Inclusive Ashesi Classroom: Bridging the Gap Equitably for the Cognitively Impaired (Dyslexia)

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***Abstract*— The goal of this project is to establish a base level of inclusiveness for future/current students of Ashesi University, specifically those with Dyslexia. Two crucial components will make up this complete initiative: a Dyslexia Screening System, and a Dyslexic Student Support System. The Dyslexia Screening System will be designed to identify students with dyslexia to ensure early diagnosis and targeted support. The Dyslexic Student Support System will be a specialized component made just for dyslexic students. This module will be designed to facilitate easy access to course materials while ensuring they are presented in a way that meets each student's individual learning needs. Through the implementation of a system that incorporates these subsystems, the project hopes to enhance the educational experience of students in Ashesi with dyslexia.**

Index Terms — inclusiveness, dyslexia, Ashesi University, Teaching methods.

I. Introduction and Related Work

In the ever-evolving landscape of higher education, the pursuit of inclusivity remains foundational to educational institutions committed to the holistic development of every one of their students. Ashesi University's dedication to excellence in education and its commitment to creating an equitable learning environment for all, places inclusivity at the core of its operations. This commitment also extends to students facing learning challenges caused by cognitive impairments such as Attention-Deficit /Hyperactivity Disorder (ADHD) and dyslexia.

The goal of the project is to establish a base level of inclusiveness for future/current students of Ashesi University, specifically those with Dyslexia. Two crucial components will make up this complete initiative: a Dyslexia Screening System, and a Dyslexic Student Support System. The Dyslexia Screening System will be designed to identify students with ADHD and dyslexia to ensure early diagnosis and support. The screening system will involve assessments and evaluations that help in identifying learning challenges. The Dyslexic Student Support System will be a specialized component made just for dyslexic students. This module will be designed to facilitate easy access to course materials while ensuring they are presented in a way that meets each student's individual learning needs. Innovative text-to-speech and vice versa capabilities, font customization, formatting choices, and a library of interactive learning tools are just a few of its features. These will be carefully created to appeal to the various learning preferences of dyslexic students.

The project is closely aligned with two key Sustainable Development Goals, specifically SDG 4: Quality Education, and SDG 10: Reduced Inequalities.

SDG 4 aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". [1] This agrees with the aim of the project which is to make education in Ashesi University inclusive, especially of dyslexic students. The project also aligns with SDG 10, which aims to "reduce inequality within and among countries"[1]. By fostering a learning system that facilitates easier learning for challenged students, Ashesi University would be taking a step towards a reduction in inequality in this regard.

The agile-driven approach was employed in the development of the system due to its flexibility in addressing the unique needs of cognitively challenged students. Agile methodologies facilitate a continuous feedback loop, ensuring the system aligns with the preferences and needs of stakeholders. This approach allows for the delivery of functional components in manageable increments, allowing faculty members to benefit early and challenged students to access course materials tailored to their needs. This methodology aims to develop a technically robust system that is attuned to the practical requirements of both faculty and challenged students, facilitating a more effective t learning environment.

A. Research Papers

"Alfaba: A Tangible Solution to Support Brazilian Dyslexic Students in their Literacy Process" [2] aims to address the critical issue of declining literacy skills among students in Brazil, particularly among the ages of 5 to 9, which is made worse by disruptions caused by the Covid-19 pandemic. With a specific focus on dyslexic students who face additional challenges in their literacy development, the paper introduces "Alfaba," as a tangible and cost-effective solution. The primary goal is to provide essential support and skill development for students' reading and writing abilities. Through professional evaluation and teacher feedback, Alfaba is designed to benefit not only dyslexic students but also all learners in need of assistance during this crucial stage of their educational journey. The results demonstrate that Alfaba effectively addresses the needs of students and aligns with the skills required for successful reading and writing development.

In a study conducted by Parker et al into a learning system specifically for college students with learning disabilities and ADHD, valuable insights into the field of inclusive learning technologies were provided. In their paper, the authors introduced a Learning Technologies Management System model, designed to bridge the gap between students with learning disabilities and the ever-evolving digital learning environment[3]. The model is

grounded in the principles of Universal Design for Instruction and proposes a proactive approach to the integration of accessible learning strategies[3]. The model realizes the importance of learning technologies in college institutions and the need to equal access for all students. It underlines the importance of technical proficiency in college education and discusses how students with learning disabilities entering postsecondary institutions often have varying levels technological proficiency[3]. They suggest that the model can be used to support their learning needs in that scenario. The authors also offer a structured framework for recognizing authentic user needs, accommodating preferences and fostering individualized strategies for learning technology proficiency. This literature provides a foundation for our research into an inclusive learning management system that aims to empower students with ADHD and dyslexia technological support. The major challenge with this system is that it creates a personalized system that caters for the needs of each diverse individual differently. This would require implementation of a wide range of features that can be technically cumbersome and difficult to manage.

Another research paper authored by Gupta et al [4] delves into the critical topic of dyslexia screening and detection in children and young adults. The primary approach discussed in the paper involves the use of gamification, specifically focusing on the identification of words with phonetic similarities. Furthermore, the paper explores various solutions aimed at enhancing the readability of digital platforms for individuals with dyslexia. These solutions include adjustments in font size, font color, background color, as well as line and paragraph spacing.The authors also discussed their final cross-platform application known as Augmentally. [4] This application has three significant features that have the potential for integration into our system. These features encompass real-time Optical Character Recognition (OCR) detection through Augmented Reality (AR), the ability to dynamically adjust application settings, and support for immersive reading experiences. These features hold promise for addressing the needs of individuals with dyslexia. However, it is essential to note that the Augmentally app has certain limitations. Notably, it offers a limited selection of three fonts and two background colors for users with dyslexia to choose from. This restricted range of choices may not adequately cater to the diverse needs of individuals with dyslexia, as it is widely recognized that a one-size-fits-all approach is not suitable for addressing the unique challenges posed by dyslexia.

Rauschenberger et al developed a web-based game application that transcends language barriers and employs machine learning for the universal screening of dyslexia. [5] The detection of dyslexia was based on indicators such as difficulties in reading and writing, as well as the user's interaction with the game, measured by factors such as the total number of clicks and duration of play. This innovative web game comprises both auditory and visual stages, making it a valuable tool for identifying individuals who may benefit from our software. Furthermore, the screening method proposed by the authors can extend its utility to pre-readers without prior language skills, broadening its scope and potential impact.

B. Notable Software Systems

Amongst the most notable software programs for helping people with dyslexia, Co:Writer[6] and ClaroRead[7] stand out as very prominent. With the help of Co:Writer, a powerful writing tool, users can improve their punctuation, grammar, and spelling. With its feature-rich toolbox, which improves writing overall, usage of a word bank, thesaurus, and sentence structure checker, it allows users to improve their writing skills and is accessible on platforms like Windows, Mac, and Chromebooks. The cost of Co:Writer's premium features should be noted, though, as this may prevent certain users from using it. Furthermore, rather than promising perfect writing, Co:Writer is a tool for improvement.

ClaroRead is an excellent text-to-speech and PDF reader that works well with Co:Writer to let people easily understand written content. Individual preferences are catered to with configurable text highlighting, adjustable reading speeds, and various speech selections. Accessibility versatility is provided by ClaroRead, which is compatible with Windows, Mac, iOS, and Android. Adjusting reading rates to a comfortable level or browsing complicated PDF pages might provide challenges. Notwithstanding these challenges, Co:Writer and ClaroRead have similar benefits. They substantially assist those with dyslexia, improving their understanding and writing abilities. They also encourage productivity and independence in learning, which helps users succeed in their academic and professional endeavors.

C. Surveys Conducted

This study conducted an online survey via Google Forms for Ashesi students to ensure that our proposed system aligns with user needs, expectations, and the overall goals of the project. This survey provided valuable insights with regards to the needs of our stakeholders.

81.8% of the students indicated that they face the difficulty of sustaining attention during tasks while 72.7% of them also showed that they frequently make careless mistakes in schoolwork. Although these symptoms alone do not determine whether a student has dyslexia, the results are enough proof that our system should address these needs.

In addition, the students indicated that software could be helpful in improving their learning experience in terms of extensive reading, highlighting fundamental concepts of lecture notes and slides, and audio transcription, among others. This informed some ideas in relation to the features the software system would have.

With regards to text appearance, the survey obtained varied responses as to students' preference such as preferring dark mode to light mode, more graphics as compared to text, using Times New Roman as a font style, as well as using larger font sizes. Once again, this would help the team make an informed decision as to the user interface of our software system.

Finally, majority of the student respondents (66.7%) preferred a web-based educational system, as compared to a mobile app (8.3%) or desktop application (25%). Hence, it would be best suited that mobile app is developed to suit the users' preference.

D. System Requirements

The stakeholders identified for the purposes of research into understanding the needs of the system's end users include:

- Office of Diversity and International Programs
- Faculty at Ashesi University
- Students at Ashesi University

The requirements elicitation process for the project included engagement with the above stakeholders to gain a better understanding of the expectations of the software system. The section below highlights the insights gained from the interviews conducted for the research.

Stakeholder Interviews

An interview with the Head of the Office of Diversity and International Programs provided diverse insights into the unique needs of individuals with dyslexia. They emphasized the implementing a one-size-fits-all solution would be unadvisable given the highly individualized needs that individuals with the challenge face. Notable points from the conversation with her include:

- Dyslexic individuals have varying and unique requirements, and a flexible approach is crucial to accommodate their specific needs.
- The software system should be designed to adapt and evolve continually to address new and emerging needs.
- Different faculty tend to handle individuals with challenges differently: conversations with them would be helpful for the needs of the system.
- A truly inclusive system considers both persons with and without the specific challenges that a solution is provided for.

Implications for the project

The insights gained from the interviews with stakeholders, particularly the Head of the Office of Diversity and International Programs, had significant implications for the development of the learning management system. The following points underscore the implications for the system:

- The system should be initially built by identifying a few needs of specific individuals with dyslexia, with functionalities that alleviate their needs
- The system should be designed with the flexibility to accommodate the changing needs of different individuals with dyslexia. These individuals would either be recommended existing solutions or have new solutions designed for their specific need
- For the development of the system to benefit from faculty engagement, a survey must be employed to gather more information on their willingness to assist students and the strategies they employ when helping students.
- The system should be available to all Ashesi students, clinically diagnosed with dyslexia or not. This guarantees that inclusivity extends beyond specific diagnosis, creating a welcoming environment for all. Furthermore, basing the system on the university's current learning management system, Canvas, removes any possible humiliation that users may feel when utilizing a separate system.

In summary, the above implications guide the project towards an adaptable system that aims to be responsive to the changing needs of its users, benefiting both challenged and non-challenged students.

The following user stories were derived from the results of our engagement with stakeholders:

User Story 1: Visual Learner

"As a university student with dyslexia who is a visual learner, I want the learning management system to include high-quality visual aids, such as diagrams, infographics, and animations. These visuals will help me better understand and retain course material by providing different perspectives and enhancing comprehension. Additionally, I need the system to offer a dedicated section where I can access and review these visual resources for each course."

User Story 2: Auditory Learner

"As a university student with dyslexia who is an auditory learner, I need the learning management system to provide a variety of audio support options. This includes audio versions of the course materials, lectures, and reading materials, allowing me to absorb content through listening. Moreover, I require the ability to adjust playback speed to suit my preferred pace. To enhance my learning experience, the system should allow me to create playlists or save important audio clips for later review."

User Story 3: Text-to-Speech Support

"As a university student with dyslexia who benefits from text-to-speech technology, I expect the learning management system to feature a comprehensive text-to-speech function. This feature should be available for all course materials, assignments, and online documents. Furthermore, the system should permit me to customize the voice, speed, and highlighting options to align with my personal preferences for auditory learning. The text-to-speech functionality should be easily accessible from any relevant page or document."

User Story 4: Customizable Font and Formatting

"As a university student with dyslexia who has specific font and formatting preferences, I need the learning management system to allow me to personalize my reading experience. This customization should include the ability to select from a range of dyslexia-friendly fonts, adjust font size, contrast, and background colors. Additionally, the system should enable me to save my formatting preferences, so I don't have to reconfigure them every time I access course materials."

User Story 5: Reading Assistance

"As a university student with dyslexia who struggles with reading lengthy texts, I would like the learning management system to offer a summarized version of the course materials. This summarization should consist of concise bullet points, key concepts, and headings, which I can access alongside the full text. Moreover, I need the system to highlight essential keywords and phrases within the text to help me quickly identify and grasp the main ideas within a passage. This feature should be accessible for both online materials and downloadable documents."

Functional requirements – FR

User Stories	Priorities
As a dyslexic university student who is a visual learner, **I want a** learning management system to include high-quality visual aids, such as diagrams, infographics, and animations **so that** I can better understand and retain course material	1
As a dyslexic university student who benefits from text-to-speech technology, **I want a** learning management system to feature a comprehensive text-to-speech function. This feature should be available for all course materials, assignments, and lectures **so that** I can better understand and retain course material through auditory means.	2
As a university student with dyslexia who has specific font and formatting preferences, **I want a** learning management system that will allow me to personalize my reading experience **so that** the time taken to read course material is cut short.	3

As a university student with dyslexia who struggles with reading lengthy texts, **I want a** learning management system that would offer a summarized version of my university course materials **so that** I can quickly identify and grasp the main ideas within a passage.	4

Non-functional requirements – NFR

User Stories	Priorities
As an Ashesi faculty, **I want the** user interface of a learning management system to be intuitive and easy to navigate, with clear labels and instructions for all features **so that** I can efficiently and effectively deliver course materials, assess student progress, and provide support to dyslexic students without facing usability barriers or confusion.	
As an Ashesi student developer **, I want a** learning management system with User preferences for fonts, formatting, and other personalization options shall be saved and persist across sessions **so that** dyslexic students can customize their learning environment for improved readability and a more tailored educational experience.	
As an Ashesi student developer, **I want a** system that should implement appropriate security measures to protect user data and ensure privacy compliance **so that** sensitive information, including the learning and personal data of dyslexic students, remains confidential and secure from unauthorized access or breaches.	
As a software administrator, **I want a** system that should be compatible with various devices and platforms, including desktops, laptops, tablets, and mobile phones **so that** dyslexic students can access educational content and resources conveniently and flexibly, using the devices that suit their individual needs and preferences.	
As a software system administrator, **I want** the system to handle a scalable number of users accessing course materials simultaneously **so that** dyslexic students can access the educational content without experiencing delays or performance issues	

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