest of the educators, parents, individuals with dyslexia and system administrators who would be responsible in the system operation and maintenance. The screening tool was designed by adapting the Instrumen Senarai Semak Disleksia (ISD) that has already been used by teachers in Malaysian schools to identify if a child has high or low probability of having dyslexic. The result from the test would determine if a child needs further examination by medical practitioner and registration in special education inclusive program.

1. BACKGROUND OF STUDY

Approximately 15% to 20% of students with learning disabilities had dyslexia, making it the most common learning disability (International Dyslexia Association, 2023). Children with dyslexia often struggled with reading, writing, and language-related tasks, which could lead to academic difficulties and reduced self-esteem. Furthermore, when dyslexia went unnoticed, it caused problems because research had shown that 62% of students with reading problems dropped out of high school (Cross River Therapy, 2022). Children needed to be screened as early as possible because, mostly, children with dyslexic characteristics were not noticed by parents due to the lack of parents' knowledge of this issue.

If there were a dyslexia support system that teachers could use to screen for reading difficulties among young children, it would facilitate faster and more accurate identification of dyslexia-related symptoms. A dyslexia support system could have provided a digital screening tool as well as disseminated information about dyslexia. It would enable parents and teachers to identify if a child was having dyslexia-related

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difficulties or not, therefore helping to plan for appropriate early intervention. The focus of this study was to help teachers and parents to determine if a child had a risk of dyslexia and make an early diagnosis. In addition, teachers could share resources by uploading into the system some samples of teaching aids and intervention techniques that have successfully helped dyslexic children. This strategy is hoped to help widen knowledge among parents and teachers about early identification and intervention.

2. LITERATURE REVIEW

This section provides some review of literatures pertaining to dyslexia and web-based portal. The discussion is expanded into the issues faced by teachers and parents in equipping themselves with specific and adequate knowledge about dyslexia screening and intervention, hence justifying the need for an online assessment and information assistance.

2.1 Dyslexia and Its Associated Difficulties

Dyslexia is defined as a specific learning difficulty characterized by reading and spelling problems that are often associated with deficit in phonological processing, though other factors and risks may have also contributed to its development (Snowling et al., 2020). Issues in phonological processing, which involved problems in perceiving and managing basic language sounds, were among the common traits of dyslexia (Siegel, 2006). Individuals with dyslexia often experienced difficulties in accurately and fluently reading text, struggling with decoding words and exhibiting slow reading speed (British Dyslexia Association, 2023). Phonemic awareness, or the capacity to recognize and manipulate specific sounds within words, could be challenging for those with dyslexia. There were also many people who had trouble to accurately and fluently recognizing or decoding words. Problems with word recognition and understanding, as well as slow and laborious reading, might have resulted from these decoding issues (Sabatini, 2022).

In addition, memory problems with letter sequences, phonetic spelling, and grammar, dyslexia could also have caused problems with spelling and writing. Other traits might have included a limited vocabulary, poor working memory, and issues with cohesive thought organization and expression. Indeed, the specific traits and their intensity could have differed between dyslexics. Cross River Therapy (2022) stated that dyslexia did not indicate a general language impairment but rather specific difficulties in the brain regions involved in phonetic processing; however, individuals with dyslexia often demonstrated high levels of creativity and intelligence and relied more on the right side of the brain for language processing.

2.2 Web-Based Portal

A web-based portal is a specially designed website that often serves as the single point of access for intentions information, one that possess prominent features such as data access, personal content, transactions, security, published content and search, thus capable of presenting information based on the user preferences (Rouse, 2017). A portal serves specific domain or services, for instance, a patient-centered health portal enables people to manage their health-related information, examine their medical records, make appointments, and contact healthcare professionals (Kummervold et al., 2020). A learning management system (LMS) is normally used in educational setting, enabling both students and teachers to access course materials, homework, grades, communication tools, and collaborative features online (Spires et al., 2019).

Additionally, a government portal, sometimes referred to as e-government portals, provides citizens with a centralized point of access to governmental resources, information, and services, including public records and applications for permits and tax filings (Vassilakopoulou et al., 2020). Meanwhile, according to Xie et al. (2020), intranets and enterprise portals acted as portals for employees in the business and

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enterprise context, providing access to internal resources, documents, collaboration tools, and corporate communications.

Obviously, there is urgent need for Malaysia to have one-stop portal that could provide support for teachers and parents in performing early screening toward at-risk children and in accessing vital information about effective intervention strategies.

2.3 Current Issues Surrounding Dyslexic Children in Malaysia

Parents and teachers need to adopt positive attitudes toward dyslexia instead of holding negative perceptions. Unfortunately, effort to reach the ideal scenario where dyslexic children receive timely diagnosis and effective intervention might be hindered because Lim, Yeo and Handayani (2022) revealed that Malaysia lacks effective teaching methods and teaching resources. Knight (2018) argued that when teachers have competent knowledge, they may show competent practices of teaching individual with dyslexia. To identify dyslexia-related symptoms among school-age children and conclude that an individual needs further examination by medical practitioner, Malaysian teachers have been using laborious and time-consuming paper-based instrument called the Instrumen Senarai Semak Disleksia (ISD). If an online screening tool that adopts ISD exists, teachers could use it to identify at-risk children in a timely manner. From parenthood perspectives, Rauf et al. (2020) unveiled that there are some types of support that parents need which could be grouped into social, peer-to-peer, financial and government support. Thus, online information resources about dyslexia must be made available. The intentions in helping teachers and parents toward a standardized online screening tools and unified information resources may be achieved by developing a web-based portal that can be accessed by anyone.

At present, The Dyslexia Checklist Instrument (ISD), which is used in Malaysian schools, determined if a child is highly probabilistically dyslexic and whether further assessment by a medical practitioner is needed. This instrument's manual nature posed difficulties for the teachers conducting the assessment. The results tabulation process required time and effort due to the vast number of pupils being evaluated. Additionally, it was challenging to efficiently store and retrieve (Rosli et al., 2022). After a child had been screened using ISD screening, they were required to seek a paper-based screening assessment.

Several studies showed that all addressed the issue of Malaysia's dyslexic children receiving insufficient attention, which was a shared concern (Liyana, Nurul, & Khuzaiton, 2013; Elly, 2023). Liyana et al. (2013) discovered that most special education teachers in their study lacked the requisite understanding of dyslexia symptoms, related challenges, and efficient intervention approaches. This made it difficult for them to give dyslexic children in their classes the best support possible. On top of that, Elly (2023) found that dyslexic children in Malaysia experienced maltreatment and were denied access to a quality education compared to their counterparts without learning disabilities. The research conducted by Liyana, Nurul, Khuzaiton (2013), and Elly (2023) highlighted the urgent need for better instruction and support for dyslexic students in Malaysia because this issue had been discussed for such a long time, year by year.

According to Abdullah Syakirin Mohamad, President-elect of the Malaysian Dyslexia Association, Malaysia urgently needed a more comprehensive educational system and more awareness campaigns for dyslexic youngsters (Elly, 2023). Furthermore, numerous studies showed how crucial it was to recognize dyslexia as soon as possible since therapies offered to dyslexic children after the initial screening had greater results in terms of learning, communication, and social skills than those given to children who were recognized later (Gupta, 2019).

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3. REQUIREMENTS ANALYSIS

This subsection discusses the method in identifying current features and functionalities of screening tool and website that disseminates information about dyslexia. It is imperative to provide an all-encompassing online solution for the dyslexia assessment and assistance so that users of the system would be able to know if a child is dyslexic or not, to take further actions and to gain access to variety of effective interventions strategies. In this study, the Instrumen Senarai Semak Disleksia (ISD) that is used by Malaysian primary schools will be digitalised, which means educators or parents could use it to answer sets of questions pertaining to a child, and the system would respond by giving feedback about the child's probability of having dyslexia. This digital version would significantly reduce the amount of time needed to calculate the score manually.

3.1 Review of Related Screening Tool and Website for Dyslexia

In identifying the requirements of an online screening tool and information assistance, some relevant screening tools and website were reviewed. It was important to search for related works having matched certain criterias such as an informative website about dyslexia, and/or a diagnostic or screening tool, therefore only four were chosen. These were Learning Success website which consists of a Dyscalculia Test, Lexercise Screener, dyslexia screening and learning style recommendation and Lexa, a prototype system designed to diagnose dyslexia through audio processing. Table 1 summarizes the key characteristics of these works.

Table 1. Comparison of four related works pertaining to screening tool

Tool	Purpose	Features	Accessibility and user-friendliness	Geographic focus	Target audience
Learning Success (Dyscalculia Test)	Offers an online test to assess and screen for dyscalculia	To identify dyscalculia and provide insights into math related learning difficulties.	Straightforward and user-friendly interface	Global	Individuals suspecting dyscalculia or struggling with math-related difficulties.
Lexercise Screener	Screening tool for identifying dyslexia and related reading difficulties	Assesses reading skills associated with dyslexia, including phonological awareness, decoding, and fluency.	User-friendly interface with clear instructions	Global	Individuals at risk for dyslexia or related reading difficulties
Dyslexia screening and learning style recommendation	Presented research and recommendations on dyslexia screening and learning style preferences	Insights and recommendations on dyslexa screening methods and consideration for tailoring learning styles to individuals with dyslexia	Accessibility varies based on publication platform	Context-dependent	Researchers, educators, professionals interested in dyslexia screening and learning style recommendations
Lexa	Web-based system dedicated to dyslexia support, offering resources, tools, and assistance.	Reading tools, assistive technologies, educational materials, dyslexia-	Focus on user friendliness and accessibility	Global	Individuals with dyslexia, parents, educators seeking dyslexia support.

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		friendly features			

Next, websites dedicated for information sharing about dyslexia were reviewed where three of the most relevant to the study were selected. They are the website of Persatuan Disleksia Malaysia (PDM), Malaysian Ministry of Education and National Organization of Dyslexia (NOD) Malaysia.

Table 2. Comparison of three related works pertaining to dyslexia website

Tool	Purpose	Features	Accessibility and user-friendliness	Geographic focus	Target audience
Persatuan Disleksia Malaysia	Information resources and support for families and individuals with dyslexia	Informative pages, local support groups, events and educational resources	User-friendly Navigation and accessibility features	Malaysia	Individuals with dyslexia, parents, educators, professionals responsible in dyslexia support
Ministry of Education, Malaysia	Information related to Malaysia education governance	Education policies, guidelines, services, school directory, online service	User-friendly navigation, search functionality	Malaysia	Malaysian citizens mainly educators, parents
NOD Malaysia	Provide support for individuals with dyslexua	Informative pages, online screening, dyslexia resources and tools	User-friendly website, clear navigation, language options	Malaysia	Individuals with dyslexia, parents, educators, professionals, researchers

3.2 Functional Requirements

Functional requirements outline the system's capabilities and specify how it should function to achieve its objectives. For example, authentication mechanisms, data formatting methods, and external interfaces are functional requirements that can be implemented within the system. The list of functional requirements are:

(i) **Registration and Login**: Users (teachers, parents, or guardians) should be able to create accounts and log in securely to access the screening tool.

(ii) **Add child information**: Users should be able to input child's age, and gender

(iii) **Screening test**: Integrate a standardized dyslexia screening test (ISD-based) consisting of tasks and exercises designed to evaluate various aspects of reading, writing, and language skills.

(iv) **Real-time analysis**: The system should analyze the screening test results instantly, providing a comprehensive evaluation of dyslexia risk. Results could be presented as low risk, moderate risk, or high risk.

(v) **Report generation**: Generate a detailed report for each child, summarizing. the screening results, including both questionnaire and test outcomes. The report should be easy to understand.

Fig. 1 portrays the Use Case Diagram for the system.

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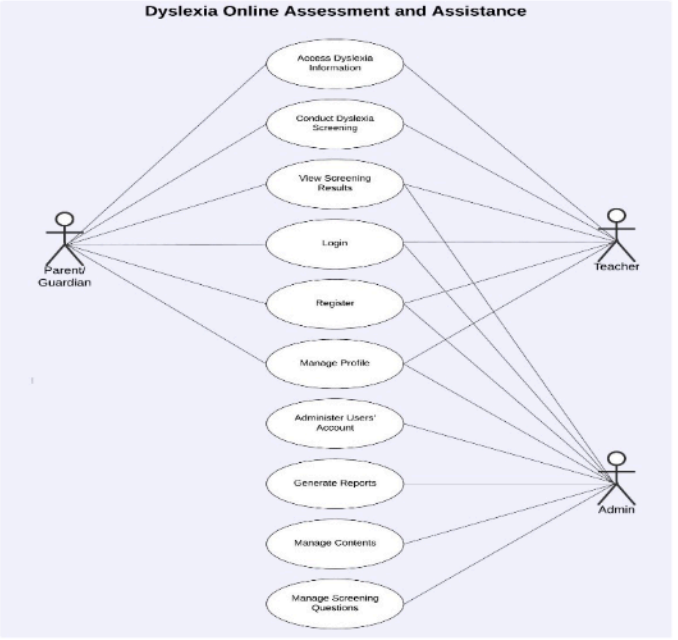

Fig. 1. Use Case Diagram

3.3 Non-functional Requirements

Non-functional requirement serves to define the performance standards and constraints which then enhances the system's functionality. Examples of non- functional requirements include ensuring security measures, compatibility with different platforms, and usability among users. The list of non-functional requirements are:

(i) **Platform compatibility**: The online system can be accessed via laptop or a desktop computer (PC).

(ii) **Usability**: Intuitive and user-friendly interface to ensure ease of use for parents and teachers.

(iii) **Performance**: able to handle simultaneously screenings without significant latency, ensuring a smooth user experience.

3.4 Tools for System Design and Development

Designing and developing an online system that has screening tools and information resources would require variety of software or tools. For this study, designing tools were identified as follows:

(i) **Draw.io**: A free diagramming software to create various types of diagrams, including flowchart, ERD, DFD, and Diagram Zero.

(ii) **Balsamiq**: A wireframing software that allows creation of user-interface sketches and navigation

Development tools must support the creation of online system with data storage and retrieval capabilities, as such the following tools must be employed:

(i) **Visual Studio Code**: Visual Studio Code (VS Code) is an Integrated Development Environment (IDE) that support programming languages PHP, HTML and CSS. It allows for creation of dynamic and interactive websites.

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(ii) **Boostrap 5.3**: It offers a range of UI components and design styles that simplify and accelerate the web development process.

(iii) **mySQL:** A database software to store data of the online system which allows table and data creation, edit and update data, and report generation.

(iv) **XAMPP**: provides a local development environment for web applications. It includes key components such as Apache (web server), MySQL (database system), PHP (server-side scripting language), and Perl (programming language).

4. SYSTEM DESIGN

The online system shall be used by a system administrator and end-users. System developers need to visualize all the components of any system, hence sitemap must be created. Prior to that, the system architecture has also been created, as shown in Fig. 2. In the system architecture, it depicts that the information system can be used for management of user information, content and reporting in the database which entails the CRUD operation (Create, Update, Delete, Display), screening tool for performing the online assessment, the user interface, the web server and the database.

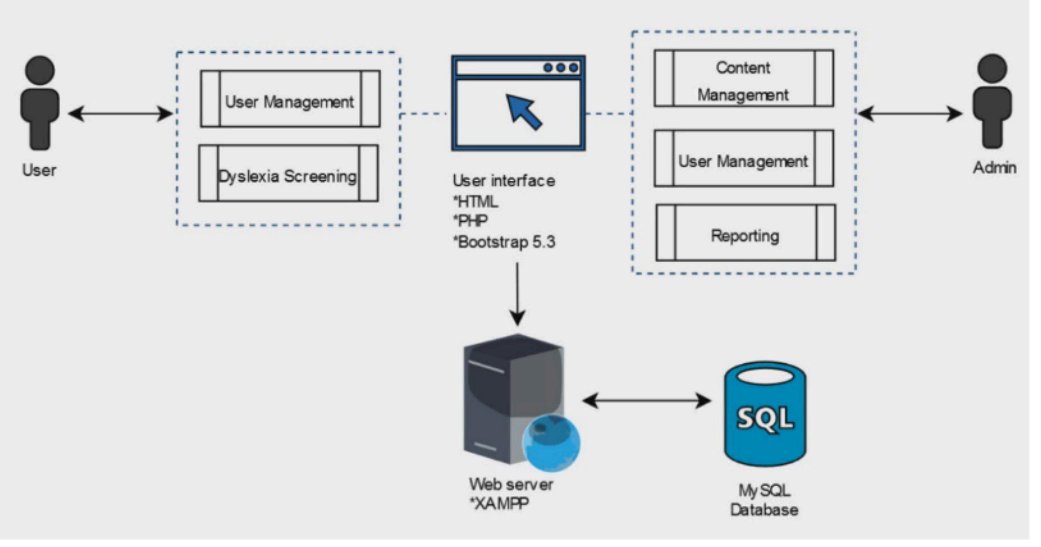

Fig. 2. System architecture

4.1 Sitemap for End-Users and System Administrator

Fig. 3 portrays the sitemap for end-users and Fig. 4 shows the sitemap for a system administrator.

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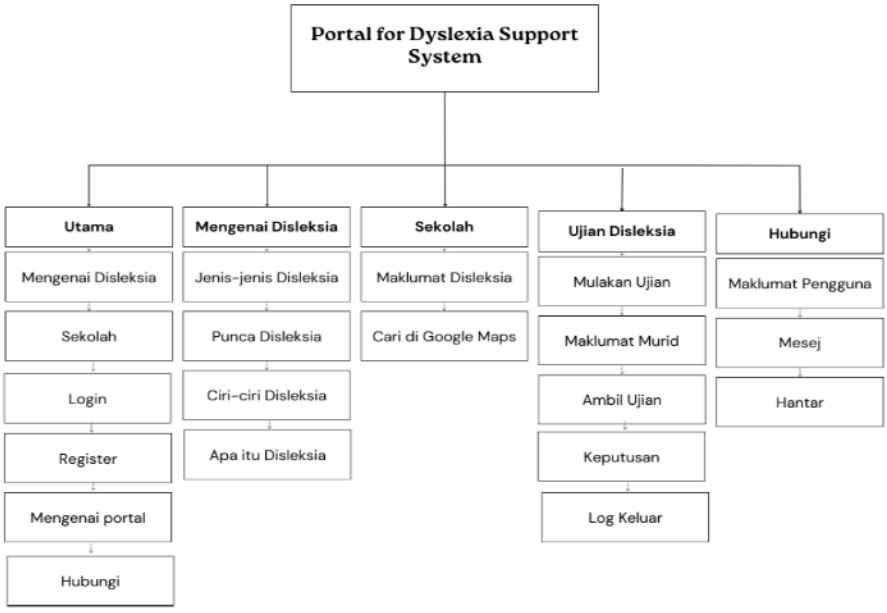

Fig. 3. Sitemap for end-users of the system

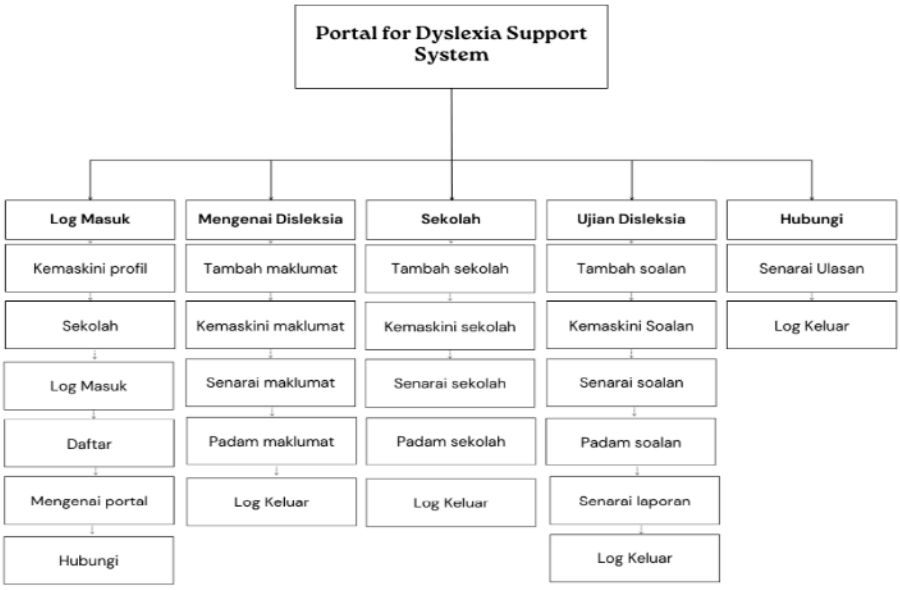

Fig. 4. Sitemap for system administrator of the system

4.2 Flowchart design

A flowchart was designed to illustrate the entire process in the online system. It elucidated to users how the dyslexia support system, equipped with a screening tool and information resources could function

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to achieve the primary goal of providing assistance to parents and teachers. For this example, a flowchart that demonstrates how an end-user could interact with the system.

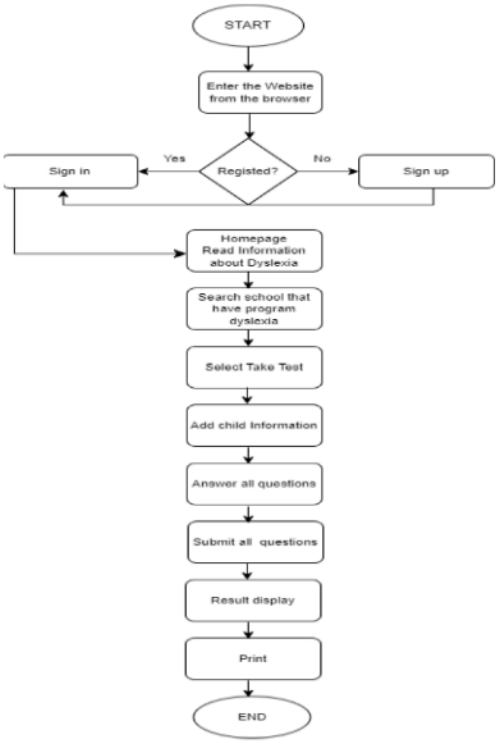

Fig. 5. Flowchart of processes involved for end-user of the online system

4.3 Scoring Calculation for ISD

The checklist mainly consists of 50 questions and three elements. The first element focuses on the student's ability to read, write, and spell. Meanwhile, the second element focuses on students' cognitive abilities. The third element focuses on each specific dyslexic characteristics found among the students. To further explain the structure of the question, it should be noted that the first element consists of the first 20 questions, followed by another 20 questions for the second element, and the third element consists of the last 10 questions. Calculation for the scoring of each element is described in Table 3. If a student scored one point for each element on the checklist, he or she would be categorized as having a high probability of dyslexia, otherwise the student would be categorized as having a low probability for dyslexia.

Table 3. Scoring calculation for Instrumen Senarai Semak Disleksia (ISD)

Element	Range of score	Score
Element 1	0 – 7	0
	8-20	1
Element 2	0 – 7	0
	8-20	1
Element 3	0 – 7	0
	8-20	1

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5. CONCLUSION

The review of existing websites and screening tools guided this study in eliciting requirements pivotal to a dyslexia online assessment and assistance. Functional and non-functional requirements have been identified. The software and tools for aiding design and development were also selected. Before the development phase of the project, use-case diagram, system architecture, sitemaps and flowchart have been created to demonstrate how users could interact with the system. The web-based system has been designed to meet the urgent needs of teachers and parents in Malaysia that is a one-stop center for executing early screening of dyslexia and searching reliable information resources with respect to ideal intervention strategies.

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7. CONFLICT OF INTEREST STATEMENT

All authors are affiliated with the College of Computing, Informatics and Mathematics, UiTM Perlis Branch, where the research on the dyslexia online assessment system was conducted. The authors declare no conflicts of interest related to this study. The research was performed independently and was not influenced by any outside funding or third-party entities.

8. AUTHORS' CONTRIBUTIONS

Aznoora Osman: initiated the ideas for the research project and conceptualize the research goals and aims, hence set the contents and direction of the manuscript; **Nurul Azni Athirah Ahmad Tarmizy**: responsibled in executing the project that is in designing and developing the system, as well as in evaluating its acceptance among sample of users; **Nadia Abdul Wahab**: validated the system by ensuring that it conforms to usability standards before it could be tested with sample of users; **Siti Sarah Md. Ilyas**: assisted with visualisation such as diagrams and charts for the paper; **Norfiza Ibrahim**: ensured correct methodology was employed during the implementation of the project.

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