LEXAYUDHA : AI-BASED PERSONALIZED REHABILITATION FOR DYSLEXIA AND DYSCALCULIA ADOLESCENTS

Project ID : 24-25J_233

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Project Proposal Report

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DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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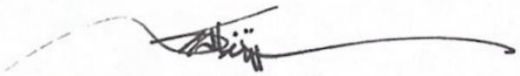
The above candidates are carrying out research for the undergraduate Dissertation under my supervision.



Signature of the supervisor:

Samantha Thelijjagoda

Date: 2024/08/23

Abstract

LexAyuda is an innovative AI-based platform for the delivery of personalized rehabilitation in adolescents affected with dyslexia and dyscalculia. These learning difficulties usually result in extreme complications related to education that include frustration, disengagement, and reduced self-esteem. Though there are assistive technologies available, existing tools lack real-time personalization that is needed to keep learners engaged to achieve improved learning outcomes. LexAyuda tries to fill this lack by adopting successfully tested medical methodologies: chromatic variation to reduce visual stress, Touch Math to improve mathematical skills, and multisensory teaching strategies.

Advanced AI techniques, such as Convolutional Neural Networks and Recurrent Neural Networks, will continuously tune the system for each student's special needs in learning. It personalizes reading content and visual settings in real-time based on student feedback. This will be realized through the development of adaptive learning algorithms, NLP-based sentence generation, and individualized instructional plans to have a far better reading performance brought out in students with dyslexia.

Furthermore, the incorporated emotion detection algorithm that makes the level of difficulty of tasks personal according to the mood of the student and customized voice outputs in accord with individual speech paces for a totally stress-free and supportive learning environment. Ultimately, reading fluency, comprehension, and user engagement will be tested to validate the effectiveness of the platform. Preliminary results are indicative that the integration of AI with established medical strategies could gain important improvements in academic and emotional outcomes of adolescents suffering from dyslexia and dyscalculia. LexAyuda plans to grow with the capability of offering a broad and scalable tool that solves, not only the current challenges for dyslexic and dyscalculic adolescents but will evolve with the new developments of artificial intelligence and educational technology.

***Keywords**: Dyslexia, Dyscalculia, AI-driven personalization, Chromatic variation, Adaptive learning*

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
AI	Artificial Intelligence
NLP	Natural Language Processing
FAQ	Frequently Asked Questions

1. INTRODUCTION

Specific learning disability, is a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations [1]. Dyslexia is one of the most common learning disabilities, with an estimated prevalence of 15-20% of people worldwide [2]. In the United States alone, more than 32% suffer from learning disabilities and specifically 19% suffer from speech or language impairment (Refer Appendix A, Figure 1) [1]. In Sri Lanka, it has been reported in 2019, that total of 2397 male students and 1140 female students from grade 1 to grade 11 repeaters to have dyslexia (Refer Appendix A, Figure 2) [3]. Perhaps, this could be one of the common learning disabilities in educational systems. Mainly, difficulties are noted in reading, decoding, and processing written information. This can cause issues with phonological processing, spelling, and word recognition. Some of these characterizations relate to failures in intelligence or initiatives taken by students. However, their core lies in the neurological processing of language, more precisely, difficulties in mapping sounds to letters and words faced by those who have dyslexia; this causes reading fluency and comprehension to be very low.

On the other hand, dyscalculia according to the British Dyslexia Association in United Kingdom has stated that about 6% of people have dyscalculia. Not only that, an estimated 25% of people have math learning difficulties which can be caused either by other neurodiverse conditions such as dyslexia or external issues such as a traumatic learning experience related to math or school absence but also they have provided with statistics that 60% of individuals with dyslexia will have difficulties with math [4].

Traditional teaching methods are inadequate to help these students, because they depend mainly on depersonalize learning strategies. Methods that could have been highly effective with the neurotypical learner can make a dyslexic or dyscalculic individual become frustrated, anxious, and even lead to lower academic performance. Therefore, it is important to have an application which can offer adolescents with learning difficulties to learn and overcome their specific disability by having the

support of personalized and proven teaching methods, within a stress free and engaging learning environment.

1.1 Background

Dyslexia is a complex, life-long learning disability that is neurobiological in origin and characterized by reading, writing, and spelling difficulties. Dyslexia may manifest in a person with normal intelligence and adequate teaching; the neurological pathway of this disorder is based on differences within simple deficits in phonological processing or, in other words, the ability to speak, read, write, and describe sounds that are linguistically relevant. This shortfall puts word decoding and sound to letter scale to test as this is generally a tedious task for the person because of which reading rate and comprehension become low. The visual stress condition of text being shown to them normally presented as distorted images or blurring images make the reading task more difficult.

In conventional education, standardized approaches are practiced where diversification of dyslexic learners cannot be accommodated. These methods tend to be ineffective for students with dyslexia because its treatments call for a multisensory method that is totally personal and not connected to phonics and the repetition of reading exercises. The ineffectiveness of these methods is indicated by the fact that so many dyslexic students keep having difficulties with reading their entire school career. Research suggests that, in the absence of prompt and effective intervention, students diagnosed with dyslexia are likely to lag significantly behind their peers in both educational and social contexts.

A proven research that has the potential to provide further avenues in the search for adjusted methodologies for dyslexic learners is the use of chromatic variation in order to improve readability. One of the most frequent complaints from people with dyslexia is visual stress. A significant reduction in the level of this discomfort comes from using a color balance between the print and the background. The ideal combination of colors, such as pale yellow and dark blue, can highly reduce the sense of unease in vision, thus improving reading speed and accuracy, along with comprehension, according to some studies like those of Pinna and Deiana, conducted in 2018 [5].

Although these findings are promising, the practical application of chromatic variations in educational technology has, until now, truly been in its infancy. Most existing tools for educational technology have been developed with static settings of visual appearance and hence totally disregard the variability in dyslexic symptoms or individual student preferences. Such a non-personalized approach contributes to reducing the effectiveness of interventions, since the optimal visual settings to one student may not be adequate for another. However, the dynamical adaptation of these settings in real-time based on student feedback through an AI interface still remains practically non-existent.

This research project is aimed to fill these gaps by creating a web-based adaptive learning system that develops a personalized and adaptive learning environment for students with dyslexia using AI. Such a platform would continuously capture the actions of students as they interact with the text and make dynamic adjustments for visual settings and content complexity accordingly, to best suit the reading experience. By making it more sensitive to each student's individual learning needs, the approach aims to work towards improving reading outcomes and the general learning environment.

Beyond the technological scope, this research will take a deep look at overall implications for dyslexic students in increasing academic performance, engagement, and self-esteem. This will be achieved by advancing the development of newer, more efficient, low-cost, and user-friendly educational tools for these students using the latest advances in AI and educational technology.

1.2 Literature Survey

The relationship between chromatic variations and dyslexia has been the subject of multiple researches in recent times with regard to the way the changes in color can impact the reading performances of dyslexic people. The study by Pinna and Deiana (2018), different sets of colors were examined carefully in reading comprehension tests for children and adults having dyslexia. They reported that the combination of certain colors, such as pale yellow and dark blue text, led to a considerable improvement in readability by reducing the visual stress and allowing for an improved recognition of

words [5]. This result points to the valuable potential of chromatic variations as simple, effective tools for supporting the reading behavior of people with dyslexia. However, despite promising results, the integration of those findings into practical educational tools still remains limited. In addition, it recommends of some color schemes and the research support for their application without really taking into regard that individual color preference can vary and that an opportunity at personalized color settings may increase reading performance to that extent. Extending this further, the idea that the textual environment for dyslexic persons should be personalized and hence can be supported further. In fact, the important key aspects highlighted in the "Dyslexia Friendly Style Guide" by the British Dyslexia Association are color contrast, font choices, background colors in designing educational material for the dyslexic learner [6]. All these are in agreement with experimental studies, for example, by Raghuram et al [7]. While guidelines on how these practices can be followed are widely available, the actual implementation of such practices is clearly missing in most digital educational platforms, especially those using real-time adaptation for different students**.**

Artificial intelligence has been identified as one of the technologies that will drastically affect personalized learning, providing ways for extremely individualized learning processes. Raghuram et al. 2019 furthered this by providing how AI was used for the development of adaptive hypermedia learning and personalizing learning experiences, especially in varying content to be perceptible according to the learner's capability or in analyzing individual student performance and being able to dynamically adapt the content's difficulty, pacing, and presentation [7]. What is to be observed, though, is that while AI has found not a few applications in the scope of educational contexts, its specific application to dyslexic students through the use of chromatic variations is considered somewhat unexplored. The integration with AI, through the adjustment of chromatics, may give a double-layered approach to personalizing learning—one focusing on the cognitive and visual challenges and another one on the needs of the student with dyslexia. In yet other innovative applications, such as that made for dyslexics, ALEXZA, with AI, using the concept of machine learning, this potential to augment dyslexic learners is further brought forth. ALEXZA uses AI to dynamically adapt learning tasks to the user's performance, providing real-time feedback and

adjustments [8]. However, as much as this application is involved with the auditory and cognitive parts of learning, it sets the first step to the extent AI can be used in the construction of personalized learning. Extension of such an approach in this case with chromatic varieties might significantly enrich the learning environment of dyslexic students, leading to a more convenient and effective reading experience for them.

With recent development of Natural Language Processing, adaptive content delivery is assured, promoted more by its capacities in sentence simplification and generation in the user's skill. Various NLP technologies, as discussed by Walipilla, have been extracted to the development of mobile-based screening systems targeting reading weaknesses due to dyslexia [2]. These systems incorporate advanced algorithms that help in breaking down analyzed text in layman's terms, thus guiding the text users for making sense out of the text and making it easier to understand for those suffering from reading disabilities. For this, NLP is able to enhance the reading ability and fluency of dyslexic students.

Furthermore, NLP integrated with AI offers another level of enhancement in personalization in education. The research on high-performance word segmentation technology draws attention to possible downsides associated with distributed character trees and utilize unknown word recognition techniques as part of the improvement of text processing for dyslexic readers. These technologies will also be helpful in adjusting the difficulty of the reading material dynamically to the student's progress, while making the work remain challenging and still approachable. In combination with AI-driven chromatic variations, NLP will enable education platforms to offer a completely adaptive reading experience that caters to both the cognitive and visual needs of dyslexic learners.

Overall, the literature concludes with some potential integrations of chromatic variations, AI, NLP, and adaptive learning systems into a wide ranging and a comprehensive, personalized educational platform for the dyslexic student. Significant strides have been made in every one of these areas, if considered singly; however, there remains a critical need for research which will bring all these elements together into a system with dynamic potential to adapt to the needs of the dyslexic learner in real time. The current proposal will address this gap by developing a web-based

platform utilizing technology to empower effective reading and learning support for dyslexic learners.

1.3 Research Gap

The chromatic variations have been shown to benefit dyslexic readers, but their practical application to educational technology, let alone in a more dynamic and AI-driven context has been fairly limited. Dyslexia is one such heterogeneous learning disability that effects uniquely in different individuals. Most of the existing interventions, therefore, apply a single model that often fails to capture the specific needs of each dyslexic learner. Conventional educational tools, however, typically realize static solutions, offering fixed color schemes or only generic content adaptations that are not responsive to specific symptoms and learning preferences of students. This, even though accidental most of the time, will only enhance the difficulties a student with dyslexia is already experiencing and subsequently create frustration, disengagement, and less-than-optimal educational outcomes.

It is the chromatic variations meaning, strategic changes to the color of text and its background which have been proved in research to yield maximum readability in people with dyslexia, through reducing visual stress while improving both word recognition and reading speed [5]. However, the static application of these chromatic variations will not be sensitive to all the various and fluctuating needs of students who are dyslexic. For instance, what works for one student will not be appropriate for another and even the same student may benefit from different visual settings while their reading skills evolve over time.

Although the amount of research in the field of application of chromatic variations is already significant and growing, its translation into educational technology is still relatively undeveloped. Most of the existing tools offer very limited personalization options and are incapable of dynamic adjustment to the user's performance in progress. For example, some applications allow the user to select from a number of preset color schemes, but these settings cannot be modified in real time according to how the student progresses or in response to feedback.

AI has long been holding enormous potential for changing the landscape of personalized learning, particularly when it comes to adapting the delivery of material based on the needs of each learner. It can read performance data of students for the purpose of providing real-time feedback and dynamically changing the level of difficulty and presentation of educational content. Nevertheless, how AI can be applied in real-time to the adaptation of visual settings, such as chromatic variations, has remained largely unexplored. It might put AI into educational tools for students with dyslexia to adjust the content difficulty but also optimize the visual presentation of text, enhancing both the cognitive and visual aspects of learning.

For example, ALEKS and Intelligent Tutoring Systems have already proved the potential of AI-driven adaptive learning paths in enhancing educational outcomes. These systems continuously test knowledge on a certain topic for a given student, adjusting his/her learning trajectory accordingly. However, their application in dyslexia-focused interventions, especially regarding the real-time adaptation of visual settings, has been somewhat limited. It is in that respect that the extension of those systems' functionalities to dynamic chromatic adjustments would provide an overall more holistic and highly personalized learning experience, covering the needs of students with dyslexia.

Secondly, in the field of education, NLP opened new ways for content adaptation, mainly, text simplification and generation at the appropriate reading level. NLP technologies can help ensure a readable text for students with dyslexia that not only is easy to see but linguistically appropriate, further enhancing the learning experience. When combined with AI-driven chromatic adjustments, it will create an adaptive learning environment where the level of difficulty and even the way text is presented change in real-time based on the person's needs.

Therefore the following research aims to fill these important gaps by proposing a Web-based solution using AI, not only to tailor the content but also modality of the reading material for students with dyslexia. This proposed application will utilize AI to track and analyze the student's continuous interactions with the text and make adjustments to the visual settings and difficulty of content in real time to optimize the learning experience. The objective of the research study is to propose a responsive and adaptive

educational tool for improving reading outcomes in dyslexic students, so that they can perform better academically.

1.4 Research Problem

The existing research gap and as the main challenge of this research suggest, is that of available educational materials for students with dyslexia and benefits to be derived if a technology-supported custom program for the affected is implemented. Dyslexia is a complex learning difficulty that is characterized by difficulty with accurate and fluent word recognition, spelling, and decoding. It affects a big percentage of the population. There are more attitudes that can be applied to support dyslexic learners, as the traditional educational methods may fail their variable needs and are designed for typically developing students. The approaches can actually make the students with dyslexia encounter more problems, become more frustrated, and have lower levels of self-esteem and poorer academic success. Some of these approaches in identifying dyslexic difficulties in students have been acknowledged over the last few decades. One such area is chromatic varieties: the prescription of particular combinations of text-background color that can help to minimize visual stress and maximize readability. Actually, there are chromatic colors that, properly combined, can dramatically increase people's performance in reading, minimizing visual stress and increasing the cognitive-load-free processing of the text. However, despite these promising results, the use of chromatic variations within educational technology has rarely been put into practice. Most present tools dealing only with static color settings are not created to be adaptable to personal student needs or to change dynamically, to give real-time feedback. At the same time, artificial intelligence is advancing and opens up another spectrum for the designing of personalized learning environments. AI-driven adaptive learning systems use student performance data to automatically adapt content and difficulty levels in order to be more reflect on each learner and, hence, more effective. Although the approach to education with AI is expected to be revolutionary, the application of these technologies remains somewhat unexplored in terms of the chromatic-variation-based intervention among people with dyslexia. Artificial intelligence applied to methodologies that have already proved effective,

such as the use of chromatic variations, can provide a double-layered personalization mechanism both on the visual and cognitive levels of challenges observed in dyslexic students. To verify the discussed gaps the following comparison of already existing system features can be used, and it highlights the possibility of implementing an innovative application to address the shortfalls in those existing systems and to fill the gap in between existing researches.

	A	B	C	D	E	LexAyudha
Chromatic Variation approach	✓	✗	✗	✗	✗	✓
Best suited chromatic variation detection	✗	✗	✗	✗	✗	✓
Color variation effectiveness	✗	✓	✗	✗	✗	✓
Best suited color variation detection	✗	✗	✗	✗	✗	✓
Complexity adjustments	✗	✗	✗	✗	✗	✓
Personalized Lessons	✗	✗	✗	✗	✓	✓
Text to Speech	✗	✗	✗	✓	✓	✓
Text Highlighting	✗	✗	✗	✗	✓	✓
User Friendliness	✗	✗	✓	✗	✓	✓
Possess a web/mobile app	✗	✗	✓	✓	✓	✓

Table 1.1: Existing System Comparison

A - On the Role of Color in Reading and Comprehension Tasks in Dyslexic Children and Adults

B - Chromatic visual evoked potentials: A review of physiology, methods and clinical applications

C - Nessy

D – ClaroSpeak

E - Alexza

The central research question that guides this research is based on the following: "How can we incorporate chromatic variations and AI to create a personalized teaching approach that improves the reading skills of dyslexic students?" in this manner, imaging beyond the single, static approach in solution orientations, opening up the horizons that may be responsive and dynamic in orientation to any changes happening to the subject. The proposed research is dedicated to the development of a web-based, chromatic variation-based reading interface that will personalize the content and visual presentation of the reading material, constantly changing these parameters in real time based on feedback. As such, it can offer a much more propitious and potent learning environment for dyslexic students to gain control over their difficulties related to reading and the improvement of their general performance within the school environment. If the website were to address the cognitive and visual difficulties of reading, this indeed goes a long way toward making reading so very much easier and more enjoyable for the dyslexic student, enhancing the likelihood of learning and taking place with much less tension. Moreover, the application of AI in this context is a rather big step forward in using technology within education, providing a scalable solution that can be adapted to the needs of each individual student on a large scale. Ultimately, this research would contribute to the advancement of more effective, personalized educational tools that would best support dyslexic students in pursuing the achievement of their full potentials. On these benefits, and from the very best of the state-of-the-art in developments within the field of AI and chromatic variations, the proposed platform undertakes an effort to bridge existent practice to dyslexic learners, therefore being inclusive and adapted to education.

2. OBJECTIVES

2.1 Main Objective

The overall objective of this research study is to design, develop, and validate a novel AI-driven web-based platform customized for enhancing reading skills and analytical skills in students with dyslexia and dyscalculia respectively. This platform will make use of cutting-edge technologies such as Artificial Intelligence, Chromatic Variation Techniques, Touch Math based Teaching, Natural Language Processing, Emotion Detection and Audio Pace Customization to deliver a highly personalized and adaptive learning environment.

Specifically, the chromatic variation-based teaching component will focus on identifying the appropriate chromatic variation types and color combinations and providing a personalized activity plan to improve reading skills of dyslexia hence aiming to resolve the most advanced challenges of dyslexia, specifically in reading fluency, reading comprehension, and visual stress, by giving students a dynamic educational tool able to adjust in real time to suit each student's needs. This will also provide the necessary support to help students who suffer from dyslexia and dyscalculia achieve better academic performances and overall learning achievements than if they had used other methods, by being more supportive, effective, and engaging in student education.

2.2 Sub Objectives

The chromatic variation is one of the main components in the system design and it will be one of the central features of the platform in providing a dynamic modification of color contrasts between text and background. These changes will come about as a result of continuous feedback from the student and ensure a system that can respond instantly to any visual discomfort or inefficiencies in reading performance. The overall purpose of this module is to reduce visual stress, one of the elementary issues that normally manifests itself among dyslexic readers, through enhanced readability and

enabling the actual act of reading to be completed in a more comfortable and efficient manner. This will be helpful in establishing an optimal reading environment based on the specific needs of each learner by supporting and improving reading fluency and comprehension. Hence, one of the main sub objectives, is to design and implement a way to find the best suited color variations and chromatic variation type for each individual.

The other core feature within the tool is AI-based personalized learning paths. This emphasizes that it is the use of artificial intelligence that is supposed to continue improving the reading performance, in terms of speed, comprehension, and accuracy, of each student, and then adapt the learning content accordingly. The AI will relevel and decomplexify the reading material in a dynamic way, such that the text is optimally challenging yet accessible to the student. Such engagingly effective learning events will only be possible in which the students are better placed to, in a gradual manner, improve the reading abilities of the students, maintaining them motivated and confident at the same time. This aspect of the platform will be used to ensure continuous, measure-based progress in students' reading proficiency through the presentation of materials that is matched to each student's current grade level competency. Furthermore, the usage of NLP, the linguistic complexity of the reading materials to be encountered by the student will be modulated based on their level of skill at the present time. This will be accomplished by breaking down sentences that are too complex, replacing difficult words with synonyms, and generating new material on a subject of some interest to the student. The above is meant to help a student go through any material with the comfort and ease that will give the student the ability to understand and appreciate reading in general. Since the element matches content to the linguistic abilities of the student, it improves one's confidence and instills the habit of gaining more confidence in reading over time. Therefore, the second most important sub objective is to analyzing student capabilities and suggesting appropriate dynamic learning lessons for the individual.

Another most important objectives is to have the platform validated via pilot testing. The subsequent step will be the full pilot, where a selected number of dyslexic users are asked to undertake exposure to the platform for a predetermined period. Qualitative and quantitative data will be derived from this pilot study to measure effectiveness

based on text reading fluency and comprehension, as well as user satisfaction. This feedback can then be integrated and used to refine and optimize the platform further for the target user group, so it can be rolled out to larger populations in full function and effectiveness.

Hence the goals of this project would help advance in creating a very powerful, scalable, and adaptive educational tool that would serve as a means to facilitate improvement in reading skills in the case of a dyslexic student. With AI, chromatic variabilities, and NLP in hand, executing a personalized, engaging, and well-performing learning experience with such technologies in one stage helps students achieve better academic results and find more positive experiences in education.

3. METHODOLOGY

The development of the AI-driven web-based platform for enhancing reading skills in dyslexic students will follow the Agile Software Development Life Cycle (SDLC) methodology. Agile was chosen for this project due to its iterative and flexible nature, which allows for continuous feedback, rapid prototyping, and ongoing refinements, an approach that is particularly well-suited for a project requiring constant adaptation to user needs and technological advancements (Refer Appendix B).

The overall use case of the application have been identified (Refer Appendix C, Figure 1) and the specific functional flow required for the chromatic variation-based teaching have been identified (Refer Appendix C, Figure 2). The high-level component overview for the module chromatic variation-based learning is as follows and to identify the concept behind the suggested whole system refer Appendix D.

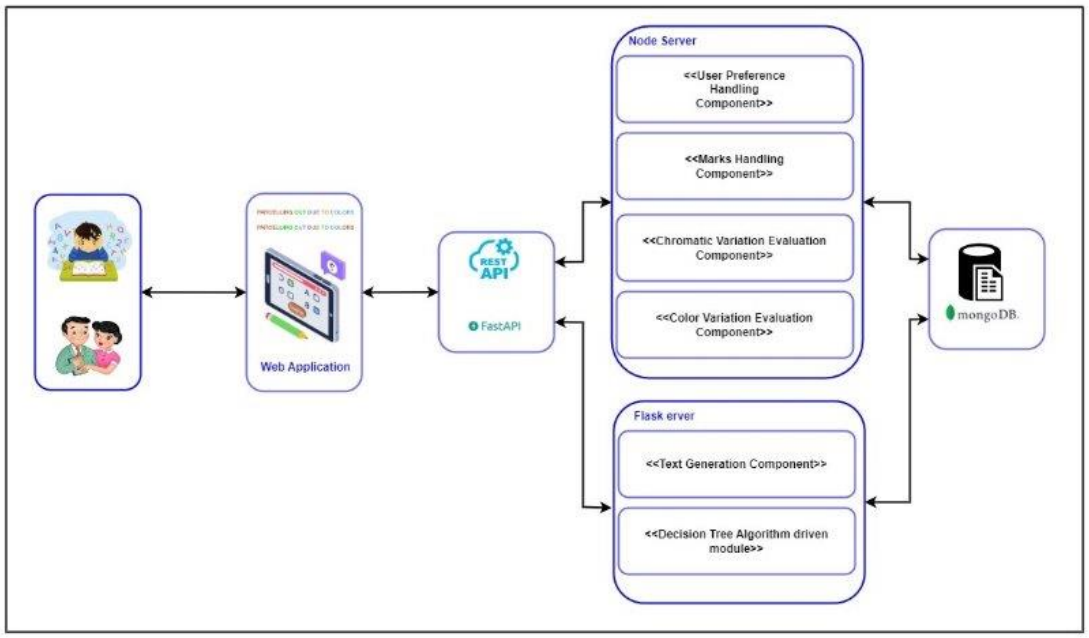

Figure 3.1: Component Overview Diagram

1. Requirements Gathering and Analysis

The project will commence with a comprehensive planning and requirements gathering phase. This initial phase involves collaboration with stakeholders, including educators, dyslexia specialists, and technology experts, to define the specific needs of dyslexic students and the desired outcomes of the platform. Based on the gathered requirements from the stakeholders, user requirements, system requirements and non-functional requirements are as follows.

Functional Requirements

- Create a personal account and access the application
- Perform suited chromatic variation and color variation tests
- View and learn personalized lessons
- Perform quizzes and assess the performance

Non-Functional Requirements

- Reliability
- Accuracy
- Security

System Requirements

- Stable internet connection
- A microphone

Personal Requirements

- Consent to provide speech audio data.

Software Requirements

- Web browser with microphone access

Additionally, during this phase, the technical architecture of the platform will also be established. The platform will be built using a robust and scalable technology stack that includes:

Frontend Development: React.js will be used for building the user interface, chosen for its flexibility, performance, and ability to create a dynamic, responsive user experience. The frontend will incorporate accessibility standards to ensure usability for dyslexic students.

Backend Development: Node.js with Express.js will be utilized for the server-side application. This combination provides a scalable and efficient environment for handling real-time data processing and communication between the frontend and backend.

Database: Cosmos DB, a NoSQL database, will be used to store user data, including personalized learning paths, performance metrics, and visual preferences. Cosmos DB 's flexibility and scalability make it an ideal choice for managing diverse and dynamic data.

Artificial Intelligence (AI) and Machine Learning (ML): Python will be the primary language for developing AI and ML models. TensorFlow and Keras will be used to build and train models that adapt learning paths and visual settings based on real-time user data in case of arisen requirement. These models will be integrated into the platform through APIs, allowing seamless interaction between the AI components and the core application.

Natural Language Processing (NLP): The NLP capabilities will be powered by Python libraries such as NLTK and SpaCy. These tools will be used to simplify and generate reading content tailored to the student's skill level. The NLP system will analyze text complexity and adjust it to match the learner’s proficiency, providing a more engaging and comprehensible reading experience.

Chromatic Variations: The Chroma.js library will be employed to manage dynamic color adjustments within the user interface, allowing real-time changes to text and background colors based on user feedback.

2. Design and Prototyping

Following the planning phase, the project will move into the design and prototyping stage. Agile’s iterative nature allows for the creation of early prototypes that can be tested and refined based on user feedback. The initial design will include wireframes

and mockups for the user interface, emphasizing accessibility and ease of use for dyslexic students (Refer Appendix F).

The design process will focus on creating a clean, intuitive interface that supports real-time interaction. Special attention will be given to the chromatic variation system, ensuring that color adjustments are easy to manage and visually effective.

Prototypes will be developed using React.js, allowing for rapid iteration and testing. These prototypes will be shared with stakeholders for feedback, ensuring that the design aligns with the educational goals and user needs. This feedback loop is critical in Agile, allowing the team to make adjustments early in the development process and avoid costly changes later on.

3. Development and Iteration

The development phase will be carried out in sprints each typically lasting two weeks and the system will be implemented using above mentioned programming languages, frameworks and tools and technologies,. During each sprint, specific features or components of the platform will be developed, tested, and refined. This iterative approach allows for continuous improvement and the incorporation of stakeholder feedback throughout the development process.

4. Testing and Quality Assurance

Testing and quality assurance are integral parts of the Agile methodology, occurring throughout the development process. Each sprint will include dedicated time for testing the new features and ensuring that they meet the required specifications and quality standards.

Unit Testing: Individual components, such as the chromatic variation system, AI models, and NLP functions, will undergo rigorous unit testing to ensure they work correctly in isolation. This will involve testing the algorithms, user interface components, and database interactions independently.

Integration Testing: Once the components are developed, integration testing will be performed to ensure that all parts of the platform work together seamlessly. This testing will focus on the interaction between the frontend and backend, the integration of AI and NLP models, and the real-time adjustment of visual settings and content.

User Acceptance Testing (UAT): Stakeholders, including educators and dyslexia specialists, will be involved in user acceptance testing to validate the platform's functionality and usability. This feedback will be crucial in identifying any issues or areas for improvement before the final deployment.

5. Deployment and Maintenance

After thorough testing and validation, the platform will be deployed using cloud services such as Azure cloud-based services, ensuring scalability and reliability. The deployment will be phased, starting with a beta release for a small group of users to gather additional feedback before a wider rollout.

Continuous Integration/Continuous Deployment (CI/CD): A CI/CD pipeline will be established to facilitate ongoing updates and improvements to the platform. This will allow the development team to deploy new features, fix bugs, and make enhancements without disrupting the user experience.

Ongoing Maintenance: Post-deployment, the platform will enter the maintenance phase, where it will be continuously monitored for performance, security, and user satisfaction. Regular updates will be provided based on user feedback and technological advancements, ensuring that the platform remains effective and relevant.

User Support: A support system will be established to assist users with any issues they encounter while using the platform. This will include comprehensive documentation, FAQs, and a helpdesk for direct support.

6. Evaluation and Feedback

The final phase involves ongoing evaluation and feedback collection to assess the platform's impact on reading skills and overall educational outcomes for dyslexic students. Data analytics will be used to measure the effectiveness of the AI-driven personalization, chromatic variations, and NLP adaptations. Feedback from users and educators will be continuously collected and analyzed to guide further development and optimization of the platform.

Commercialization Aspects of the Product

It is in fact a business opportunity for the proposed AI-driven adaptive web-based platform, as it uniquely fills the gap in the education sector empowered by personalization in adaptive learning experiences for students with dyslexia. The potential number of people with dyslexia is fairly large, and interest in effective and scalable educational solutions has been quite pervasive and growing at a very fast rate. By providing a solution using artificial intelligence, chromatic variations, and natural language processing, the platform will be positioned as part of the best in class for this EdTech marketplace.

Target Market

The two target markets for this solution will primarily be schools and other educational facilities, as well as parents of dyslexic students. Key Target Audiences for these target markets include:

- Primary and Secondary Schools: Public and private schools that afford special education programs have a great opportunity. These will most frequently be looking out for a package that can help teach such children with learning disabilities, and what the platform will offer in terms of personalized and adaptive learning will effectively meet this demand.
- Parents: Parents of dyslexic children make another crucial segment of the market. In general, parents are more than glad to pay for materials or services which would enable their children to climb up the ladder educationally, especially if the regular learning methodologies have failed.

Educational technology companies: Suitable educational technology companies can also become collaborative to scale the reach of this platform. Many of these companies work to expand their product lines with creative solutions; in this light, the inclusion of this platform in their existing suites will be beneficial for both parties.

Dyslexia Advocacy Groups: It can form alliances with independent, non-profit making dyslexia advocacy groups dedicated to making lives with dyslexia better and echo this platform for more visibility and credibility in general.

Pricing models

This would be a flexible pricing strategy that caters to the needs and budgets of the target market in order to be successful financially. For the purpose of pricing, it may use any one of the following models:

- Subscription based model: The plan will apply a tiered subscription model at a fee charged, plus the features required. With the next tier of features being the advanced tiers, which include advance analytics and an extended library of content with further customization options, the example of one basic tier including the core features, such as individual learning paths and chromatic adjustments. Therefore, depending on the level of service needed, the price will range from $5 and above monthly.
- Freemium Model: That is why, for instance, on this platform, a freemium model could be used where all the basic functionalities would be free of charge. Therefore, users would have experience of the platform and subsequently transfer to the paid version. By subscription, premium feature advanced AI-driven content customization, detailed progress reports, and more support options could be unlock.

Market Strategy

A market strategy will be put in place to commercialize the platform successfully .

- Marketing and Outreach: Participating in educational technology related meetings and visiting places offering education for dyslexics and dyscalculics can be of importance, which will enable the creation of brand awareness. This helps to network potential clients and other stakeholders. Impressions on the potentials of the platform for benefiting students with dyslexia and dyscalculia can be achieved through the demos or presentations made at these events.
- Online marketing will be conducted through digital campaigns that place ads on social media, educational forums, and search engines for both school and parent buyers. Thought leadership on this subject will be built using content marketing for those in education for whom dyslexia is a concern. Collaboration

with schools and special education programs will facilitate early testing for the platform.

- Dyslexia advocacy groups can boost the believability as well as exposure in the community. Support for the platform as well as ongoing development can be provided through these groups based on input.

Sales Channels

- Direct Sales: Working on a face-to-face basis with schools, colleges, and school districts to make aware the platform and close contracts.
- Online Sales Portal: The channel will also be purchasable and subscribed to through online sales portals, thus being easily accessible to individual customers and smaller institutions.

Only high customer support will help in the retention of the user base and, thus, ensure word-of-mouth publicity. The support services will consist of onboarding assistance, training sessions for educators, and continuous technical support.

Regular updates and improvements, based on user feedback, will maintain the relevance and effectiveness of the platform and thereby secure customer satisfaction in the long term.

Global Expansion

In future, after the platform is developed for the English-speaking markets, the company will get further development of the platform, which will provide an opportunity to cover many languages and educational systems across the globe. The content and the user interface of the platform will be localized based on the specific needs of the international markets.

Revenue Projections and Long-Term Vision

This is so because, if well priced and marketed, large potential can be realized in terms of revenue generation on this platform. Most of the revenues in the first few years will come from subscription sale. Further with the growth, when the user base has

increased, more ways can be figured out to better monetize the platform, such as data analytics services provided to institutions or premium content and features.

4. PERSONAL AND FACILITIES

The chromatic variation-based teaching component will be planned, implemented and delivered as per the below task management plan and per the allocated timeline (Figure 1, 2). For the overall task breakdown for the system refer Appendix E.

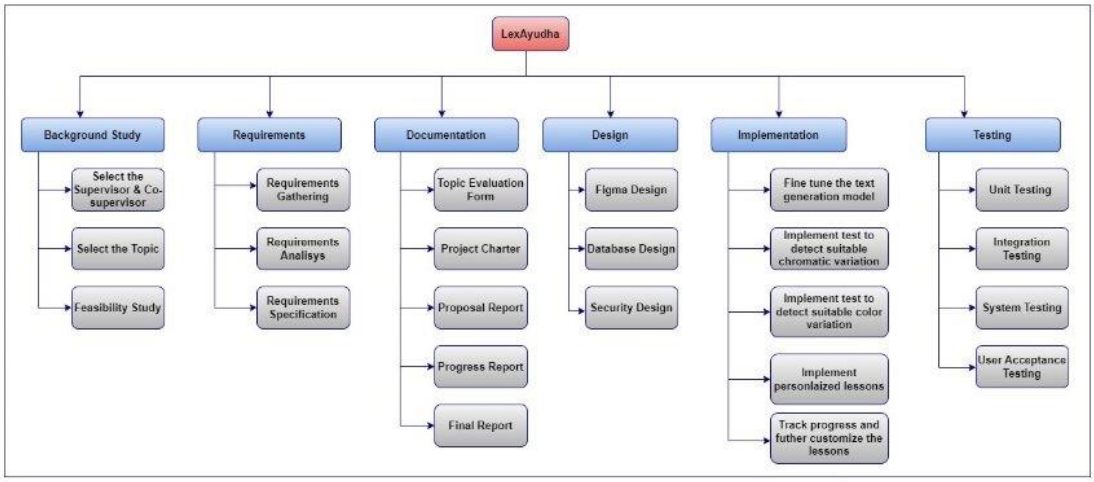

Figure 4.1: Work Breakdown

Figure 4.2: Gantt Chart

5. BUDGET AND BUDGET JUSTIFICATION

The proposed system was planned on a budget in a way that the cost can be reduced and hence could provide a feature rich application to the end users for an affordable price for them. Below is the planned budget for the proposed system and the budget justification. Please note that the budget allocation and the selection of the vendors can be slightly change with future findings and requirements.

Proposed Budget and allocation

Table 5.1: Proposed Budget

Description	Cost
Azure Blob Storage	$ 0.018 per GB (first 5GB free)
Azure Cosmos DB	Free tier (50 GB free for year)
AWS SageMaker	$ 0.10/hour (16 GB RAM)
Azure Virtual Machines	Free tier (750h)
Azure Speech to Text	$ 1 /hour (5 hours free per month)
AWS SES	Free (3000 emails per month)
Vercel – Frontend Deployment	Free tier
Render – Backend Deployment	Free tier

Budget justification

Azure Blob storage: Azure blob storage was chosen for it competitive pricing and the free tier. It provides $ 0.018 per GB after the free first 5GB. Blob storage has one of the lowest storage prices compared to AWS S3 bucket $ 0.023 per GB and google clouds $ 0.026 per GB. Blob Storage is well-suited due to its ease of integration, flexibility, and ability to handle unstructured data and also Azure provides a more affordable entry point while still maintaining high performance and scalability.

Azure Cosmos DB: Azure cosmos DB was selected as No SQL Database for its cost effective and extensive free tier offering 50GB of free storage per month for the first year. This makes it's the most suitable option compared to the AWS dynamodb (25 GB per month for a year) and google firestore (1 GB per month for a year). Cosmos DB also provides globally distributed, low-latency access to data, which is ideal for a real-time application like Lexayudha, where performance is critical for storing and retrieving results and feedback. Additionally, Cosmos DB supports multiple NoSQL APIs, making it flexible.

AWS SageMaker: AWS SageMaker can select as the best choice to address the machine learning parts due to its robust platform and flexible pricing options. At $0. 10/hour for an ml. t3. medium instance, SageMaker also presents a a highly cost-effective solution to running machine learning computations. It also easily interconnects with other AWS services, so this is advantageous if you decide to upscale system's AI models.

Azure Speech to Text: Azure Speech to Text was chosen for its low cost ($1/hour) and a free monthly allowance of 5 hours, which is beneficial for projects with moderate usage. Also compared to AWS and Google speech to text prices which is $1.44/hour and free 60 minutes for month, Azure speech to Text is more suitable for the system. The service's high accuracy in transcribing audio to text, along with its integration capabilities within the Azure ecosystem, makes it ideal for project's potential need for speech processing

6. REFERENCES

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7. APPENDICES

Appendix A

Figure 2. Among students ages 3–21 served under the Individuals with Disabilities Education Act (IDEA), percentage distribution of selected disability types: School year 2022–23

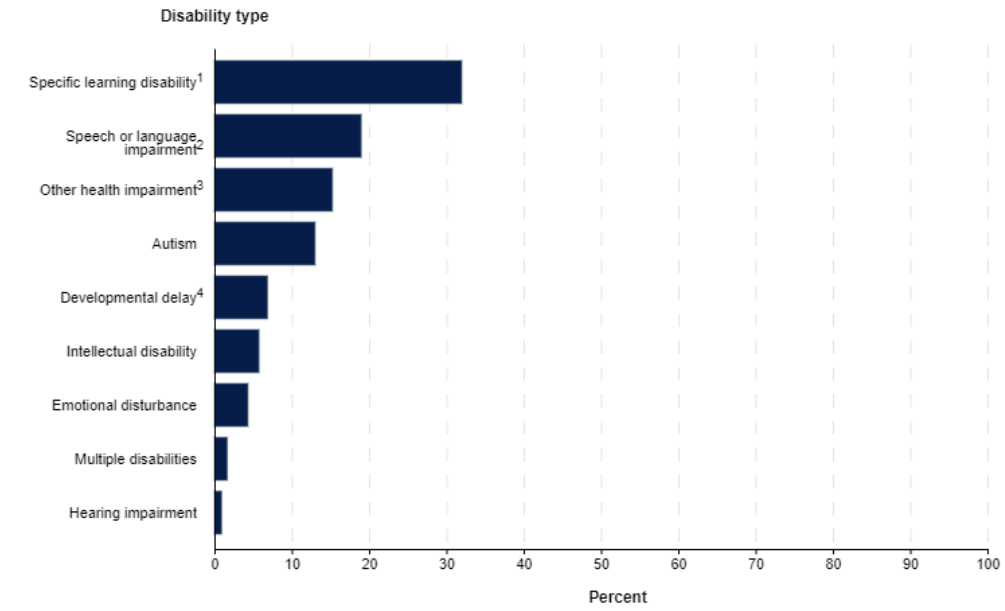

Figure 7.1:Percentage distribution of selected disability types

Source: National Center for Education Statistics – U.S. Department of Education http://nces.ed.gov/programs/coe/indicator/cgg/students-with-disabilities?utm_source=coe_share&utm_medium=figure_tool&utm_campaign=copied_url#2

Grade	Multiple Impairments		Hearing Impairments				Visual Impairments				Speech Language Difficulties		Dyslexia		Interllectual Impairments		Physical Disabilities		Epilepsy		Emotional Problems		Other		Total
			Complete		Half		Complete		Half																
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Grade 1	327	202	15	12	41	39	19	6	386	297	454	172	149	81	417	251	145	106	50	27	217	55	100	63	2320
Grade 2	258	170	16	14	58	55	24	11	485	394	410	179	172	86	510	271	148	111	50	36	263	65	84	69	2478
Grade 3	279	169	8	14	68	52	25	15	663	626	358	139	283	141	571	311	159	98	57	33	265	73	100	61	2836
Grade 4	256	135	9	13	80	47	37	13	736	652	304	149	291	141	609	356	173	95	60	34	224	72	97	65	2876
Grade 5	197	166	17	11	59	63	23	23	690	704	230	94	255	148	533	304	139	95	42	42	233	64	87	42	2505
Grade 6	138	108	10	12	88	52	25	15	600	745	155	46	303	133	403	196	127	83	48	30	212	54	92	62	2201
Grade 7	135	58	6	15	71	60	29	14	792	893	158	50	227	113	345	167	117	74	55	30	192	51	78	49	2205
Grade 8	107	59	11	11	60	78	23	16	904	942	128	54	203	68	323	159	120	70	53	39	239	59	71	40	2242
Grade 9	67	46	12	9	63	51	24	18	716	1020	96	44	226	102	294	132	106	77	40	31	184	52	71	35	1899
Grade 10	71	30	6	6	54	41	30	18	636	931	74	32	162	72	198	134	98	77	26	32	184	54	45	32	1584
Grade 11	42	25	12	12	44	36	10	18	613	736	54	29	120	52	170	114	64	74	19	24	135	36	33	23	1316
Grade 11 (Repeaters)	1	2	0	1	2	4	2	0	39	42	5	1	6	3	5	8	5	4	2	0	2	1	3	3	72
Total	1878	1170	122	130	688	578	271	167	7260	7982	2426	989	2397	1140	4378	2403	1401	964	502	358	2350	636	861	544	24534

Source: Annual School Census Data -2019, MoE, Sri Lanka

Figure 7.2: Disability among Students in General Class and Government Schools, Recorded in the Year

Source:https://www.childwomenmin.gov.lk/uploads/common/statistical-hand-book.pdf

Appendix B

Figure 7.3: Agile Methodology

Appendix C

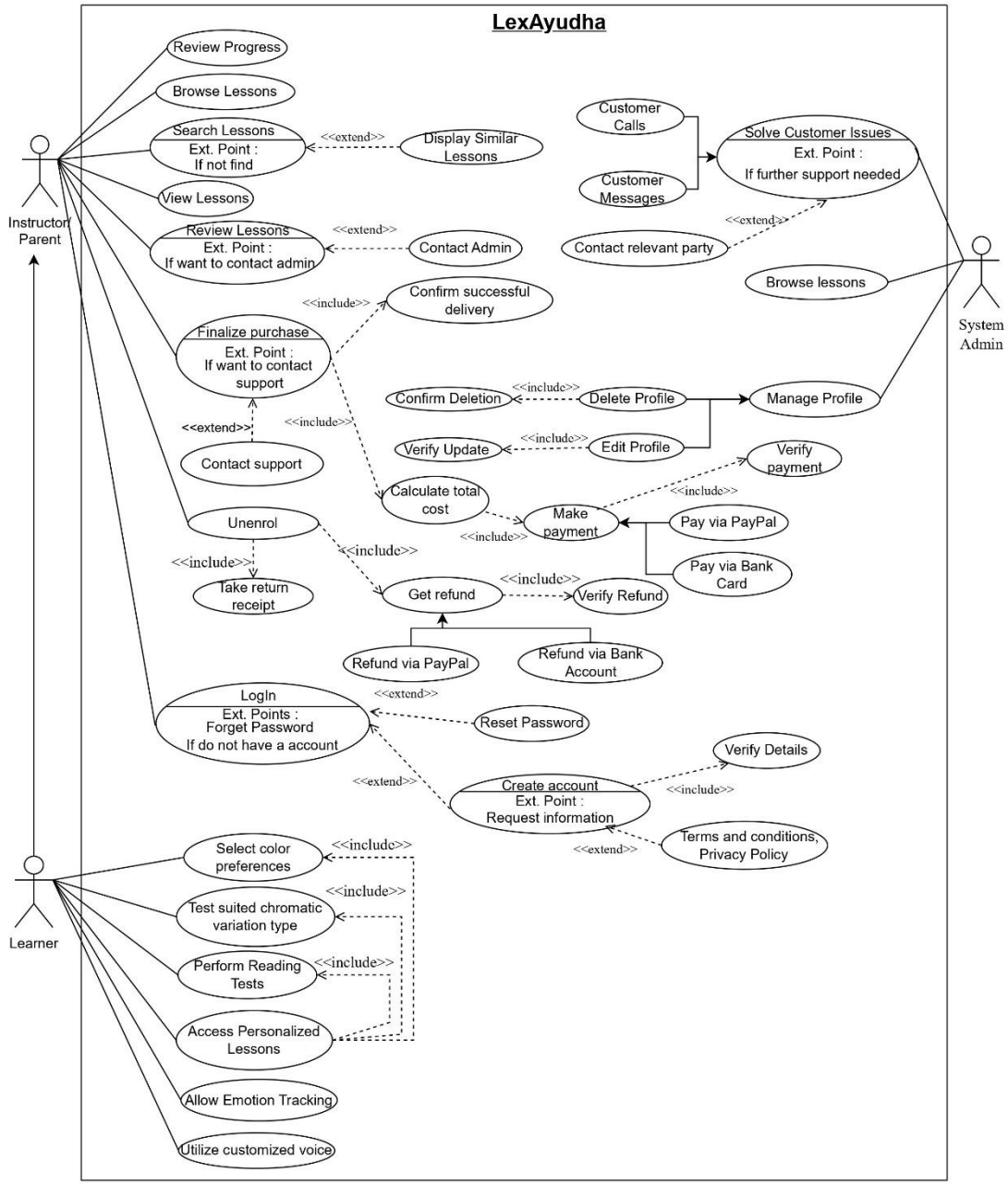

Figure 7.4: Use Case Diagram

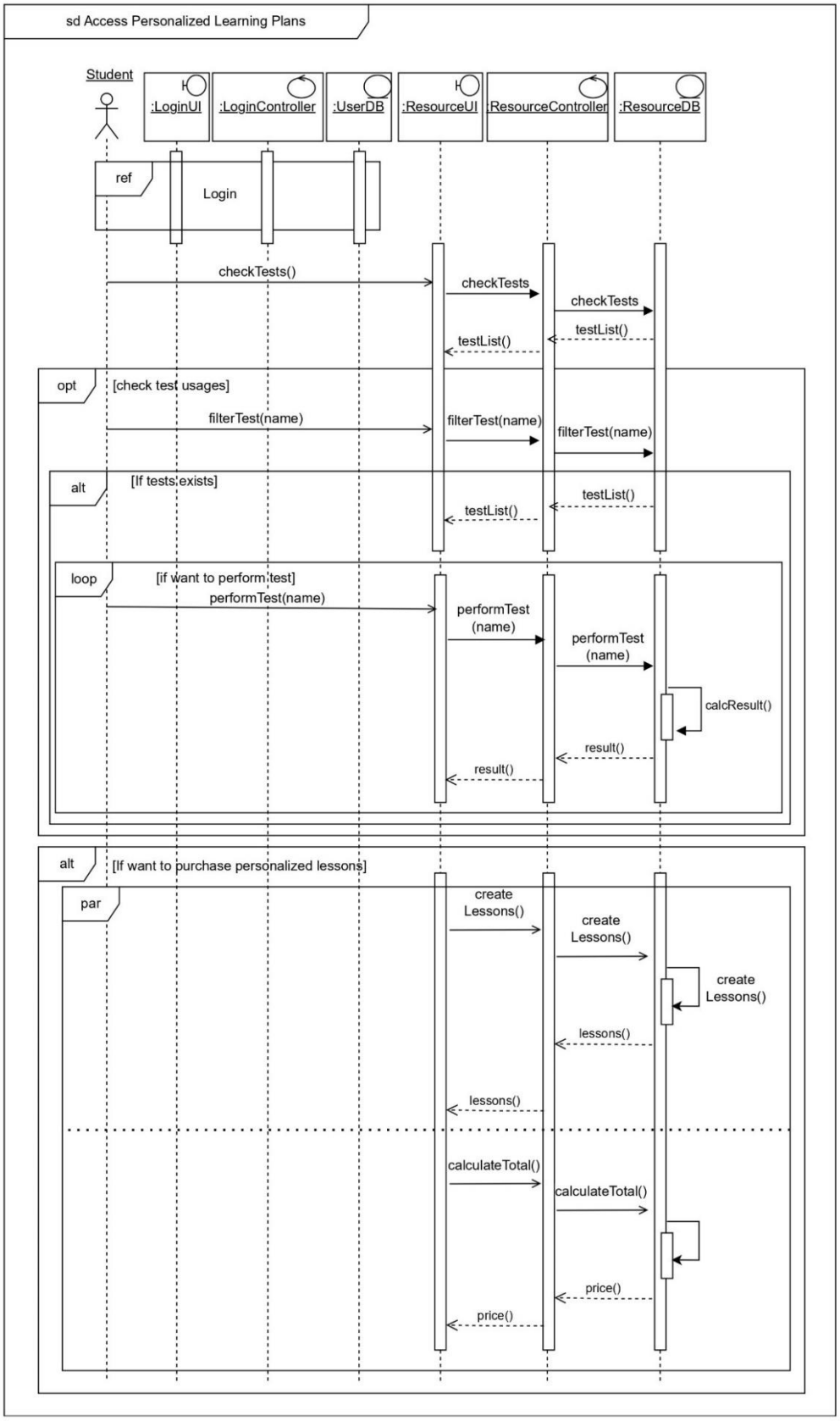

Figure 7.5: Sequence Diagram for Accessing Personalized Learning Plans

Appendix D

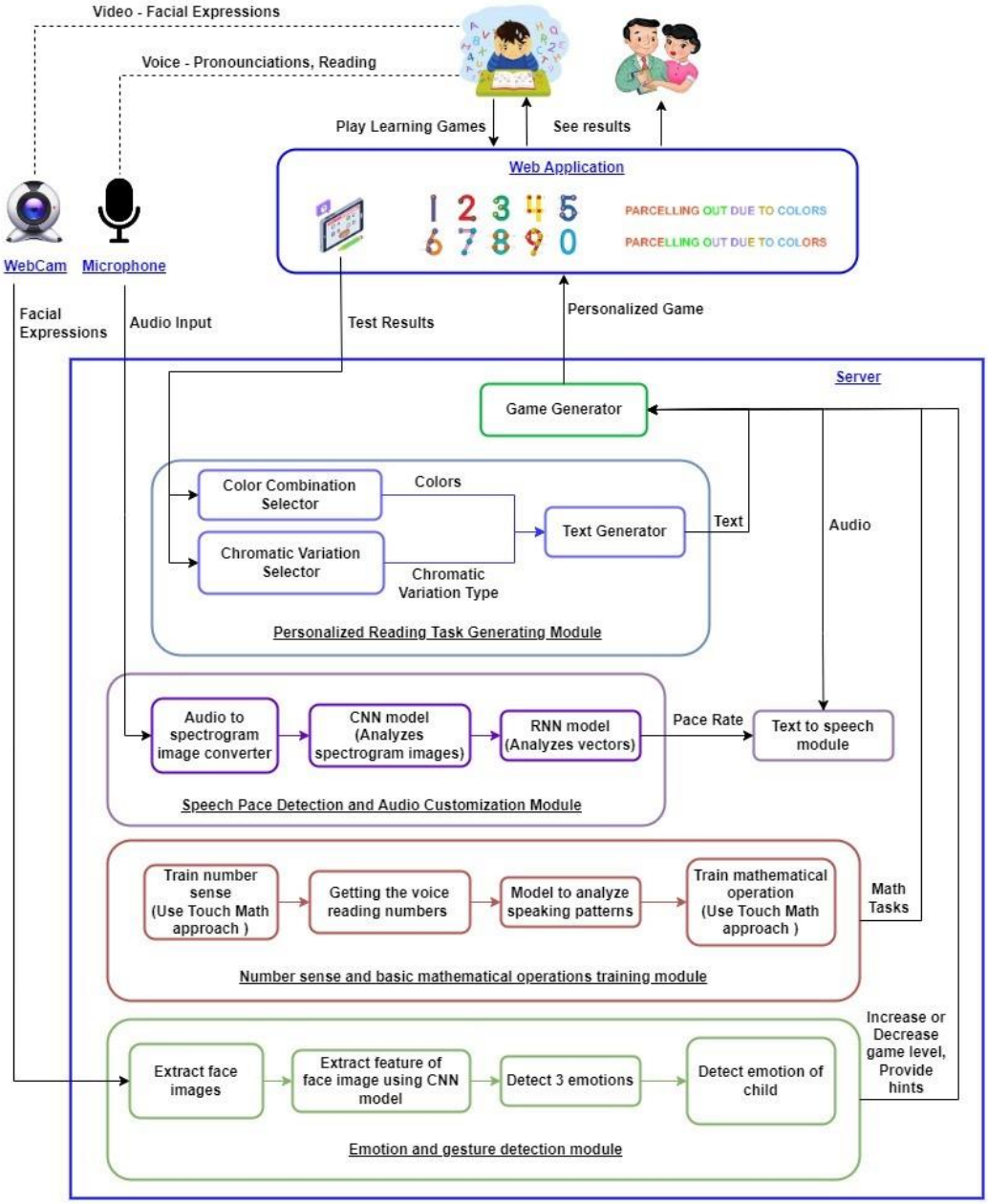

Figure 7.6: System Overview Diagram

Appendix E

Table 7.1: Work Breakdown Structure

Student Name	Student ID	Research Component
Silva T.U.D	IT21318320	1. Create a sample test to identify the efficient color combinations for the child. 2. Create a sample test to identify the most efficient chromatic variation type for the child. 3. Create a test to check the reading skills of the child to customize the complexity levels of the tasks. 4. Create personalized reading task plans for each child.
Madusanka G.K.I	IT21189944	1. Emotion Recognition Algorithm Development 2. Real-Time Adaptive Feedback Loop 3. Personalized Emotional Baseline Establishment 4. Integration of Emotion Regulation Strategies and provide feedback to educators and parents
Thalangama T.P	IT21223594	1. Implementing a speech pace detection AI model that outputs the pace as a numerical value.

		2. Implementing a pace incorporating text to speech (TTS) model.
Dissanayake M.G.T.W	IT21319174	1. Implement Touchpoints on numerals for tactile learning 2. Providing a memorizing approach to improve mathematical skills. 3. Integrates visual, tactile, auditory, and kinesthetic elements.

Appendix F

Figure 7.7: Figma Design

Figma Prototype URL :

https://www.figma.com/design/Ckg8mccpPmfjz2uACpbjkn/Research?node-id=490-164&t=SUp0WheYeHs6mXcX-1