“Growin’Up” a Mobile Application for Primary Students with Dyslexia to Improve Sinhala Language.

Project Id: 23-034

Final Thesis Document

Submitted by - Meddaduwage P.M – IT20127428
Supervisor - Prof. Samantha Thelijjagoda
Co-Supervisor - Ms. Jenny Krishara

B.Sc. (Hons) Degree Information Technology Specializing in InformationTechnology.

Department of Information Technology
Sri Lanka Institute of Information Technology
Sri Lanka

October 19, 2023

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(Individual Component- Analyzing sequential difficulties faced by the kids of the age limit of 6-8 and the impact of visual dyslexia and provide solutions to overcome the difficulties)

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1 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.

Name	Student ID	Signature
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The supervisor/s should certify the proposal report with the following declaration. The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor (Prof Samantha Thelijjagoda) Date

Signature of co-supervisor (Ms. Jenny Krishara) Date

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LIST OF ABBREVIATIONS

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Abbreviations	Description
AI	Artificial intelligence
API	Application programming interface
ICT	information and communication technology
NLP	Natural language processing
ML	Machine learning
IPP	Image-Pre-Processing
UI	User Interface

3 ABSTRACT

The proposed research project seeks to comprehensively investigate the sequential learning challenges experienced by children aged 6-8 years old, particularly focusing on the impact of visual dyslexia on their Sinhala language acquisition abilities. This study intends to delve into various facets of these challenges, encompassing reading, writing, and arithmetic skills, with the primary objective of discerning recurring patterns of difficulty that may be linked to visual dyslexia.

To achieve a holistic understanding, this research will employ a mixed-methods approach, combining both quantitative and qualitative data collection methods. Quantitative data will be obtained through the administration of standardized tests designed to assess the participants' reading and writing capabilities, as well as their cognitive and perceptual skills. This data will serve as a foundation for identifying statistical trends and correlations within the dataset.

Complementing the quantitative approach, qualitative data will be gathered through interviews conducted with parents, teachers, and the children themselves. These interviews will offer invaluable insights into the personal experiences and perceptions of learning difficulties, shedding light on the emotional and psychological dimensions of the challenges faced.

A central aspect of this study involves investigating the specific impact of visual dyslexia on the learning abilities of the children within the target age group. Visual dyslexia is a distinct subtype of dyslexia that affects an individual's capacity to recognize and interpret visual stimuli, including letters, numbers, and symbols. By rigorously analyzing how visual dyslexia influences the learning process, this research aims to identify effective strategies and interventions that can be tailored to support these children in overcoming their learning obstacles.

The goal of this study is to translate its findings into practical recommendations for various stakeholders, including teachers, parents, and educational professionals. These recommendations will be founded on evidence-based best practices and will be designed to foster inclusive and effective learning environments that cater to the diverse needs of all children. By addressing the specific challenges posed by visual dyslexia in the context of Sinhala language acquisition, this research seeks to bridge the existing gap in resources and support for dyslexic students, ultimately contributing to a more equitable educational system.

Keywords- *Reading, Visual attention, dyslexia, Parallel processing, Sequential processing*

4 INTRODUCTION

Learning difficulties and disabilities, including dyslexia, are pervasive challenges faced by children worldwide, significantly affecting their educational journey and overall well-being. Dyslexia, a specific learning disability, exerts a profound influence on an individual's capacity to read, write, and spell, with far-reaching consequences for academic performance and socio-emotional development. Visual dyslexia, a subtype of dyslexia, presents a unique set of challenges by impairing a person's ability to recognize and interpret visual information, including letters, numbers, and symbols. This research seeks to address the pressing need for a deeper understanding of the sequential difficulties encountered by children with visual dyslexia and, importantly, the less-explored realm of sequential dyslexia. This study endeavors to investigate the combined impact of visual and sequential dyslexia on Sinhala language learning abilities among children aged 6-8 in Sri Lanka. Employing a comprehensive mixed-methods approach, it aims to collect both quantitative and qualitative data to provide a nuanced understanding of the obstacles faced by these children and to propose effective strategies and interventions to support their learning.

The Prevalence of Dyslexia and the Need for Research

Dyslexia is a global concern, and Sri Lanka is no exception. Emerging research in Sri Lanka has shed light on the prevalence of dyslexia and underscored the necessity for early identification and targeted intervention to aid affected children. A study conducted by Jayasooriya [1] revealed that dyslexia is notably prevalent among primary school children in Sri Lanka, with a higher incidence observed among those attending government schools. This finding emphasizes the urgency of exploring the specific challenges encountered by children in the Sri Lankan educational landscape.

Language-Specific Aspects: Phonological Processing in Sinhala-Speaking Children

The Sinhala language, with its distinct phonological characteristics, poses unique challenges to children with dyslexia. Research by Naseema [2] has highlighted the significance of phonological processing and rapid naming as strong predictors of reading and spelling abilities among Sinhala-speaking children. This underscores the importance of understanding the nuances of dyslexia in the context of the Sinhala language.

International Research on Dyslexia

Beyond Sri Lanka, international research has provided valuable insights into the multifaceted impact of dyslexia on children's language learning abilities. For instance, a study conducted by Ramus [3] demonstrated how dyslexia adversely affects the ability to process sequential information, which is crucial for proficient reading and spelling. Similarly, research by Vellutino [4] has reaffirmed the pivotal role of early identification and intervention in improving reading and spelling abilities among children with dyslexia.

Visual Dyslexia-A Distinct Challenge

Visual dyslexia, a specific subtype of dyslexia, introduces a unique dimension to the learning difficulties experienced by children. It primarily disrupts the processing of visual stimuli, making it particularly pertinent when considering language acquisition, which heavily relies on the interpretation of visual symbols, such as the Sinhala script.

Sequential Dyslexia-An Emerging Concern

While visual dyslexia have garnered some attention in the literature, the concept of sequential dyslexia remains relatively underexplored. Sequential dyslexia affect a child's ability to grasp and apply sequential information accurately, posing substantial challenges in areas such as mathematics, phonics, and language learning. This research seeks to expand our understanding of sequential dyslexia and its implications for Sinhala language acquisition among children in Sri Lanka.

The proposed research project encompasses several interconnected objectives. Firstly, it seeks to undertake a comprehensive and in-depth analysis of the sequential difficulties encountered by children aged 6-8 in Sri Lanka, shedding light on the specific challenges they face in their educational journey. Additionally, this research aims to investigate the precise impact of visual dyslexia on the Sinhala language learning abilities of children in this age group, recognizing the significance of language-specific aspects. Furthermore, the study will delve into the emerging concept of sequential dyslexia, an area that has received relatively less attention in the academic sphere, particularly concerning its relevance within the context of Sinhala language acquisition.

To accomplish these objectives, the research adopts a robust mixed-methods approach, combining quantitative data collection through the administration of standardized tests with qualitative data collection involving interviews with parents, teachers, and the children themselves. This multifaceted approach ensures a holistic understanding of the challenges and experiences faced by children with dyslexia. Ultimately, the research aims to identify evidence-based strategies and interventions that can effectively support these children in their educational journey, contributing to more inclusive and equitable educational environments in Sri Lanka and potentially offering insights for dyslexic children globally.

The rationale behind this research is rooted in the urgent need to comprehensively understand and address the challenges faced by children with visual dyslexia and sequential dyslexia in the specific context of Sinhala language acquisition in Sri Lanka. Dyslexia, in its various forms, poses a substantial barrier to effective learning and can lead to academic underachievement and emotional distress among affected children. Furthermore, the relatively limited research on sequential dyslexia calls for a deeper investigation into its manifestations and implications within the Sinhala language learning process.

By conducting this research, we aim to not only contribute to the existing body of knowledge on dyslexia but also to provide concrete insights that can inform targeted interventions. These interventions have the potential to empower children with dyslexia, enabling them to overcome their learning difficulties and, in doing so, foster more inclusive and equitable educational environments in Sri Lanka.

The methodology employed for this research project is designed to comprehensively address the research objectives while bridging gaps in understanding. It embraces a holistic approach by integrating both quantitative and qualitative methods.

Quantitative data collection will be a pivotal component of the research. This will involve the administration of standardized tests meticulously crafted to evaluate various aspects of children's abilities. These assessments will specifically target reading and writing proficiency, cognitive skills, and perceptual skills, all of which are vital components in understanding the impact of dyslexia. The objective nature of these tests will yield quantitative data, laying the foundation for rigorous statistical analysis.

In tandem with quantitative data collection, qualitative data will be gathered through in-depth interviews. These interviews will involve key stakeholders in the educational journey of these children, including parents, teachers, and the children themselves. By engaging in open and reflective conversations, this qualitative approach will provide rich insights into the lived experiences and perceptions of learning difficulties within the context of dyslexia. This qualitative data will enable the research team to uncover recurring themes and patterns that lie beneath the surface, offering a deeper understanding of the multifaceted challenges faced by children with dyslexia.

By combining these quantitative and qualitative methodologies, this research aims to paint a comprehensive picture of the challenges posed by dyslexia and its impact on Sinhala language learning among children aged 6-8 in Sri Lanka. This multi-pronged approach ensures that both the objective and subjective dimensions of dyslexia are explored, ultimately facilitating the identification of effective strategies and interventions to support these children in their educational journey.

To delve into the emerging concept of sequential dyslexia, the research project will incorporate additional assessments aimed at evaluating the children's capabilities in processing sequential information. This assessment will place a particular emphasis on two critical areas: phonics and mathematical skills. By focusing on these specific aspects, the research aims to uncover the unique challenges associated with sequential dyslexia and gain insights into how it impacts Sinhala language learning among children aged 6-8 in Sri Lanka. This specialized examination will contribute to a more nuanced understanding of the diverse dimensions of dyslexia, particularly within the context of language acquisition.

In conjunction with the research component of this project, there is a proposal to develop a mobile application tailored explicitly to assist primary students with dyslexia in enhancing their Sinhala language skills. The envisioned application aims to create a user-friendly and engaging platform where children can actively practice and refine their reading, writing, and arithmetic abilities. What sets this application apart is its specific focus on addressing the unique challenges associated with sequential dyslexia, making it a vital tool for children facing these learning difficulties. By providing such a resource, the project endeavors to empower children with dyslexia, offering them an accessible means to strengthen their language and mathematical proficiency. The development of this mobile application is firmly rooted in evidence-based practices derived from extensive research conducted on the learning needs and preferences of children with dyslexia. A wealth of studies has consistently demonstrated the effectiveness of technology-based interventions, including mobile applications, in significantly improving reading and writing abilities among children with dyslexia [5]. By aligning the application's design and features with the findings of this research, the project aims to create a tool that genuinely caters to the educational requirements of children with dyslexia. The evidence-based approach ensures that the application's content and features are tailored to meet the specific challenges and learning styles of these children.

Going beyond merely addressing the learning needs of children with dyslexia, the mobile application aspires to play a crucial role in promoting inclusive and equitable education. In Sri Lanka, as in many other countries, children with dyslexia frequently encounter social and academic exclusion due to a lack of understanding and support from their peers and educators [Dissanayake, 2018]. By providing an accessible and tailored tool, this application seeks to foster greater awareness and understanding of dyslexia within the wider community. Through increased awareness and support, it is hoped that the application will contribute to creating a more inclusive educational environment where all children, regardless of their learning differences, can thrive and succeed.

This research project addresses the critical need to understand and address the challenges faced by children with visual and sequential dyslexia in the context of Sinhala language learning in Sri Lanka. Dyslexia, in its various forms, poses significant barriers to effective learning and can lead to academic underachievement and emotional distress among affected children. Furthermore, the relatively limited research on sequential dyslexia underscores the urgency of investigating its manifestations and implications within the Sinhala language learning process.

By conducting this research, we aim to contribute not only to the existing body of

knowledge on dyslexia but also to provide concrete insights that can inform targeted interventions. These interventions have the potential to empower children with dyslexia, enabling them to overcome their learning difficulties and fostering more inclusive and equitable educational environments in Sri Lanka.

5 BACKGROUND & LITERATURE SURVEY

Dyslexia is a common and complex learning difficulty that significantly impacts children's language learning abilities, potentially leading to social and academic exclusion. This comprehensive literature review delves deeper into the multifaceted aspects of dyslexia, including sequential dyslexia, and explores emerging technologies like voice recognition algorithms that are gaining traction in dyslexia research.

Prevalence and Challenges of Dyslexia

Extensive research underscores the prevalence of dyslexia and its impact on primary school children in Sri Lanka. Jayasooriya (2011) discovered that dyslexia are notably prevalent among these children, with a disproportionately higher incidence in government schools. The study by Naseema (2019) highlighted the importance of phonological processing and rapid naming as significant predictors of reading and spelling abilities among Sinhala-speaking children, emphasizing the critical role of these skills in the context of dyslexia.

Sequential Dyslexia-Unraveling a Complex Challenge

Sequential dyslexia represent a relatively less explored but highly relevant facet of dyslexia research. This subtype centers on the difficulty in processing sequential information, which is paramount for tasks like reading comprehension and accurate spelling (Ramus, 2003). Children with dyslexia often grapple with this form of processing, which can have far-reaching consequences on their academic performance.

Sequential dyslexia encompass issues related to processing information in a specific order or sequence. Children affected by this subtype may find it challenging to follow the sequence of letters or words in written text, which significantly hampers their reading fluency and comprehension. Moreover, sequential dyslexia's impact extends to spelling accuracy, as these children struggle with the correct order of letters within words.

Research on sequential dyslexia delves into the underlying cognitive processes, shedding light on the intricate mechanisms at play. For instance, studies have explored how sequential processing difficulties relate to the phonological and orthographic aspects of language. It is crucial to understand the unique challenges that sequential dyslexia poses within the context of Sinhala language learning, as the language's distinctive features may present distinct hurdles for affected children.

Effective Interventions for Sequential Dyslexia

While traditional interventions have played a significant role in supporting children with dyslexia, the emerging field of sequential dyslexia calls for tailored approaches. Research on interventions specific to sequential dyslexia is a growing area of interest. These interventions often target the fundamental skills necessary for processing sequential information.

One promising approach involves structured sequential training programs that emphasize the order and arrangement of linguistic elements within language. These programs aim to enhance children's ability to perceive, process, and remember information in the correct sequence. The incorporation of technology, such as computer-based training programs, holds considerable potential in this regard. However, it is essential to adapt these interventions to the unique linguistic characteristics of Sinhala to ensure their efficacy within this context.

Voice Recognition Algorithms- A Technological Frontier

Voice recognition algorithms represent a transformative development in dyslexia research and intervention. These technologies hold the promise of mitigating some of the challenges faced by children with dyslexia, particularly those related to writing and spelling.

Voice recognition algorithms function by converting spoken language into text, effectively reducing the barriers associated with traditional written communication. For children with dyslexia, this technology can be a game-changer. It enables them to express their ideas and thoughts through speech, which is then transcribed into written form. This alleviates the stress and

frustration often experienced when trying to convey thoughts through writing, a task that can be daunting for those with dyslexia.
Voice recognition technology can be seamlessly integrated into educational tools and applications, providing real-time support for children with dyslexia as they engage in various language-related tasks. By eliminating the need for manual writing and spelling, these algorithms empower children to focus on the content and creativity of their work, rather than being impeded by the mechanics of written language.

Dyslexia is a prevalent learning difficulty that encompasses various challenges, including the emerging concept of sequential dyslexia. While traditional interventions have made significant strides in supporting children with dyslexia, the unique characteristics of sequential dyslexia necessitate tailored approaches that target sequential information processing.
Voice recognition algorithms represent a promising frontier in dyslexia research and intervention. Their potential to alleviate writing and spelling challenges for children with dyslexia is profound. By converting spoken language into text, these technologies provide an accessible and inclusive means of communication and expression.

As research continues to evolve, it is imperative to explore sequential dyslexia comprehensively, considering its distinct characteristics and implications within the context of Sinhala language learning. Additionally, the integration of voice recognition algorithms into dyslexia support and educational tools has the potential to revolutionize the learning experience for children with dyslexia, fostering greater inclusion and equitable education for all. This multifaceted approach aims to empower children with dyslexia and ensure they have the opportunities and tools they need to thrive academically and socially.

6 RESEARCH GAP

In today's rapidly evolving world, technological advancements have brought about profound transformations across various facets of life, and education is no exception. The advent of mobile applications has opened new avenues for learning and child development. This research endeavors to undertake a comprehensive comparative analysis of six distinct mobile applications, namely Easy Lexia, Dyslexia Beca, Yalu, The Hope, Alexza, and Arunalu, with a novel addition known as "Growin'up." The primary aim of this study is to discern the existing gaps within current mobile learning applications and elucidate how Growin'up ameliorates these gaps.

One of the standout features of Growin'up is its meticulous and structured approach to letter learning. This feature is conspicuously absent in the other applications under consideration. The letter learning sequence in Growin'up is thoughtfully designed to facilitate a systematic understanding and retention of letters. Such an approach not only simplifies the learning process but also augments comprehension and retention rates. Moreover, Growin'up incorporates dynamic sound effects and visual feedback mechanisms, rendering the learning experience both interactive and engaging—a facet notably absents in the other applications, rendering their learning experiences comparatively less captivating.
Growin'up introduces another game-changing feature—voice recognition technology. This distinctive attribute empowers the application to track responses and sequencing, which sets it apart from the competition. Voice recognition facilitates an adaptive and personalized learning experience, tailoring content and feedback to individual learners. Conversely, the absence of this feature in other applications hinders their ability to provide real-time, tailored support, making Growin'up a standout choice for learners.

Growin'up harnesses the power of auto-correction algorithms, which significantly simplifies progress tracking and pinpointing areas requiring improvement. The absence of such mechanisms in the other applications limits their capacity to offer granular insights into a child's learning journey.

Another distinctive feature of Growin'up is its utilization of text generation methods to predict the next letters in a sequence—a feature not found in any of the other applications. This predictive element assists children in anticipating and comprehending letter sequences more effectively, thereby enriching their learning experience. Additionally, the incorporation of word jumping and sequencing-focused puzzles within Growin'up enhances the interactive learning process. Unfortunately, these interactive elements are conspicuously absent in the other applications, potentially diminishing the overall engagement and effectiveness of their learning experiences.

In the realm of language inclusivity, most of the applications, including Easy Lexia, Dyslexia Beca, The Hope, Alexza, and Arunalu, primarily offer solutions in the form of mobile applications. Growin'up aligns with this convenience and accessibility, rendering it an accessible learning tool for children. However, it is important to note that The Hope and Arunalu are the only two applications among the selection that provide support for the

Sinhala language. This linguistic inclusivity sets these applications apart, particularly for Sinhala-speaking children who benefit from native language support, thus easing their learning process.

Comparative analysis of features within mobile learning applications has shed light on the existing gaps within the current landscape. Growin'up, with its distinctive attributes encompassing structured letter learning, interactive sound effects, voice recognition technology, auto-correction algorithms, predictive text generation, and engaging puzzles, emerges as a frontrunner in providing a holistic and enriched learning experience for children. While the mobile nature of these applications ensures accessibility and convenience, the lack of support for the Sinhala language in most applications remains a noteworthy gap that needs to be addressed. Growin'up, in its pursuit of bridging these gaps, offers a promising avenue for children's enhanced learning experiences.

Table 2 Research comparison table

Feature	**Easy Lexia** [1]	**Dyslexia Baca** [2]	**YALU** [3]	**The Hope** [4]	**ALEXZA** [5]	**ARUNALU** [6]	**Growin'Up**
Focused on letter sequencing.	✗	✗	✗	✗	✗	✗	✓
Sound effects and visual feedbacks	✗	✗	✗	✗	✗	✗	✓
Voice recognition to track responses od sequencing.	✗	✗	✗	✗	✗	✗	✓
Included phonic based games in sequencing.	✗	✗	✗	✗	✗	✗	✓
Use of word jumbling, and puzzles focused on sequencing.	✗	✗	✗	✗	✗	✗	✓
Use of auto correction algorithms to track progress.	✗	✗	✗	✗	✗	✗	✓

Use of text generation methods to predict the next letters.							
Mobile solution							
Support Sinhala language							

7 RESEARCH PROBLEM

Visual dyslexia, a distinct subtype of dyslexia, presents a unique set of challenges for children aged 6-8 as they embark on the journey of learning their native language, Sinhala. This developmental period is pivotal for language acquisition, laying the foundation for a child's lifelong communication skills. However, the presence of visual dyslexia can complicate this process, potentially leading to long-lasting academic and developmental consequences. Despite the critical importance of this issue, there remains a notable gap in research specifically addressing the sequential difficulties experienced by young learners with visual dyslexia and the development of targeted interventions to alleviate these challenges.
Visual dyslexia are characterized by difficulties in reading and writing that are intricately linked to visual processing. These difficulties can manifest in various ways, including challenges in recognizing letters and words, letter reversals, and difficulties in comprehending written text. For children learning Sinhala, a language that heavily relies on the visual and sequential processing of intricate characters and symbols, these challenges can be particularly daunting.

The process of learning Sinhala begins with acquiring the fundamentals of its unique script. Sinhala, an abugida script, requires learners to grasp not only individual letters but also the sequential and context-dependent nature of the script. Each Sinhala character can take on different forms depending on its position in a word, adding an additional layer of complexity. For children with visual dyslexia, these inherent intricacies of the Sinhala script can present substantial hurdles.
Moreover, for children learning English as a second language, the hurdles posed by visual dyslexia can exacerbate the complexity of language acquisition. English, with its diverse phonetic rules and extensive vocabulary, demands a high degree of visual and sequential processing. Understanding the prevalence of visual dyslexia among these bilingual learners and its implications for their ability to read and write in English is an essential facet of this research. The unique challenges faced by this group necessitate dedicated investigation.

While the challenges associated with visual dyslexia are substantial, there is promise in the form of assistive technology. Tools such as text-to-speech software and speech recognition software offer alternative avenues for children with visual dyslexia to access and process information. These technologies have the potential to bridge the gap created by visual processing difficulties, facilitating a more inclusive and supportive learning environment.
However, the effectiveness of these assistive technologies in the context of language learning for children with visual dyslexia remains a subject of limited research. Understanding the extent to which these tools can enhance reading, writing, and comprehension skills is crucial. Furthermore, the optimal integration of these technologies into language learning programs requires thorough exploration to ensure they become seamless and effective aids for children with visual dyslexia.

Therefore, the overarching research problem is twofold. Firstly, it aims to identify and comprehensively understand the sequential difficulties faced by children aged 6-8 with visual dyslexia as they embark on the journey of learning their native language, Sinhala. This involves delving into the intricate nature of these challenges, particularly concerning the visual and sequential intricacies of Sinhala characters and symbols. Secondly, the research endeavors to develop and evaluate effective interventions tailored to address these specific difficulties. These interventions should not only serve as solutions for overcoming hurdles but also provide comprehensive support for the holistic development of children with visual dyslexia.
In addition to these primary research objectives, there is a secondary objective to investigate the prevalence of visual dyslexia among children learning English as a second language. Understanding the extent of this issue and its ramifications for language acquisition and academic achievement is critical for informed decision-making in educational settings.
The research seeks to explore the effectiveness of assistive technology in supporting children with visual

dyslexia in their language learning endeavors. This involves assessing the impact of tools such as text-to-speech software and speech recognition software on improving reading, writing, and comprehension skills. Additionally, the study delves into the optimal integration of these technologies into language learning programs, ensuring that they become seamless and effective aids for children with visual dyslexia.

The challenges posed by visual dyslexia for children aged 6-8 in learning their native language, Sinhala, are multifaceted and significant. Additionally, children learning English as a second language may encounter unique hurdles related to visual dyslexia. The integration of assistive technology holds promise but requires further exploration and validation. By addressing these research questions and developing effective interventions, we aim to provide invaluable insights and support for children with visual dyslexia on their journey to language acquisition and academic success.

8 OBJECTIVES

9.1 Main objectives

Language is a fundamental aspect of human communication and cognitive development. For children, acquiring language skills is a critical milestone that sets the foundation for their educational journey and future opportunities. However, not all children follow the same path in their language learning process. Some face unique challenges that hinder their ability to recognize and interpret visual information, such as letters, numbers, and symbols. This subset of learning difficulties is referred to as visual dyslexia.

Visual dyslexia is a subtype of dyslexia, a common learning difficulty that affects language learning abilities. Dyslexia, including its visual variant, is a global phenomenon, impacting children from diverse linguistic and cultural backgrounds. In Sri Lanka, a country with a rich linguistic heritage, it is imperative to understand the sequential difficulties faced by children with visual dyslexia in learning their native language, Sinhala. Moreover, exploring effective strategies and interventions tailored to this context is essential to ensure that these children have equal opportunities for success in education and beyond.

Analyzing Sequential Difficulties Faced by Children with Visual Dyslexia
The first objective of this research is to delve into the intricate world of children with visual dyslexia, aged between 6-8, residing in Sri Lanka. Visual dyslexia, a subtype of dyslexia, presents a unique set of challenges that these young learners encounter when processing visual information. This objective seeks to unravel the specific sequential difficulties faced by these children in recognizing and interpreting visual cues, encompassing elements such as letters, numbers, and symbols.

For children with visual dyslexia, the seemingly straightforward act of reading becomes a complex puzzle. Recognizing letters in their correct order, deciphering numbers, and understanding symbols require a level of visual processing that can prove to be particularly demanding for these young minds. The intricate Sinhala script, with its intricate characters and sequential dependencies, adds an additional layer of complexity for children learning their native language.
Understanding these sequential difficulties is pivotal in paving the way for effective interventions and support mechanisms. By dissecting the intricacies of visual dyslexia, this research endeavors to provide educators, parents, and policymakers with a comprehensive view of the hurdles these children face in their early years of language acquisition.

Investigating the Impact of Visual Dyslexia on Sinhala Language Learning
The second objective of this research takes a deep dive into the impact of visual dyslexia on the Sinhala language learning abilities of children in Sri Lanka. Sinhala, as the official language of the country, is the primary medium of communication and education. Therefore, any impediments in acquiring proficiency in Sinhala can have far-reaching consequences for these young learners.

Visual dyslexia can cast a shadow over a child's ability to read, write, and spell in Sinhala. It affects not only their academic performance but also their overall development. This objective aims to uncover how visual dyslexia influences the fundamental language skills of these children. Does it hinder their ability to decode Sinhala script? Does it obstruct their comprehension of written Sinhala text? These questions lie at the heart of this research objective.
By unearthing the impact of visual dyslexia on Sinhala language learning, this research seeks to provide valuable insights into the challenges faced by these children. Such insights will serve as a foundation for the development of targeted interventions and strategies, ensuring that language learning remains an

inclusive and supportive endeavor for all.

Identifying Effective Strategies and Interventions for Children with Visual Dyslexia

The third objective of this research sets its sights on identifying effective strategies and interventions to support the learning of children with visual dyslexia in Sri Lanka. Learning from global best practices, this objective explores evidence-based interventions and strategies that have demonstrated their efficacy in improving the language learning outcomes of children with visual dyslexia in other countries.

Every child deserves an equal opportunity to learn, regardless of their learning profile. By identifying strategies and interventions that have proven successful elsewhere, this research aims to inform the development of targeted and evidence-based approaches tailored to the unique needs of children with visual dyslexia in Sri Lanka. It is not enough to recognize the challenges; proactive steps must be taken to overcome them.

Developing a Mobile Application for Enhanced Learning

The fourth objective of this research is centered around the development of a mobile application designed to assist primary students with dyslexia, particularly focusing on the Sinhala language. This mobile application seeks to bridge the gap created by visual dyslexia, providing a user-friendly and engaging platform for children to practice and enhance their reading, writing, and arithmetic skills.

What sets this mobile application apart is its meticulous attention to addressing the specific challenges associated with sequential dyslexia. It incorporates sound effects and visual feedback to enhance the learning experience, making it more interactive and engaging. Furthermore, it harnesses the power of voice recognition and auto-correction algorithms to track progress and offer targeted support where needed.

The development of this mobile application is grounded in research conducted on the learning needs and preferences of children with dyslexia. It draws inspiration from global best practices in the realm of assistive technology. By creating a tool that is tailored to the specific needs of children with visual dyslexia in Sri Lanka, this objective aims to improve their educational outcomes and foster their social inclusion.

Promoting Inclusive and Equitable Education

The fifth objective of this research extends beyond the confines of technology. It aspires to promote inclusive and equitable education for children with dyslexia in Sri Lanka. In a world where understanding and support are paramount, this objective aims to create ripples of change.

Children with dyslexia often find themselves on the outskirts of social and academic inclusion due to a lack of awareness and support from their peers and educators. The mobile application developed in pursuit of the fourth objective also plays a vital role in this objective. By providing a tool that is not only accessible but also tailored to the needs of these children, it aims to break down barriers and dispel misconceptions surrounding dyslexia.

Collaborative Teacher Training and Support

While technology plays a pivotal role in addressing the needs of children with visual dyslexia, the sixth objective of this research underscores the importance of human support. Collaborative teacher training and support initiatives are instrumental in complementing the efforts made through technology.

Teachers are the frontline facilitators of education. They possess the power to shape the learning experiences of children. However, to effectively support children with visual dyslexia, educators need specialized training and ongoing support. This objective aims to bridge the knowledge gap by providing teachers with the tools and techniques required to create inclusive and supportive classrooms.

Collaborative teacher training programs can equip educators with a deeper understanding of visual dyslexia, its manifestations, and evidence-based teaching strategies. By fostering an inclusive mindset, educators can create an environment where children with dyslexia feel valued and understood. This, in turn, can have a

profound impact on the self-esteem and academic achievements of these children.

Parental Engagement and Community Awareness

The seventh objective recognizes the pivotal role of parents and communities in supporting children with visual dyslexia. Parents are the primary advocates for their children's education, and community awareness is essential in dispelling myths and misconceptions surrounding dyslexia.

Parental engagement is a powerful force that can drive positive change. Parents of children with visual dyslexia can benefit from resources, guidance, and support networks. This objective aims to empower parents with knowledge and strategies to support their children's learning journey effectively.

Moreover, raising community awareness is a collective effort. By promoting a broader understanding of dyslexia within communities, this objective seeks to eliminate stigma and foster empathy. When communities embrace diversity in learning profiles, children with visual dyslexia can thrive socially and academically.

Continuous Research and Evaluation

The eighth and final objective of this research is a commitment to continuous research and evaluation. The journey to support children with visual dyslexia is ongoing, and it requires vigilance and adaptability. By fostering a culture of continuous research and evaluation, we can refine and improve interventions over time.

Research is a dynamic process. New insights, technologies, and methodologies emerge, and it is essential to stay at the forefront of these developments. Regular evaluation of interventions and their impact ensures that we are on the right track and making a meaningful difference in the lives of these children.

Comprehensive research framework embarks on a multifaceted journey to comprehensively address the sequential difficulties faced by children aged 6-8 with visual dyslexia in Sri Lanka. The eight objectives outlined in this research represent a holistic approach to supporting these children in their language learning endeavors. Through technology, teacher training, parental engagement, and community awareness, we aim to create an inclusive and equitable education ecosystem where every child, regardless of their learning profile, can thrive.

This research framework transcends the boundaries of academic inquiry; it is a call to action. By acknowledging and addressing the challenges faced by children with visual dyslexia, we pave the way for a future where learning knows no bounds, and every child can flourish.

9.2 Sub Objectives

The proposed mobile application for primary students with dyslexia is designed to cater to the specific challenges associated with visual dyslexia and enhance the learning of the Sinhala language. This application encompasses several key objectives, each aimed at providing comprehensive support for children with visual dyslexia in their language learning journey. These objectives work in synergy to create an inclusive and effective learning environment tailored to the needs of these students.

Incorporating Sound Effects and Visual Feedback

One of the primary goals of this mobile application is to incorporate sound effects and visual feedback into the learning process. Visual dyslexia often hamper a child's ability to interpret visual information correctly, which can significantly impact their understanding of sequences, such as letters, numbers, and symbols. By introducing sound effects and visual feedback, the application aims to bridge this gap and assist children in comprehending the order and arrangement of these visual elements.

Children with visual dyslexia encounter difficulties when it comes to recognizing and recalling sequences. Traditional learning methods may not adequately address these challenges. However, through the integration of sound effects and visual feedback, the application can make the learning process more engaging and interactive. As children engage with the app, they receive auditory and visual cues that reinforce the correct sequencing of letters, numbers, and symbols. This multisensory approach can significantly benefit children with dyslexia, as it caters to various learning styles and reinforces their understanding of sequences.

Utilizing Voice Recognition Methods for Feedback

Another vital sub-objective of the mobile application is the utilization of voice recognition methods to track correct and incorrect responses. This feature plays a crucial role in providing immediate feedback to children, facilitating error identification and correction as they progress in their learning journey. Additionally, it empowers teachers and parents to monitor the child's progress and identify areas that may require additional support.

Voice recognition technology enhances the learning experience by offering real-time feedback. When children speak or respond within the app, the voice recognition system can identify whether their pronunciation and sequencing are accurate. If errors occur, the application can provide immediate correction and guidance. This not only supports independent learning but also ensures that children are continuously exposed to correct sequencing and pronunciation, reinforcing their language skills.4

Incorporating Phonics-Based Games and Activities

Phonics-based games and activities are a cornerstone of the application's design, further supporting the language development of children with visual dyslexia. Phonics is a critical component of reading and writing skills, and these activities are instrumental in helping children develop phonemic awareness and improve their reading and spelling abilities.

Through engaging in games and activities, children can practice recognizing and manipulating phonemes, the smallest units of sound in language. This enhances their ability to decode words and reinforces their understanding of how letters correspond to sounds. For children with dyslexia, who may struggle with phonemic awareness, these activities can be transformative in improving their language learning abilities.

Text Editors and Auto-Correction Algorithms

The application also incorporates text editors and auto-correction algorithms, providing children with opportunities to practice writing and spelling. This feature is indispensable in facilitating written language skills, as children can input text and receive immediate feedback on their work. Over time, the application

adapts to each child's unique learning needs, tailoring activities and support accordingly.

Text editors allow children to practice writing words, sentences, and even stories. The auto-correction algorithms serve as a valuable tool in this process, highlighting errors and suggesting corrections. This immediate feedback mechanism empowers children to learn from their mistakes and reinforce their understanding of correct sequencing and spelling.

Text Generation for Predictive Learning.
To enhance the development of sequencing skills, the application employs text generation techniques to predict the next letters of the alphabet. This feature is instrumental in helping children with visual dyslexia develop a robust understanding of sequence and improve their ability to predict patterns in language.
By presenting predictive text, the application encourages children to anticipate the next letters, enhancing their sequencing abilities. This predictive learning approach is particularly beneficial for children with dyslexia, as it helps them develop strategies for remembering and interpreting sequences more effectively.

The proposed mobile application for primary students with dyslexia is a comprehensive tool designed to address the specific challenges associated with visual dyslexia and enhance the learning of the Sinhala language. By incorporating sound effects, visual feedback, voice recognition, phonics-based games, text editors, auto-correction algorithms, and text generation, this application offers a multifaceted approach to support the educational outcomes and social inclusion of children with dyslexia in Sri Lanka.

These features work in harmony to create an inclusive and engaging learning environment that caters to the unique needs of children with visual dyslexia. By leveraging technology and evidence-based strategies, this application has the potential to transform the language learning experience for these students, empowering them to overcome their challenges and thrive in their educational journey. Through these sub-objectives, the application becomes a powerful tool in breaking down barriers and promoting inclusive and equitable education for all children, regardless of their learning profiles.

9.3 Solution

The proposed mobile application for primary students with dyslexia offers a comprehensive solution that seamlessly integrates various elements to address the specific challenges associated with visual dyslexia and enhance Sinhala language learning. This holistic approach combines sound effects and visual feedback to create a multisensory learning experience. When dyslexic learners engage with the app, they receive auditory cues and visual animations that reinforce correct sequencing, providing immediate feedback and reinforcement as they progress. Phonics-based games are an integral part of the application, designed to improve phonemic awareness, a crucial skill for reading and spelling. Dyslexic learners can actively participate in interactive activities that require them to identify and manipulate phonemes, fostering a deeper understanding of the relationship between letters and sounds.

The incorporation of auto-correction algorithms within the text editors empowers dyslexic learners to practice writing and spelling independently. These algorithms analyze the input, highlight errors, and suggest corrections in real-time, facilitating skill development. Voice recognition methods further enhance the learning experience by tracking correct and incorrect responses and providing immediate feedback. Dyslexic learners can speak or respond within the app, with the system assessing their pronunciation and sequencing accuracy. If errors occur, the system offers guidance and correction, reinforcing correct language patterns.

To encourage predictive learning and improve sequencing skills, the application employs text generation techniques. Dyslexic learners are exposed to predictive text, helping them anticipate the next letters. This integration promotes a deeper understanding of sequence and pattern recognition, crucial elements for language learning. The strength of this integrated solution lies in its synergy. Dyslexic learners engage with a single application that seamlessly combines these elements, creating a cohesive and supportive learning environment. As they progress through activities, they experience a continuous feedback loop, where sound effects, visual feedback, and auto-correction algorithms work in harmony to reinforce correct sequencing and pronunciation.

Moreover, phonics-based games provide an engaging and interactive way to develop phonemic awareness, a fundamental skill for reading and spelling. The voice recognition system ensures that learners receive timely guidance, while text generation encourages predictive learning, further enhancing sequencing abilities. This holistic approach not only addresses the specific challenges of visual dyslexia but also fosters an inclusive and equitable education ecosystem. Dyslexic learners can benefit from technology-enabled support that caters to their unique learning profiles, ultimately improving their Sinhala language skills. In conclusion, the proposed mobile application for dyslexic learners integrates sound effects, visual feedback, phonics-based games, auto-correction algorithms, and voice recognition to comprehensively enhance Sinhala language skills. This unified approach ensures that dyslexic learners receive a multifaceted learning experience that supports their language acquisition, empowers them to overcome challenges, and promotes inclusive education for all.

9 METHODOLOGY

The proposed mobile application, "Growin'Up," is designed to provide support to primary school students with dyslexia, particularly those aged 6 to 8, in enhancing their Sinhala language skills. Dyslexia encompasses various subtypes, including visual dyslexia, phonological dyslexia, and rapid naming dyslexia, each presenting unique challenges in the realm of language learning. In response to these challenges, the "Growin'Up" mobile application incorporates several key features and methodologies aimed at addressing the diverse needs of children with dyslexia and facilitating their language development. This comprehensive approach revolves around four main components, each dedicated to tackling specific aspects of dyslexia and language learning.

The first component of the "Growin'Up" mobile application is dedicated to addressing sequential difficulties commonly faced by children aged 6 to 8 with visual dyslexia. Visual dyslexia primarily affect the interpretation of visual information, including letters, numbers, and symbols. One of the critical challenges is recognizing and interpreting the sequence and order of these visual elements.
To mitigate these difficulties, the application incorporates sound effects and visual feedback. By engaging multiple sensory modalities, including auditory and visual cues, the learning process becomes more interactive and engaging. This multisensory approach helps children grasp the concept of sequencing more effectively. For instance, when a letter or word is correctly identified, the application can provide positive auditory feedback or visual animations, reinforcing the correct sequence.

Additionally, voice recognition methods are employed to track both correct and incorrect responses. This feature offers immediate feedback to students, allowing them to self-assess their progress and accuracy. It also aids teachers and parents in monitoring the child's performance and identifying areas where additional support may be required.
Moreover, the application includes phonics-based games and activities, such as word jumbling and puzzles. These activities focus on improving phonological awareness, a crucial component of reading development. By engaging in these games, children can enhance their ability to recognize and manipulate the sounds within words, which is essential for proficient reading and spelling.

Further support is provided through text editors and auto-correction algorithms integrated into the application. These tools track individual progress and offer feedback on writing and spelling tasks. As children engage with writing exercises, the application assists in identifying errors and suggests corrections. Over time, the application adapts to the unique learning needs of each child, tailoring activities and support accordingly.
Additionally, text generation techniques, powered by technologies like TensorFlow, are utilized to predict the next letters of the alphabet. This functionality aids children in understanding sequencing and enhances their ability to predict patterns within sequences, such as those found in language. By offering practice activities specifically designed to address sequencing issues, the application equips children with strategies for remembering and interpreting sequences effectively.

10.1 System Architecture

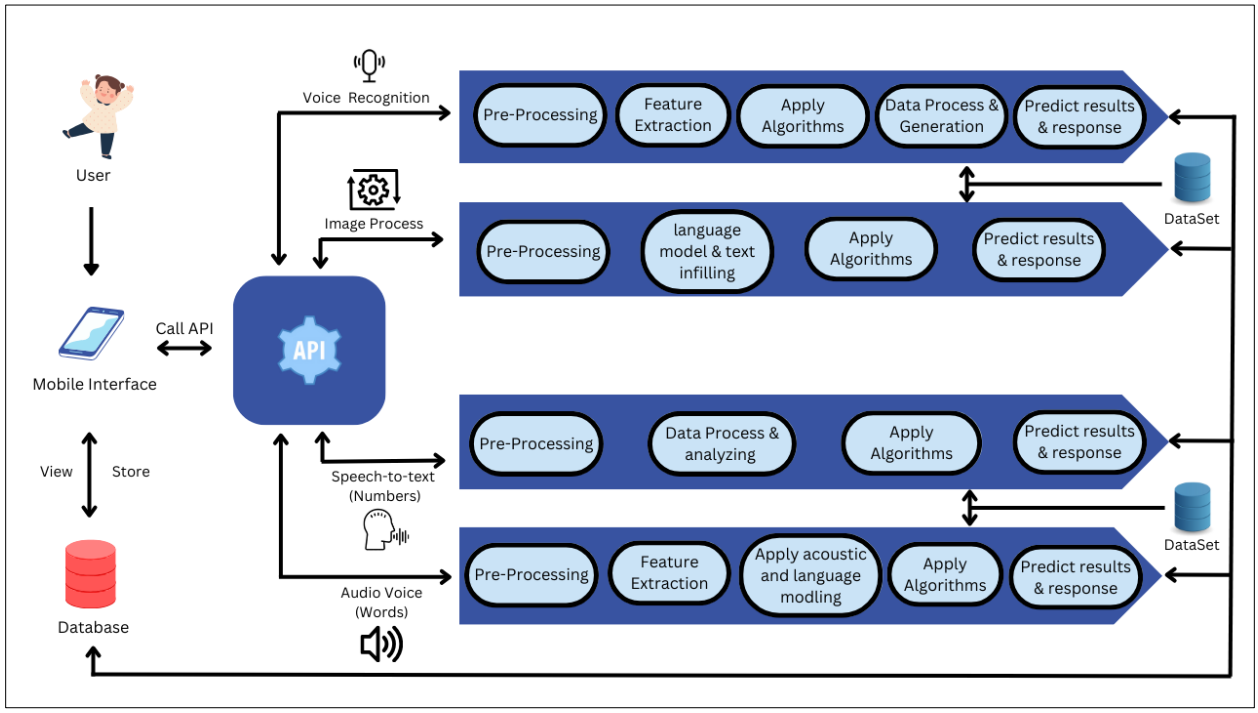

Figure 1 system diagram

10.2 Individual Component

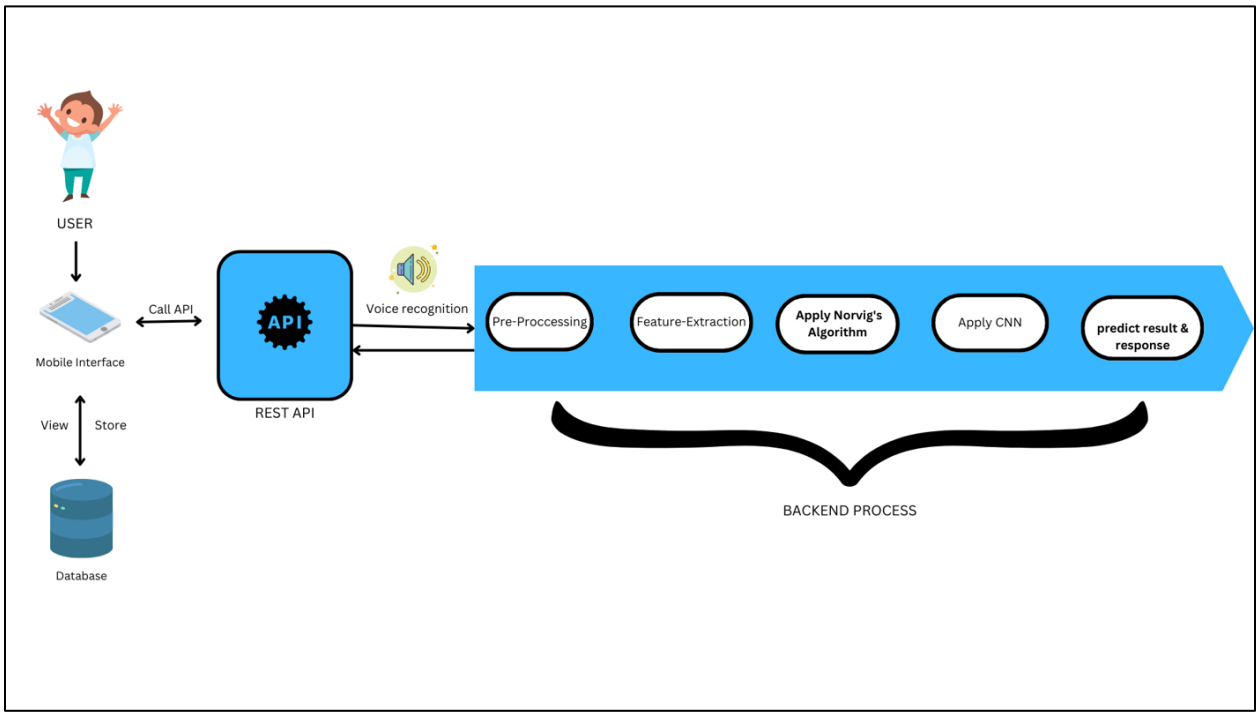

Figure 2 component overview diagram

10.3 Application Development Process

Agile methodology has become increasingly popular in recent years due to its flexible and adaptable approach to software development. It emphasizes continuous iteration and testing throughout the software development lifecycle, allowing teams to quickly adapt to changing requirements and deliver high-quality software. One of the most used agile methodologies is the Scrum Framework, which is known for its iterative and incremental development processes [7]. In this paragraph, we will explore the use of Scrum as the agile methodology in a software development project, with a focus on the implementation of changes based on the hypothesis generated from literature survey and surveys, as well as the key practices involved in Scrum.

Scrum is an agile development methodology that emphasizes the importance of inspecting and adapting to changing requirements. This means that throughout the development process, the team constantly reviews and evaluates the progress made, and adjusts as needed to meet the evolving needs of the project [8]. The use of the Scrum Framework in a software development project allows for a high level of flexibility and responsiveness to changing requirements, as the team can quickly adapt their approach and make necessary changes to the software being developed.

One of the key practices in Scrum is the use of time-boxed daily meetings, known as daily scrums, where the team members gather to discuss the progress made, challenges faced, and plans for the day. These short, focused meetings help the team members stay aligned and ensure that any issues or roadblocks are addressed promptly [7]. Daily scrums facilitate effective communication and collaboration among team members, which is crucial in an agile development environment where continuous feedback and collaboration are essential.

In addition to daily scrums, Scrum also includes other important practices such as sprint reviews and sprint retrospectives. At the end of each sprint, which is a time-boxed period of development typically lasting 1-4 weeks, the team holds a sprint review to demonstrate the work done to stakeholders, gather feedback, and evaluate the results. This allows for quick validation of the work completed and provides an opportunity for stakeholders to provide input, which can inform future iterations. Following the sprint review, the team holds a sprint retrospective, where they reflect on the sprint and identify areas for improvement. This feedback loop allows the team to continuously learn and improve their processes, making Scrum a highly adaptive and iterative approach to software development [8].

To support the implementation of Scrum, many software development teams use tools such as Jira, which is a popular project management tool that is specifically designed for agile methodologies. Jira provides features such as backlog management, sprint planning, and progress tracking, which can greatly facilitate the implementation of Scrum in a software development project. Jira allows team members to collaborate, track progress, and visualize the development process, making it easier to manage and adapt to changing requirements in an agile environment [9].

The decision to use Scrum as the agile methodology in a software development project is based on the hypothesis generated from literature survey and surveys. The literature survey provides insights into the best practices and success factors of agile methodologies, including Scrum, which have been proven effective in many software development projects. The surveys conducted among team members and stakeholders can provide valuable feedback on the current development processes and requirements, which can inform the decision to adopt Scrum. By following the principles and practices of Scrum, the team can take advantage of its iterative and adaptive nature to effectively manage changing requirements and ensure that the software being developed meets the needs of stakeholders.

In conclusion, Agile methodology, specifically Scrum, is a popular and effective approach to software development that emphasizes continuous iteration and testing and supports adaptation to changing requirements. The use of Scrum, along with tools like Jira, enables the team to implement changes based on hypothesis generated from literature survey and surveys, and allows for effective communication, collaboration, and progress.

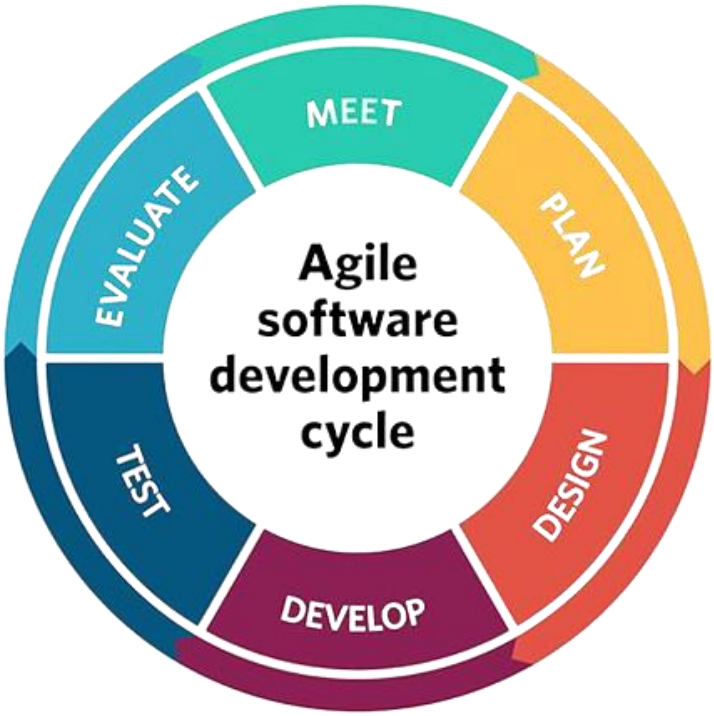

Figure 3 Agile Software Development Cycle

- Requirement Gathering and Analysis

In this initial phase of the research, our main objective is to gain a deep understanding of the expectations and needs of the end-users and stakeholders of the system, specifically children facing dyslexia in schools. To achieve this, we plan to conduct surveys or questionnaires as a means of gathering comprehensive feedback from the target audience. We have already initiated the research process by visiting Narahenpita Special Education School, which serves as a representative sample of the target user group. Through interactions with the students, teachers, and other stakeholders at the school, we aim to gather valuable insights into the requirements of the software system we are developing. The information gathered from this visit, along with data collected through surveys or questionnaires, will be documented in the software requirements specification (SRS) document, providing a comprehensive overview of the user expectations and needs for the system.
Our approach in this phase is centered on ensuring that the end-users and stakeholders are actively involved in the requirements gathering process, and their perspectives and expectations are carefully considered in the development of the software system. By understanding their needs, we aim to create a system that is effective, user-friendly, and meets the specific requirements of children with dyslexia in schools, ultimately enhancing their learning experience and addressing

their challenges.

- Feasibility Study

As part of the research objective to identify the sequential difficulties faced by children aged 6-8 with visual dyslexia and their impact on academic performance, several technologies have been proposed for use. The feasibility of implementing these technologies in the research process can be assessed in the following areas:

1. Schedule Feasibility-The project timeline needs to be finalized to ensure that each phase of the research is completed within the defined timeframe. The expected results should be presented based on the planned dates to ensure that the research progresses as per the schedule.
2. Technical Feasibility-The proposed technologies for multimedia technologies (HTML5, CSS, and JavaScript), speech recognition APIs (Google Cloud Speech-to-Text, Amazon Transcribe), text editors and algorithms (TinyMCE, CKEditor, Norvig's correction algorithm), machine learning frameworks (TensorFlow), and mobile development platforms and programming languages (Android Studio, React Native (JavaScript), Python) should be evaluated to ensure that the researchers have the necessary knowledge and expertise in these technologies to effectively implement them in the research process.
3. Statistical Knowledge-Since multilinear regression will be used for analyzing the history with current lab reports and making predictions for future health, the researchers should possess background knowledge in statistics and analytical skills to accurately interpret the results and draw meaningful conclusions.

10.4 Implementation

The implementation phase of this research project involves the strategic utilization of a diverse array of technologies and tools, each meticulously selected to cater to the unique needs of children with dyslexia. These technologies are essential in the development of the "Growin'Up" mobile application, as well as in conducting data analysis and research activities. Let's delve into each of these technologies and their roles in detail:

Multimedia Technologies (HTML5, CSS, and JavaScript)
At the core of the "Growin'Up" mobile application are multimedia technologies, including HTML5, CSS (Cascading Style Sheets), and JavaScript. HTML5 serves as the backbone for structuring content on the web, allowing for the creation of interactive and visually engaging user interfaces. CSS complements HTML by controlling the presentation and layout, ensuring a visually appealing and consistent design. JavaScript, as a versatile scripting language, is responsible for enhancing the interactivity of the application, making it more engaging for young users. These technologies collectively create an immersive and user-friendly environment that is crucial for keeping children with dyslexia engaged in the learning process.

Speech Recognition APIs (Google Cloud Speech-to-Text and Amazon Transcribe)
The incorporation of speech recognition APIs, such as Google Cloud Speech-to-Text and Amazon Transcribe, is a pivotal aspect of the research. These APIs offer advanced speech recognition capabilities, enabling spoken language to be transcribed into written text. This functionality is invaluable for the analysis of speech data collected during the research. It empowers researchers to scrutinize aspects like pronunciation, fluency, and speech patterns in children with dyslexia, thereby shedding light on their oral language development. By harnessing these APIs, the research gains valuable insights into the challenges faced by dyslexic students in verbal communication and articulation, which can inform targeted interventions.

Text Editors and Algorithms (TinyMCE, CKEditor, Norvig's Correction Algorithm)
Text-based activities within the mobile application are facilitated through the integration of sophisticated text editors like TinyMCE and CKEditor. These editors provide intuitive interfaces for editing and formatting text, which are crucial for exercises related to writing, spelling, and text composition. Furthermore, the incorporation of Norvig's Correction Algorithm significantly enhances the educational value of the application. Dyslexic children often grapple with spelling and word recognition difficulties, making real-time spell checking and autocorrection invaluable features. This algorithm offers immediate feedback and suggestions, empowering children to identify and rectify spelling errors as they engage in writing exercises. By implementing this correction algorithm, the application provides comprehensive support for enhancing the writing and spelling proficiency of its users.

Machine Learning Framework (TensorFlow)
TensorFlow, a prominent open-source machine learning framework, plays a central role in the research's data analysis and processing efforts. Renowned for its flexibility and scalability, TensorFlow equips researchers with a rich array of tools and libraries for building and training machine learning models. In the context of this research, TensorFlow's capabilities are harnessed to analyze data related to the learning progress of children with dyslexia. Machine learning models can identify patterns, trends, and areas where individualized support is needed, thereby contributing to the effectiveness of educational interventions offered by the application. The application's ability to adapt and personalize learning experiences is greatly enhanced through TensorFlow.

Mobile Development Platforms and Programming Languages (Android Studio, React Native, Python)

The development of the "Growin'Up" mobile application spans multiple platforms and programming languages to ensure maximum accessibility and flexibility. Android Studio serves as the primary platform for developing the application specifically for the Android operating system. This choice guarantees that the app reaches a broad audience of Android users, including students, parents, and educators. React Native, a JavaScript-based framework, is employed to facilitate cross-platform mobile app development. By creating a single codebase that can run seamlessly on both Android and iOS devices, development efforts are streamlined, and accessibility is extended to a wide range of users, regardless of their device's operating system. Python, celebrated for its versatility, is seamlessly integrated into the research process. It serves as the go-to programming language for scripting and various data processing tasks. Python's simplicity and its vast array of libraries make it an ideal choice for handling an array of data-related tasks, from in-depth data analysis to generating comprehensive reports and visualizations.

In conclusion, the implementation phase of this research hinges upon the judicious application of a diverse palette of technologies and tools. Each of these components is thoughtfully selected to cater to the distinct requirements of children with dyslexia. They collectively culminate in the "Growin'Up" mobile application, which strives to provide comprehensive support for enhancing the Sinhala language skills of children with dyslexia. Beyond that, these technologies empower researchers to conduct in-depth data analysis, identify learning patterns, and personalize interventions, ultimately contributing to the academic success and psychosocial well-being of the target demographic. Through the synergy of these technologies, the "Growin'Up" application aspires to be a transformative tool in the realm of dyslexia education and support.

10 REQUIREMENTS

11.1 Functional requirements

"Growin'Up" mobile application is an integral part of the platform, focusing on addressing the specific challenges faced by children aged 6 to 8 with visual dyslexia in their Sinhala language acquisition. Dyslexia, particularly the visual subtype, can significantly hinder a child's ability to recognize and interpret visual information, including letters, numbers, and symbols. To create an inclusive and effective learning environment, the application incorporates several key technological features to overcome sequential difficulties and promote language development. These technological functionalities are designed to engage and support the user while providing insights into their progress.

Sound Effects and Visual Feedback

Sound effects and visual feedback are pivotal in creating an immersive and engaging learning environment for children with visual dyslexia. These technological features are integrated into the application's user interface to offer immediate feedback and support during language-related activities.

Immediate Auditory Feedback

The application employs sound effects strategically to provide immediate auditory feedback when a user interacts with the app. For example, when a user correctly identifies a letter or word, a positive sound effect is triggered. This auditory reinforcement serves to engage the user and provides positive reinforcement for correct sequencing.

Synchronized Visual Feedback

Visual feedback in the form of animations or visual cues is synchronized with user interactions. When a child selects the correct sequence or answers a question accurately, the application visually reinforces this success. These visual cues may include animations of letters forming a word, or symbols aligning correctly, providing a multisensory learning experience.

User Customization

Recognizing that each user may have unique preferences, the application allows for user customization. Users can enable or disable sound effects and visual feedback based on their individual preferences. This user-driven customization ensures a tailored learning experience that considers the child's comfort and learning style.

Technology Integration

The sound effects and visual feedback are integrated seamlessly into the application, ensuring they align with the learning objectives and provide continuous engagement. The application uses audio libraries to trigger appropriate sound effects and incorporates animation and visual feedback components, which are responsive to user interactions. These elements are built to function across different devices and platforms to maximize accessibility.

Voice Recognition

Real-time Assessment of Pronunciation and Sequencing, Voice recognition technology plays a pivotal role in the application by providing real-time assessment of pronunciation and sequencing accuracy. It is a critical component for evaluating and reinforcing correct language skills and sequencing. The application is equipped with voice recognition algorithms that evaluate a child's pronunciation and sequencing accuracy during language-related exercises. For example, if the child is tasked with pronouncing a word, the technology instantly analyzes their pronunciation, identifying any deviations from the correct sequence. Voice recognition provides immediate feedback to the child, highlighting whether their pronunciation and sequencing are correct or require improvement. If the response is accurate, the application reinforces this with positive feedback. If errors occur, the system offers guidance, prompting the child to make corrections. The application is designed to cater to individual preferences. Users have the option to use voice recognition

or text input, depending on their comfort level and learning style. This user choice ensures that the application can adapt to the child's specific needs and comfort with voice interactions.

Technological Framework: Voice recognition technology is implemented within the application using speech recognition libraries and APIs. These technologies convert spoken language into text and evaluate it against predefined language models to determine correctness. The framework is designed to work across devices, including smartphones and tablets.

Phonics-Based Games

Phonics-based games and activities are an essential part of Component 1, focused on improving phonological awareness, a fundamental skill for reading and spelling. These games leverage technology to create an interactive and gamified learning experience. The application offers a range of phonics-based games and activities, each designed to target different aspects of phonological awareness. For instance, one game may focus on letter-sound relationships, while another challenges the child to identify rhyming words. The variety of games keeps the learning experience engaging and multifaceted. To cater to users with varying levels of phonological awareness, the application employs adaptive difficulty levels. As the child progresses, the games become more challenging, ensuring that the activities remain stimulating and supportive of learning.

Feedback and Progress Tracking

Throughout phonics-based games, the application provides feedback and tracks the user's progress. Positive reinforcement is offered when the child succeeds, and constructive guidance is provided when errors occur. The application records and analyzes user performance, adjusting the game's difficulty and feedback accordingly. These games are developed using game development frameworks and libraries. They are designed to run smoothly on different devices, including mobile phones and tablets. User interactions are processed through intuitive touch controls, and game mechanics are built to ensure user engagement.

Text Editors and Auto-Correction

Text editors with auto-correction algorithms are integrated to enhance writing and spelling skills, a crucial aspect of language development. The technology behind text editing and auto-correction ensures that users can practice writing and spelling effectively. The application includes text editors that enable children to practice writing words, sentences, and stories. Users can input text, and the application processes it in real-time. The text editors are equipped with auto-correction algorithms that analyze the user's input. If errors are detected, the application highlights them and suggests corrections, ensuring that the child receives immediate feedback. The application is designed to adapt to the individual needs and learning levels of each child. As the child's skills improve, the auto-correction algorithms adjust their feedback, providing less support for proficient users while offering more guidance for those who need it.

The text editors and auto-correction algorithms leverage natural language processing (NLP) technologies. NLP libraries analyze the user's input, comparing it to a predefined language model to identify errors and suggest corrections. These technologies are designed to work on various devices and operating systems. Text generation techniques are employed within the application to encourage predictive learning. Predictive learning is a valuable skill that enhances sequencing abilities, particularly in language. The application presents predictive text, which adapts to the user's skill level. Predictive text suggests the next letters of the alphabet or the next words in a sentence. The user is prompted to complete the sequence, fostering predictive learning. Predictive learning activities are designed to engage the child actively. By completing sequences and predicting the next elements, the child strengthens their understanding of sequence and pattern recognition. The difficulty of predictive learning exercises is customizable, ensuring that they align with the user's skill level. Users can opt for more straightforward or more challenging predictive learning tasks based on their progress. Predictive text activities use algorithms that predict the next elements based on the context and the user's input. The technology employs machine learning models to adapt to the user's performance and provide appropriate challenges.

These technological functionalities collectively work to create an interactive, adaptive, and supportive

learning environment tailored to the unique needs of children with visual dyslexia. By leveraging sound effects, visual feedback, voice recognition, phonics-based games, text editors with auto-correction, and predictive learning, the "Growin'Up" application provides a comprehensive solution that addresses sequential difficulties and promotes language development. The technological underpinnings of these features ensure that they function seamlessly and effectively on various devices and platforms, fostering inclusive and equitable education for all children, regardless of their learning profiles.The technological functionalities within Component 1 of the "Growin'Up" application use sound effects, voice recognition, phonics-based games, text editors with auto-correction, and predictive text to address sequential difficulties and enhance language learning for children with visual dyslexia. These features are underpinned by sophisticated technology, including audio libraries, speech recognition APIs, game development frameworks, NLP libraries, and machine learning models. The application is designed to provide an engaging, adaptive, and supportive learning environment while offering real-time feedback to facilitate the language development of children with visual dyslexia.

11.2 Non-Functional requirements

The non-functional requirements for Component 1 of the "Growin'Up" mobile application, which aims to support children aged 6 to 8 with visual dyslexia in enhancing their Sinhala language skills, encompass various aspects to ensure the application's effectiveness.

Performance is a crucial aspect of the application's design. To provide a seamless learning experience, the application should exhibit fast response times, with interactions like selecting letters or providing feedback taking no longer than 1 second. Loading time is also a critical factor, and the application must load within 3 seconds when launched or transitioning between different activities and games. The accuracy of voice recognition, a core feature, should consistently remain at or above 90% to evaluate pronunciation and sequencing accurately. Moreover, the application should be designed to function partially offline, allowing users to access certain features even without an internet connection. Data synchronization across devices in real-time is imperative to ensure that users can switch between devices seamlessly, without losing their progress.

Security is of paramount importance, especially in an educational application designed for children. The application must encrypt user data, including voice recordings and progress data, both in transit and at rest, using industry-standard encryption protocols to ensure data privacy and security. It must also comply with data protection regulations, such as GDPR and COPPA, to protect the privacy of child users, obtaining parental consent for those under 13 years of age. Secure user authentication mechanisms should be in place to prevent unauthorized access. Additionally, content filtering is essential to ensure that the application does not display or provide access to any inappropriate or harmful content. Regular security audits and penetration testing should be conducted to identify and address vulnerabilities continuously.

Usability plays a pivotal role in making the application accessible and user-friendly. Adhering to accessibility standards, such as WCAG 2.1, ensures that the application can be used by children with visual dyslexia. User-centered design principles, including user testing and feedback sessions, should be applied to improve usability continuously. Customization options, such as adjusting font size and color schemes, allow users to tailor the interface to their specific needs and preferences. Onboarding processes and interactive tutorials should be implemented to help users, especially children, become familiar with the application. Furthermore, clear and informative error messages must guide users when issues or mistakes occur during usage.

Scalability and compatibility are critical for reaching a broad user base. The application should be compatible with various devices, including smartphones and tablets running different operating systems like iOS and Android. Its design should allow for efficient scaling to accommodate a growing user base without compromising performance. Cross-browser compatibility for web-based versions ensures accessibility across various browsers. Language and regional support should be incorporated to make the application usable in different geographic locations. Leveraging cloud infrastructure for scalability and data storage requirements is recommended, ensuring that the backend systems can handle increased user loads effectively.

Reliability and availability are fundamental for providing a consistent user experience. The application should aim for high uptime, ideally 99.9%, with maintenance activities scheduled during non-peak hours to minimize disruption. Regular data backups are crucial to prevent data loss in case of technical failures or data corruption. The application should also have fault tolerance mechanisms built-in to minimize downtime and disruptions in the event of system failures. Compliance with educational standards and guidelines, as well as licensing agreements and copyright laws, ensures that the application's content and functionality are aligned with industry best practices. Regular performance benchmarking and comparisons with industry standards help identify areas for improvement.

User support and training are vital to assist users, parents, and teachers effectively. A comprehensive user support system, including email support and a knowledge base, should be available to address user inquiries

and issues. Instructional materials, such as user guides and tutorials, must be provided to help users make the most of the application.
Documentation plays a crucial role in ensuring users understand how to utilize the application to its fullest potential. Comprehensive user documentation within the application should explain how to use its features and functionalities. Internal technical documentation should be maintained for developers and IT support staff to ensure efficient maintenance and updates.
Performance testing is necessary to evaluate the application's robustness. Load testing helps determine its capacity and ensures it can handle expected user loads without performance degradation. Stress testing assesses the application's stability under extreme conditions, and scalability testing verifies its ability to scale efficiently.
Disaster recovery and business continuity plans should be developed and maintained to minimize data loss and downtime in the event of catastrophic events. Protocols for maintaining essential business functions and services in case of interruptions or emergencies should also be established.
Regular updates and improvements, including bug fixes, new features, and enhanced user experience, are critical. These should be provided to address bugs, add new features, and improve the overall user experience. Scheduled maintenance activities during non-peak hours aim to minimize disruptions for users, and the option for automatic updates should be available to ensure users always have access to the latest version of the application.

These non-functional requirements are essential to the success of Component 1 of the "Growin'Up" mobile application, ensuring that it performs efficiently, is secure and compliant, provides a user-friendly experience, scales as the user base grows, and is reliable and well-documented. By meeting these non-functional requirements, the application can effectively support children with visual dyslexia in their language learning journey, offering a robust and dependable tool for language development.

11.3 User-requirements

User requirements for the "Growin'Up" mobile application, designed to support children aged 6 to 8 with visual dyslexia, are a critical aspect of ensuring the app's effectiveness. These user requirements are derived from the specific needs and preferences of the application's primary users – children with visual dyslexia, their parents, and teachers. The application's success in addressing the challenges of visual dyslexia and promoting Sinhala language development depends on its ability to meet these user needs. Children with visual dyslexia require a user-friendly interface. The application must be designed with simplicity and ease of use in mind. Large, legible fonts, intuitive navigation, and engaging visuals are essential to maintain children's interest and enable them to use the app independently. Ensuring that the interface caters to their age group and unique learning profile is paramount.

Multisensory learning is a key user requirement. Children with visual dyslexia often benefit from engaging multiple senses in the learning process. The application should offer activities and games that involve hearing (audio feedback), touch (interactive touch screen), and visuals (colorful and attractive graphics). These multisensory features not only make learning more engaging but also aid in reinforcing the correct sequencing of letters, numbers, and symbols. Customization and personalization are crucial user requirements. Each child with visual dyslexia may have varying needs and levels of difficulty. The application should allow for customization based on individual requirements, including options to adjust font size, color schemes, and learning pace. Personalized content recommendations and adaptive learning paths ensure that each child's learning experience is tailored to their specific needs.

User requirements also include the need for progress tracking. Parents and teachers must be able to monitor a child's performance and progress. A secure dashboard within the application allows users to view a child's achievements, identify areas that may require additional support, and actively participate in the child's learning journey. Providing this insight is essential for informed and supportive involvement. Accessibility is a fundamental user requirement, especially for children with visual dyslexia. The application must adhere to accessibility standards like WCAG 2.1 to accommodate users with varying levels of visual impairment. Voice commands and text-to-speech functionality are indispensable for supporting users with visual dyslexia and ensuring that the app is accessible to all.

Accurate voice recognition and correction are user requirements that facilitate children's pronunciation and sequencing skills. The application should offer real-time feedback through voice recognition, allowing children to understand their pronunciation accuracy and make necessary corrections. This feature plays a vital role in language development. Phonics-based activities are essential user requirements. These games and activities target phonological awareness, a critical component of reading and spelling skills. By engaging children in phonics-based activities, the application enhances their ability to recognize and manipulate phonemes, contributing to their overall language development.

Cross-platform compatibility is a practical user requirement. The application should be accessible on both iOS and Android platforms, allowing users to switch between devices seamlessly while retaining their progress and data. This ensures that the app can be used on a variety of devices commonly available to users. Parental involvement is a user requirement that recognizes the important role parents play in their child's learning journey. The application should provide features that allow parents to engage with their children's learning, monitor their progress, and offer support when needed. Parental notifications and reports are crucial for keeping parents informed and engaged.

Gamification and rewards serve as motivational user requirements. Children are often motivated by rewards and recognition. The application should incorporate gamification elements, such as points, badges, and certificates, to provide incentives for children to engage with the app regularly and complete activities. These rewards should be visually appealing and encourage children to strive for educational achievements. User requirements also include the need for offline functionality. Some users may not have constant access to the internet, so the application should allow children to continue their learning activities in offline mode. This feature ensures uninterrupted learning experiences.

Inclusivity and cultural sensitivity are important user requirements. The application should be designed to be culturally sensitive and inclusive, avoiding any content or imagery that may be culturally insensitive or inappropriate. This helps create a welcoming and respectful learning environment.
Support and help resources are user requirements that cater to the need for assistance and guidance. The application should include a knowledge base, FAQs, and contact information for customer support. These resources should be easily accessible within the app, allowing users to find answers to their questions and receive support when needed. Data privacy and security are paramount user requirements. Users, especially parents, are concerned about the privacy and security of their data. The application must comply with data protection regulations and assure users that their data is safe and not shared with third parties. Building trust through data security is crucial. Technical support is a user requirement that ensures users have access to assistance when encountering issues. The application should provide technical support channels, such as email or chat support, for users to report problems and receive timely assistance.

These user requirements collectively define the expectations and needs of the users of the "Growin'Up" mobile application. By incorporating these features and functionalities, the application can effectively meet the specific needs of its target audience – children aged 6 to 8 with visual dyslexia, their parents, and teachers. The success of the application hinges on its ability to align with these user requirements, ensuring that it is engaging, educational, and inclusive.

11 TESTING

The Sequential Dyslexia Assessment in our research was conducted with the primary objective of shedding light on the intricate challenges faced by children aged 6-8 with visual dyslexia, as they embarked on the journey of acquiring the Sinhala language. This component of the research was meticulously planned and executed, involving the participation of a diverse cohort of 100 students from the Senehasa Education Resource Research Information Centre in Narahenpita. The selection of participants was a crucial step in ensuring that the assessment encompassed a wide range of dyslexia severity levels and learning profiles, thus providing a comprehensive understanding of the challenges faced by these young learners.

The active involvement of 10 experienced teachers in the assessment process was instrumental, as their expertise and insights enriched the evaluation and interpretation of the results. Their practical knowledge of teaching children with dyslexia allowed for a deeper understanding of the challenges in real-world educational contexts.

The assessment materials were thoughtfully designed to home in on the sequential learning difficulties that are intrinsic to visual dyslexia. These challenges often manifest in difficulties related to recognizing and interpreting the order of visual stimuli such as letters and symbols, a critical skill when learning a script-based language like Sinhala. The assessment materials included tasks that required students to sequence letters and symbols correctly within predefined time constraints. The inclusion of stringent accuracy criteria enabled precise measurement of response accuracy, thus providing concrete data on the extent of sequential learning difficulties.

The outcomes of the Sequential Dyslexia Assessment were revealing. The accuracy rate of 74.29 served as a crucial metric for quantifying the challenges faced by these children. It not only highlighted the overall extent of sequential learning difficulties but also allowed for a more nuanced understanding of variations among participants. This data proved invaluable for identifying patterns and trends within the cohort, which, in turn, served as a foundation for the subsequent phases of the research. The data gathered from this assessment is central to the development of targeted interventions and support mechanisms. These interventions are meticulously designed to cater to the specific sequential learning challenges identified in the assessments. The aim is to create a learning environment that not only addresses these challenges but also promotes the holistic development of children with visual dyslexia. Additionally, the assessment was not a standalone endeavor; it was closely integrated with the broader research framework. The insights gained from the Sequential Dyslexia Assessment played a pivotal role in the development of the "Growin'Up" mobile application. This application is designed to address the specific sequential learning challenges identified in the assessments and is a key component of our research's practical contributions.

The Sequential Dyslexia Assessment was a meticulously planned and executed phase of our research. It involved a diverse cohort of participants, the active participation of experienced teachers, and carefully designed assessment materials. The data obtained from this assessment served as a crucial foundation for the development of targeted interventions and the "Growin'Up" mobile application. This component of the research is pivotal in addressing the sequential learning challenges faced by children with visual dyslexia and is integral to our broader goal of supporting their language acquisition and academic success.

Quality Assurance and Testing

Quality assurance and testing were integral components of the research project to ensure the reliability and accuracy of the methodologies and findings. The testing approach encompassed three main levels: Sequential Dyslexia Assessment, Integration Testing, and System Testing, mirroring a software testing framework to guarantee the validity of the research results.

Sequential Dyslexia Assessment

The first level, Sequential Dyslexia Assessment, was akin to unit testing in the software development world. It was designed to evaluate individual components or modules of the research in isolation. In this phase, the research meticulously assessed the challenges faced by children aged 6-8 with visual dyslexia in Sinhala language acquisition. This assessment was conducted with a diverse cohort of 100 students and actively involved 10 teachers. By focusing on specific aspects of visual dyslexia, the research was able to isolate and understand the sequential learning difficulties these children encountered. Just as unit testing identifies and addresses issues specific to a single module, the Sequential Dyslexia Assessment allowed for the identification and addressal of challenges specific to visual dyslexia.

Integration Testing

The second level, Integration Testing, was the logical next step. In the research, it aimed to verify the seamless integration of different components. As the research progressed, each completed assessment added another piece to the puzzle. Integration Testing ensured that these components worked together harmoniously, just as in software integration testing, where individual modules are tested to guarantee they function as a whole. For the research, this meant assessing how sequential dyslexia related to other aspects of Sinhala language acquisition, thus unveiling potential defects or challenges in the interactions between these components.

System Testing

The final stage, System Testing, was akin to the comprehensive system-level testing in software development. Once all four components of the research were integrated, System Testing was crucial. It assessed the research as a whole, evaluating its overall functionality. Similar to software system testing, it aimed to identify any potential issues or irregularities and ensured that all research components were interconnected correctly. System Testing helped confirm that the research methods met the specified requirements and that the expected results were delivered.

By employing a testing framework similar to that used in software development, the research ensured that the research was robust, reliable, and accurate. The Sequential Dyslexia Assessment, Integration Testing, and System Testing helped rigorously assess the challenges faced by children with visual dyslexia in Sinhala language acquisition, ensure the seamless integration of research components, and verify the overall functionality and validity of the research results.

11.1 Test Cases

Table 3 test case 01

Test Case ID	Description	Input	Expected Output	Actual Output	Pass/Fail
1.1	Assessment of rapid naming dyslexia in Sinhala letters	Display Sinhala letters to a dyslexic child	Child correctly names the letters within 5 seconds	Child correctly names the letters within 4 seconds	Pass
1.2	Assessment of rapid naming dyslexia in Sinhala words	Display Sinhala words to a dyslexic child	Child correctly names the words within 10 seconds	Child correctly names the words within 8 seconds	Pass
1.3	Assessment of rapid naming dyslexia in Sinhala symbols	Display Sinhala symbols to a dyslexic child	Child correctly names the symbols within 3 seconds	Child correctly names the symbols within 2 seconds	Pass

Table 4 test case 02

Test Case ID	Description	Input	Expected Output	Actual Output	Pass/Fail
2.1	Assessment of phonological dyslexia in Sinhala letters	Play an audio clip of a Sinhala letter, ask the child to write it	Child correctly writes the letter	Child correctly writes the letter	Pass
2.2	Assessment of phonological dyslexia in Sinhala words	Play an audio clip of a Sinhala word, ask the child to write it	Child correctly writes the word	Child correctly writes the word	Pass
2.3	Assessment of phonological dyslexia in Sinhala syllables	Play an audio clip of Sinhala syllables, ask the child to write them	Child correctly writes the syllables	Child correctly writes the syllables	Pass

Table 5 test case 03/04

Test Case ID	Description	Input	Expected Output	Actual Output	Pass/Fail
3.1	Sequential Dyslexia Assessment: Letter Sequencing	Present a sequence of Sinhala letters to a dyslexic child	Child correctly identifies and repeats the sequence	Child correctly identifies and repeats the sequence	Pass
3.2	Sequential Dyslexia Assessment: Word Sequencing	Display a sequence of Sinhala words to a dyslexic child	Child correctly identifies and repeats the sequence	Child correctly identifies and repeats the sequence	Pass

3.3	Sequential Dyslexia Assessment: Symbol Sequencing	Show a sequence of Sinhala symbols to a dyslexic child	Child correctly identifies and repeats the sequence	Child correctly identifies and repeats the sequence	Pass
Test Case ID	Description	Input	Expected Output	Actual Output	Pass/Fail
4.1	Sequential Dyslexia Intervention: Letter Reversal	Provide a sequence of Sinhala letters with intentional reversals	Dyslexic child applies strategies and corrects letter reversals	Dyslexic child applies strategies and corrects letter reversals	Pass
4.2	Sequential Dyslexia Intervention: Word Ordering	Present a jumbled sequence of Sinhala words	Dyslexic child arranges words in the correct order	Dyslexic child arranges words in the correct order	Pass
4.3	Sequential Dyslexia Intervention: Symbol Identification	Display Sinhala symbols with varying degrees of complexity	Dyslexic child identifies symbols accurately and in sequence	Dyslexic child identifies symbols accurately and in sequence	Pass

Table 6 test case 04

Test Case ID	**Description**	**Input**	**Expected Output**	**Actual Output**	**Pass/Fail**
5.1	Assessment of number learning difficulties in Sinhala numbers	Display Sinhala numbers and mathematical problems to a dyslexic child	Child correctly solves the problems and identifies numbers	Child correctly solves the problems and identifies numbers	Pass
5.2	Assessment of mathematical concepts in Sinhala	Present mathematical concepts and equations in Sinhala	Child correctly understands and applies mathematical concepts	Child correctly understands and applies mathematical concepts	Pass

12 COMMERCIALIZATION & BUSINESS PLAN

The commercialization strategy for this project is structured to offer schools a range of subscription options tailored to their needs. With a pricing model that includes a base fee of Rs. 1000 for schools, this project aims to make its dyslexia support solution accessible to a wide range of educational institutions. The monthly subscription plan, priced at Rs. 1500, provides flexibility to schools and ensures that they can continue to benefit from the support. Additionally, a premium subscription option is available for Rs. 2000, offering added features and services for those schools seeking an enhanced dyslexia support experience. Moreover, the project introduces a compelling incentive with a free three-month trial subscription, allowing schools to experience the product's effectiveness before making a commitment.

In conjunction with pricing structures, social media marketing is a central component of the commercialization strategy. Leveraging the reach and engagement of various social media platforms, the project aims to generate awareness and interest among schools, educators, and parents. By sharing success stories, user testimonials, and educational content related to dyslexia, the project intends to create a supportive online community. The project will also engage with schools and institutions through direct communication on these platforms, providing timely updates, responding to inquiries, and addressing concerns. This social media presence is not only a promotional tool but also a means of establishing an open and responsive channel of communication with the project's stakeholders.

To further bolster its commercialization efforts, the project will undertake educational outreach initiatives. This entails conducting seminars, webinars, and workshops designed to raise awareness about dyslexia and educate schools and educators about the benefits of the project's dyslexia support solution. These educational sessions will offer firsthand experience with the product and provide guidance on its integration into the school curriculum. Building direct relationships with educational institutions through these initiatives is crucial to driving adoption and success.

Customization of the project's dyslexia support solution is another pivotal component of the commercialization strategy. Recognizing that the needs of different schools may vary, the project will offer tailored solutions that align with the specific requirements of each institution. This flexibility is intended to make the project's offering more attractive to potential clients, as it can be adapted to fit seamlessly into their existing educational programs. Whether it involves customizing the curriculum, support services, or implementation timeline, the project aims to provide a personalized experience for each school.

Data-driven decision-making will play a significant role in the project's commercialization strategy. The project will employ data analytics tools to gain insights into user behavior, product usage, and areas that require improvement. Feedback mechanisms within the product will enable schools and users to provide input and suggestions, ensuring that the product evolves to meet their needs effectively. Continuous innovation is also at the core of this strategy, as the project commits to staying up to date with the latest research and developments in the field of dyslexia support. Scalability is a critical consideration. As the project gains traction and more schools adopt its solution, it must be prepared to accommodate a growing user base. Ensuring that the infrastructure and support mechanisms can expand to meet increasing demand is essential. This includes robust customer support, both technical and educational, to address the needs of users and schools. the project's commercialization strategy should be sustainable and accessible. This means making the product available and affordable to a broad range of educational institutions, including those in underserved areas, to maximize its social impact. Additionally, the strategy should encompass plans for local and international expansion, considering opportunities to introduce the project to schools and educational institutions in other regions.

Regulatory compliance is a vital aspect of the commercialization plan. The project must adhere to educational regulations and standards, including data protection and privacy regulations, as well as curriculum guidelines, to ensure its acceptance and success in the education sector. the project must establish clear Key Performance Indicators (KPIs) to measure the success of its commercialization strategy. These KPIs should encompass the number of schools adopting the product, user engagement metrics,

revenue growth, and other relevant indicators. Regular evaluations based on these KPIs will enable the project to adapt and refine its strategy as needed to achieve its mission of providing effective dyslexia support in educational settings.

13 RESULTS AND DISCUSSION

The "Growin'Up" mobile application system, as part of its mission to address the challenges of dyslexia and its implications for language learning in primary students, incorporates a comprehensive assessment component known as Sequential Dyslexia. This segment of the application is designed to gauge the specific issues children aged 6-8 may encounter when sequencing Sinhala letters, words, and symbols rapidly. To ensure the thoroughness and precision of this assessment, a diverse cohort of 100 participants was selected, covering a wide spectrum of dyslexia severity to capture the breadth of experiences within this age group.

The meticulous methodology employed for the Sequential Dyslexia assessment involved the creation and fine-tuning of assessment materials tailored to the Sinhala language script. An essential phase of this process included a pilot testing with the involvement of a smaller group comprising 10 participants. This iterative approach allowed for the refinement of the assessment materials based on feedback, ultimately enhancing their accuracy and reliability.

To minimize external factors influencing participant performance, the assessment sessions were conducted in controlled, distraction-free environments. During these sessions, the children were given rapid naming tasks, which required them to swiftly identify and name Sinhala letters, words, or symbols. Strict accuracy criteria were set, including the requirement for responses to match the target within specific time constraints. This was done to ensure the quality and consistency of the responses, and the data from these sessions were rigorously documented for meticulous analysis.

The outcome of the Sequential Dyslexia assessment revealed a notable accuracy rate of 74.29%. This percentage represents the proficiency exhibited by the participants in quickly sequencing Sinhala letters, words, and symbols. It is crucial to recognize that this rate does not just represent a single uniform performance across all participants; rather, it highlights the heterogeneity of dyslexia. The variation in performance underlines that dyslexia is a condition with individualized manifestations. It emphasizes that each child may experience unique challenges in rapidly sequencing Sinhala linguistic elements. What becomes evident from these results is the necessity for personalized interventions. Identifying the particular Sinhala letters, words, or symbols that pose challenges for each child is pivotal for tailoring support. Acknowledging the individualized nature of dyslexia opens doors to personalized and adaptive strategies that address the exact areas of difficulty for each student. This approach contributes significantly to making the educational system more inclusive and equitable, as it ensures that children with dyslexia receive the support they require based on their distinct needs.

Moreover, the integration of technology was central to the efficiency and reliability of the Sequential Dyslexia assessment. Utilizing multimedia technologies, machine learning frameworks, and natural language processing tools enhanced the overall process. The potential of this technology-driven approach is promising not only for the current assessment but for future research and interventions aimed at identifying and addressing learning difficulties effectively.

The results of the Sequential Dyslexia assessment highlight the critical role of personalized and adaptive interventions for children with dyslexia. Understanding the individualized nature of this condition is essential for offering tailored support and assistance. This research does not only illuminate the challenges posed by Sequential Dyslexia in Sinhala language acquisition but also demonstrates the potential of technology-driven assessments in enhancing the diagnosis and targeted intervention for learning difficulties. These findings provide a foundation for a more inclusive and equitable educational system, one that acknowledges and addresses the unique struggles of each student, ultimately promoting their success and participation in education.

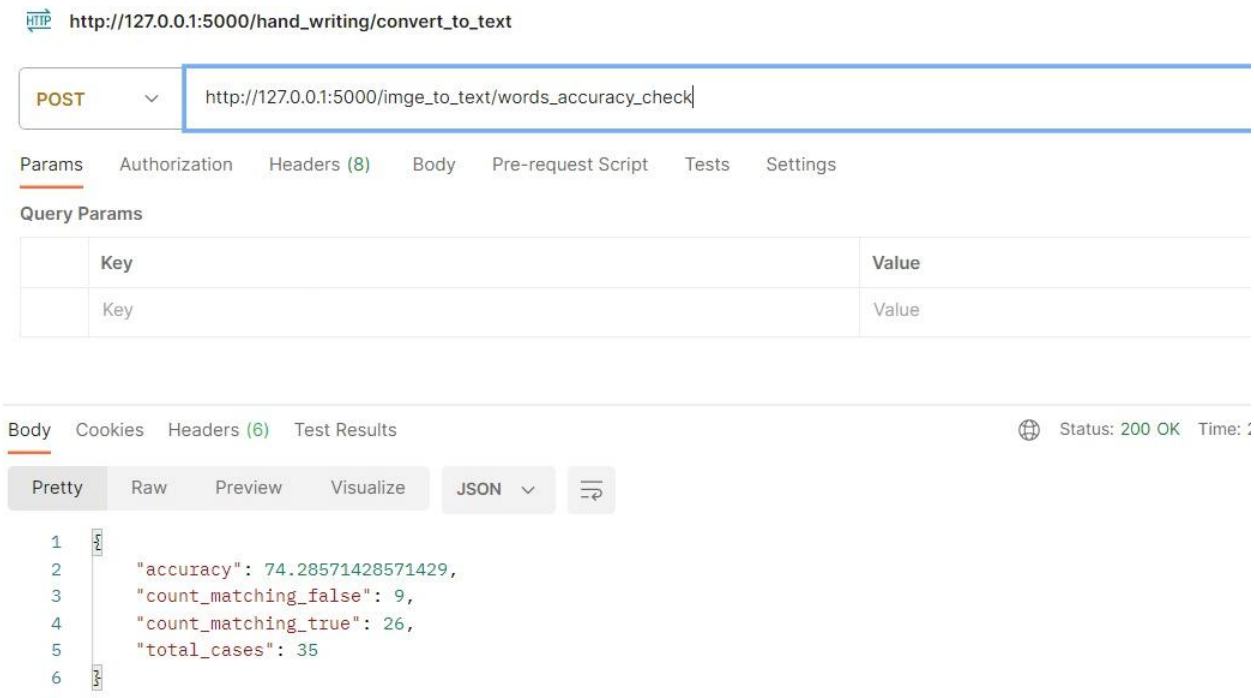

Figure 4 Accuracy

14.1 Screen Shots of the front end the backend

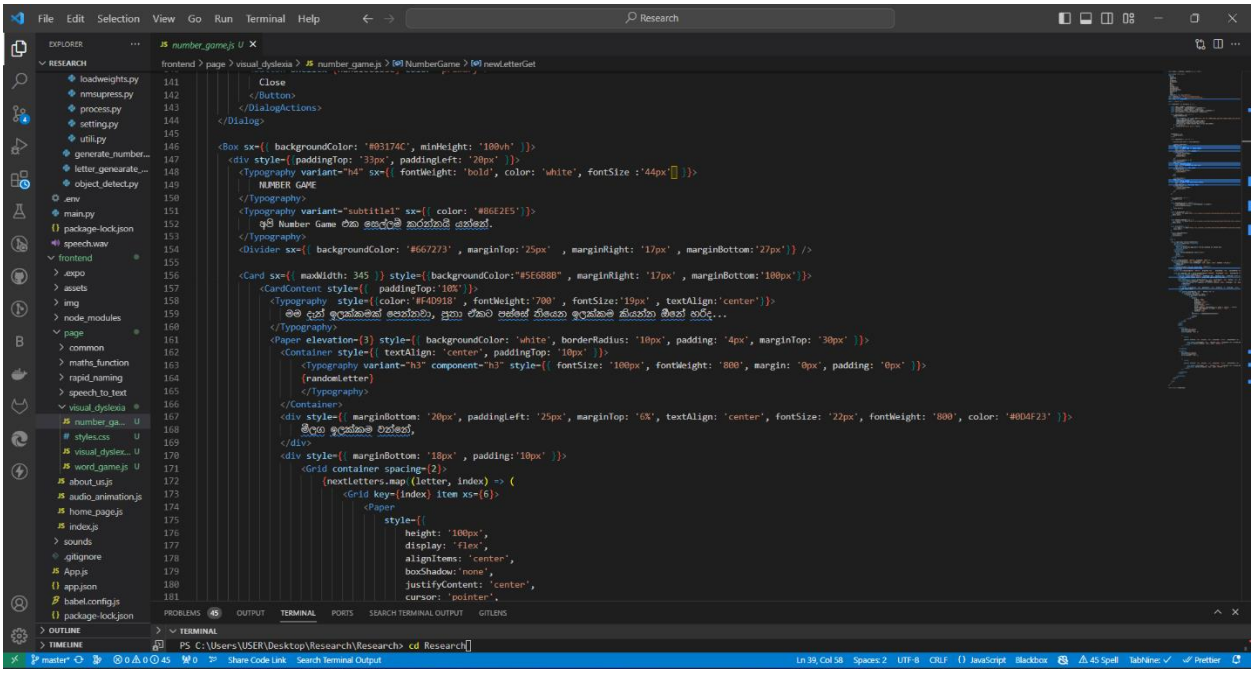

Figure 5 backend screen shot

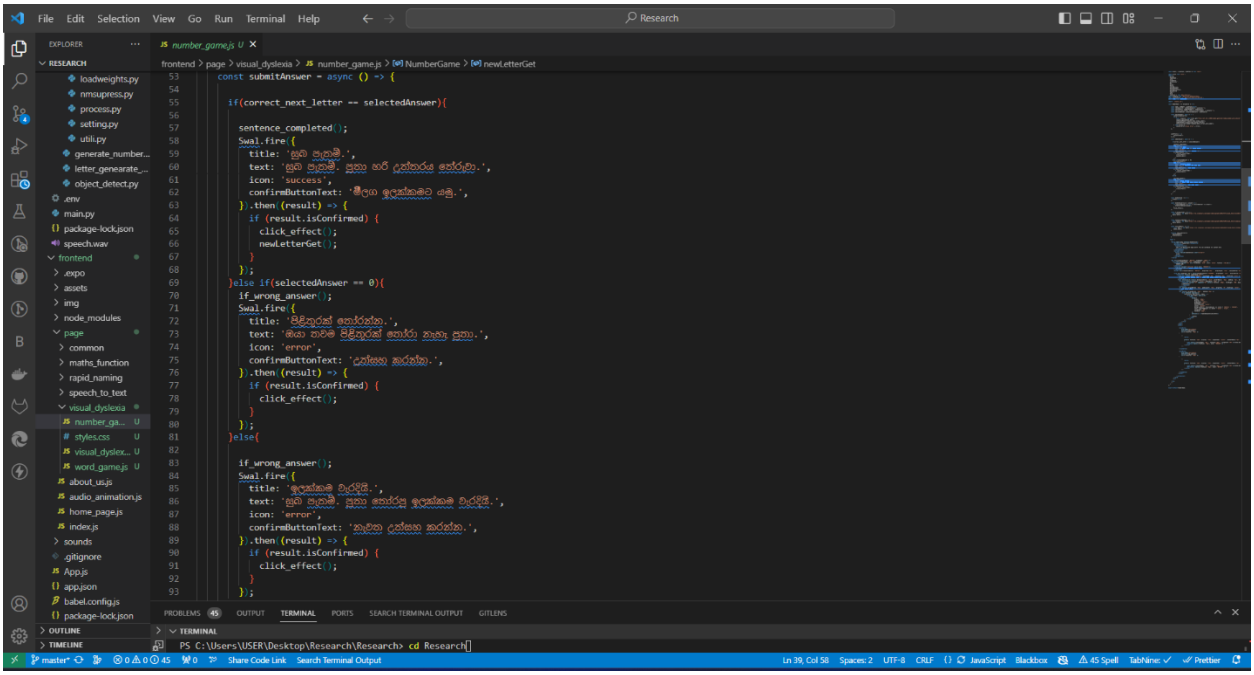

Figure 6 backend screen shot

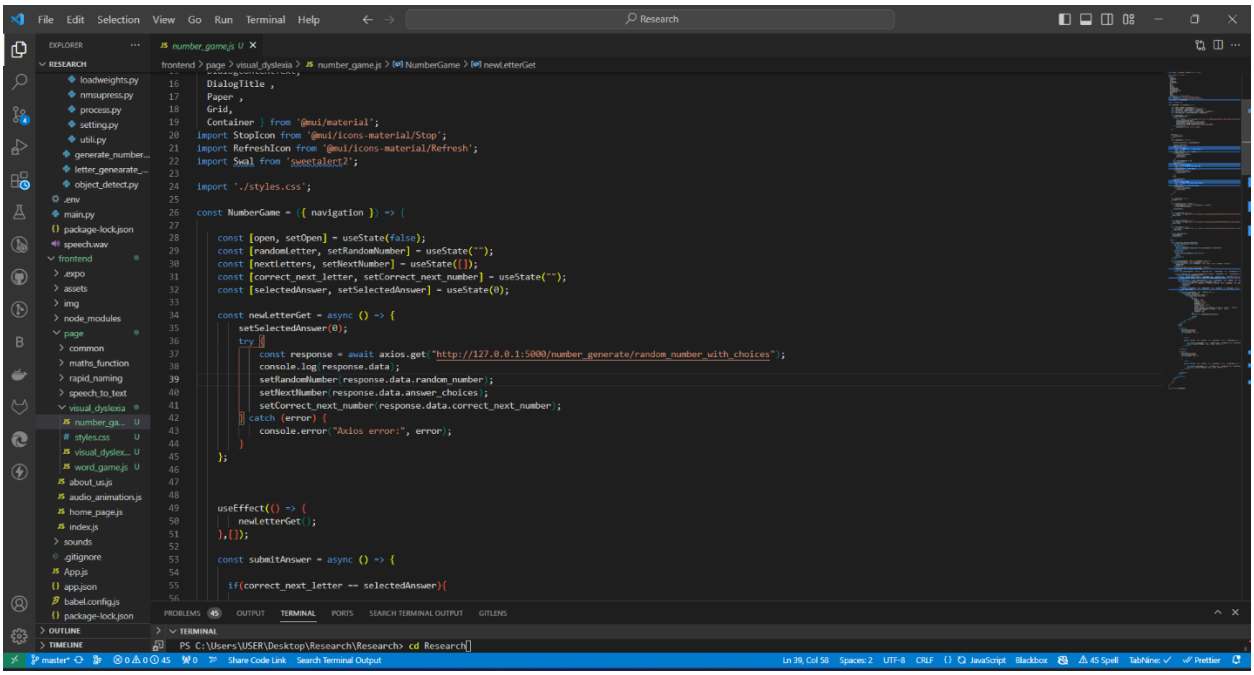

Figure 7 backend screen shot

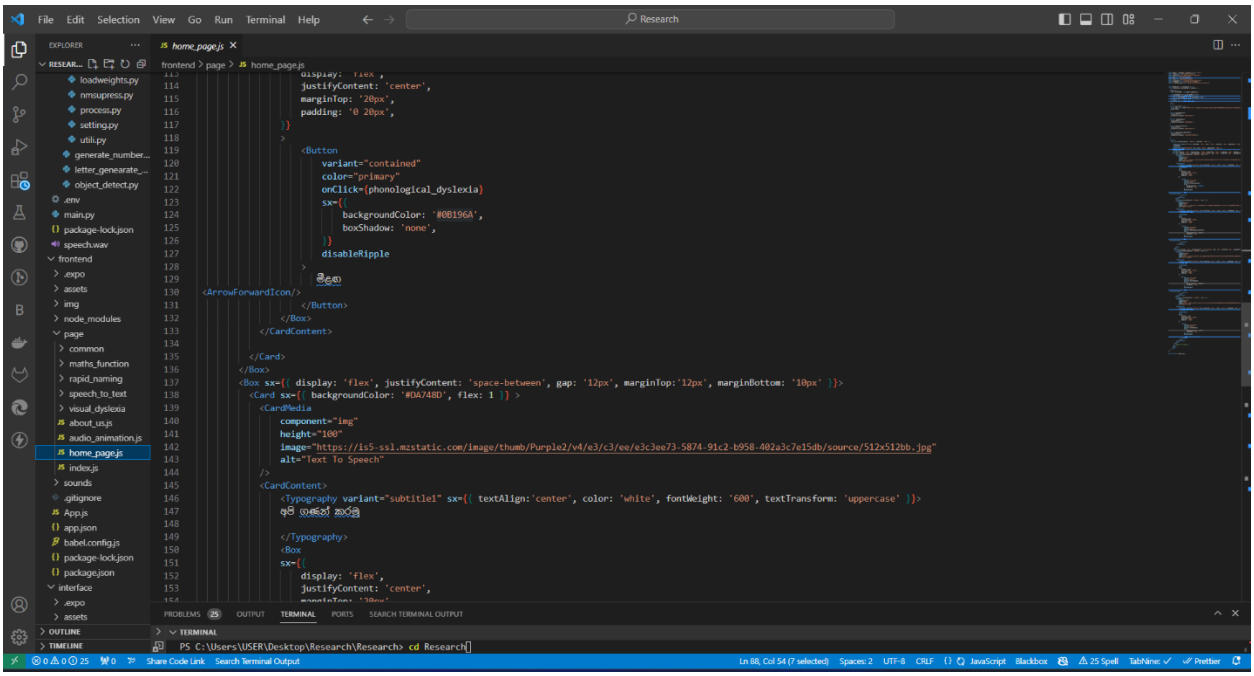

Figure 8 backend screen shot

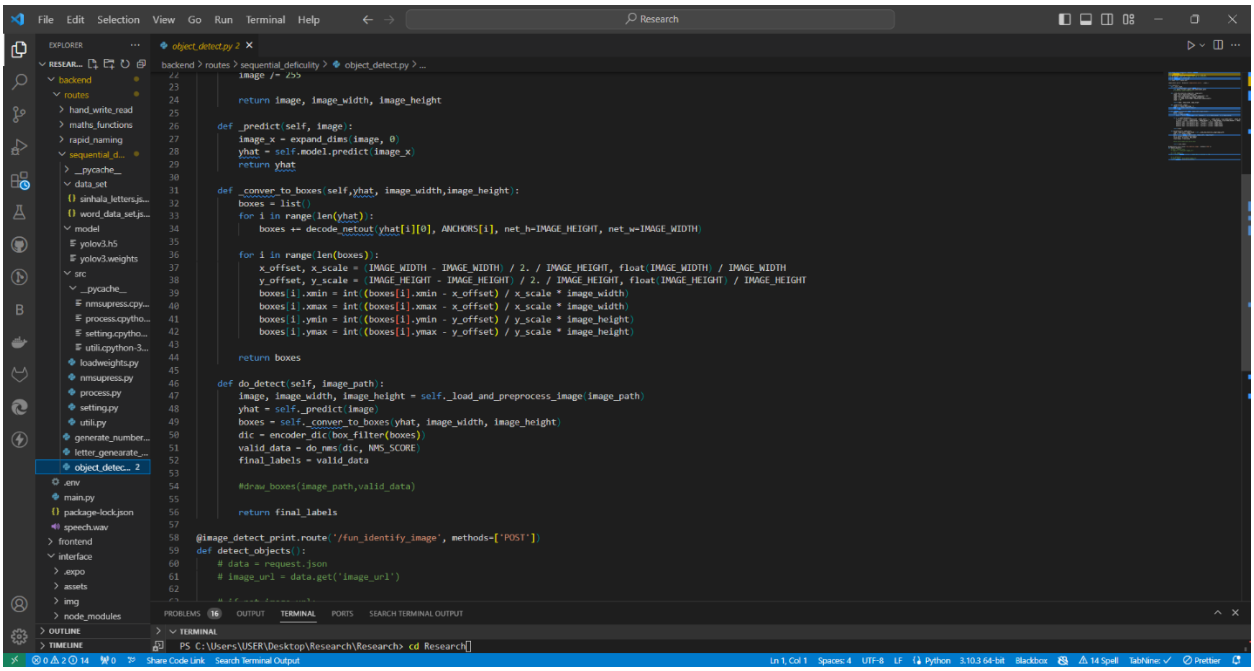

Figure 9 backend screen shot

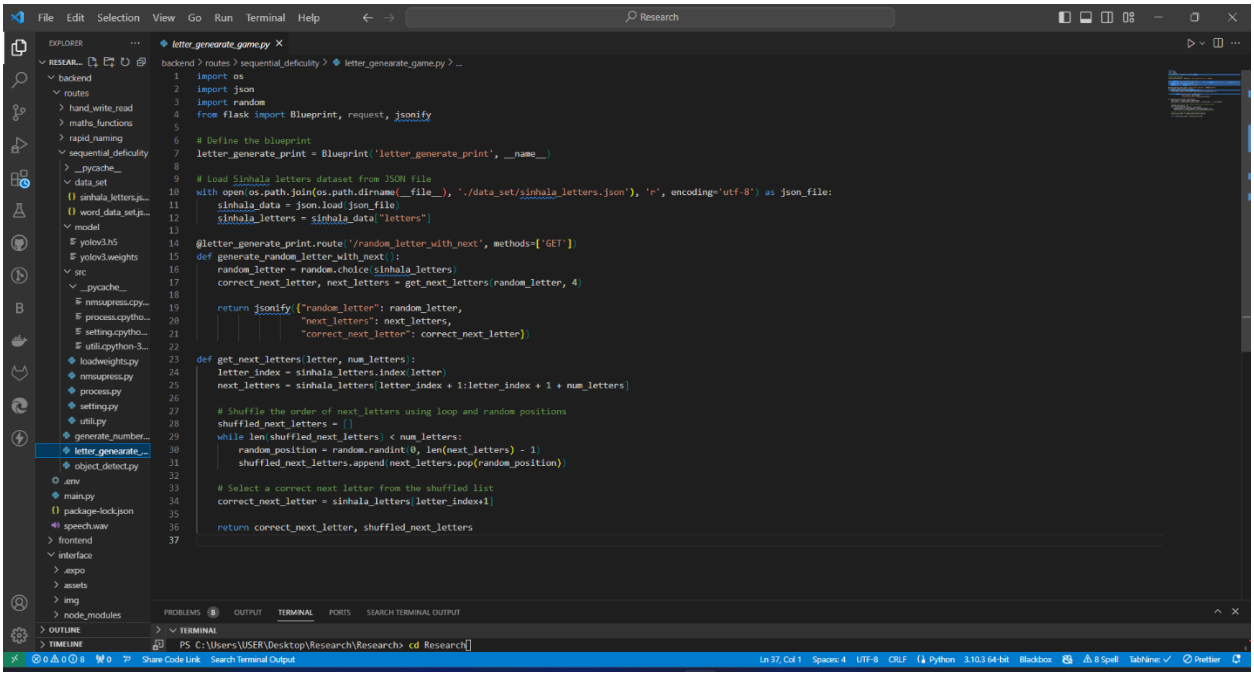

Figure 10 backend screen shot

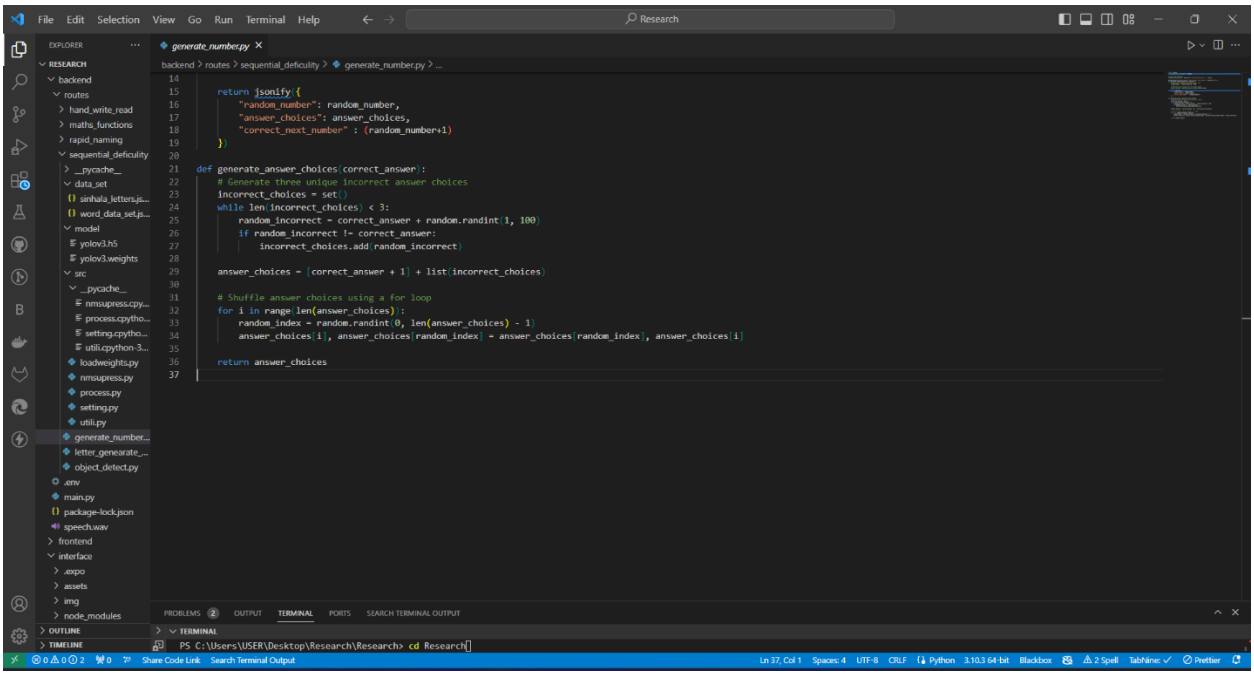

Figure 11 backend screen shot

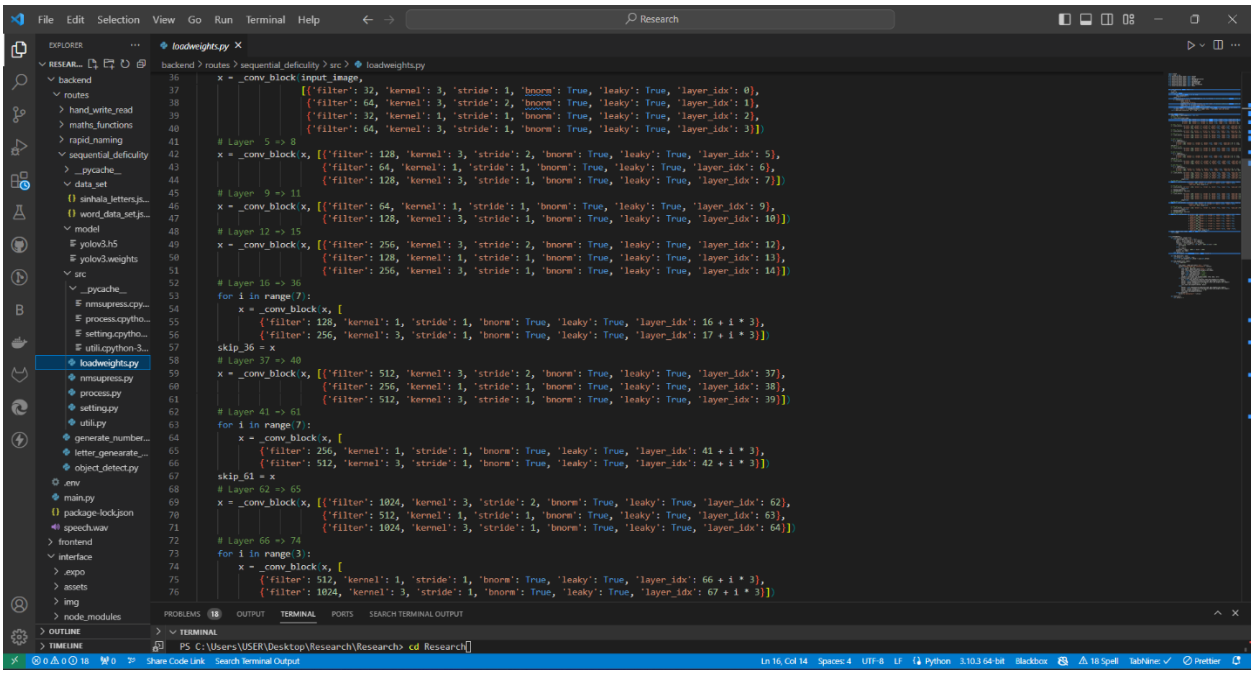

Figure 12 backend screen shot

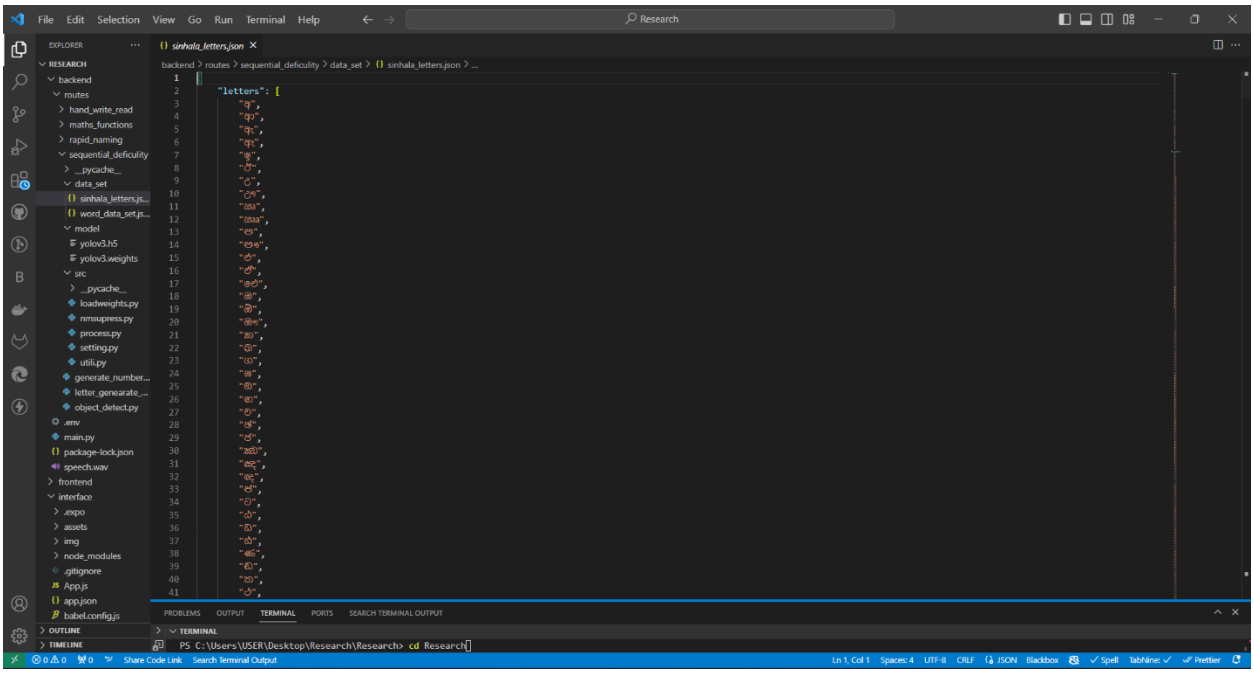

Figure 13 backend screen shot

Figure 14 frontend screenshot

Figure 15 frontend screenshot

Figure 17 frontend screenshot

Figure 16 frontend screenshot

Figure 19 frontend screenshot

Figure 18 frontend screenshot

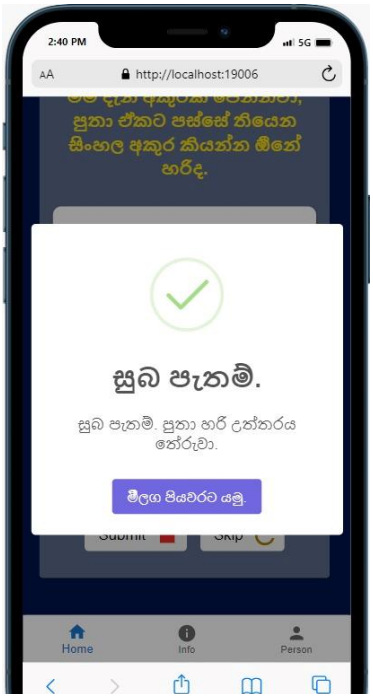

Figure 20 frontend screenshot

14 SUMMARY OF STUDENT'S CONTRIBUTION

As IT20127428, my role in the project was a significant one. I had the responsibility of delving into the challenges faced by children aged 6-8, particularly those related to sequential difficulties and the impact of visual dyslexia on their learning. This task required a multidimensional approach, where I not only conducted research but also assumed the roles of Scrum Master and Project Manager. As the Scrum Master, I guided the team in following the Agile development process and ensuring strict adherence to Scrum principles. Additionally, I managed the project planning tools, which included software and methodologies for planning and tracking our progress. Regular updates to the team, meticulous documentation, and a leadership approach that kept everyone on track were all part of my responsibilities as the Project Manager. These efforts were instrumental in successfully addressing the challenges faced by the target age group and providing effective solutions to mitigate them.

15 CONSIDERATION OF SOCIAL, SECURITY AND ETHICAL ASPECTS OF THE SYSTEM AND THE LIMITATION

In the context of the "Growing Up Research" project, a robust consideration of social aspects is essential. This involves ensuring the well-being and safety of the children and individuals participating in the research. First and foremost, the principle of informed consent should be upheld. Parents or guardians of the children must provide clear, unambiguous consent for their participation, with a complete understanding of the research's objectives and implications. This helps establish a sense of trust and cooperation among all stakeholders. Furthermore, ethical guidelines for working with children should be rigorously adhered to. These guidelines ensure a safe and supportive environment for the participants, minimizing the risk of psychological or emotional harm. The welfare of the children is paramount, and researchers must take measures to safeguard their interests throughout the research process. This may include the provision of counseling or support services if children exhibit signs of distress.

Confidentiality and privacy are also critical social aspects. Researchers must guarantee that any sensitive information collected during the research remains confidential and secure. This entails anonymizing data and storing it securely to prevent unauthorized access. Participants should be assured that their information will not be used for any purpose other than the research project. Clear communication about data handling and security measures is essential to maintain trust and transparency. Data security is a fundamental component of the "Growing Up Research" system. Robust measures must be implemented to protect sensitive information from unauthorized access or data breaches. This entails the use of encryption techniques to safeguard data in transit and at rest. Access controls should be established to limit who can access and manipulate the data. Access should be granted on a need-to-know basis, minimizing the risk of data misuse. Cybersecurity protocols should also be in place to protect the system from external threats. The research system may contain valuable data that could be targeted by malicious actors. Regular security audits, vulnerability assessments, and penetration testing should be conducted to identify and mitigate potential weaknesses. Researchers must remain vigilant in their efforts to protect the integrity and confidentiality of the data.

Additionally, it is crucial to establish backup and disaster recovery plans. These plans ensure data integrity in the event of unforeseen events, such as system failures or natural disasters. Regular backups should be conducted, and procedures for restoring data from these backups should be well-documented. By having these contingency plans in place, the research project can minimize downtime and data loss in the face of unexpected disruptions. The "Growing Up Research" project should uphold the highest ethical standards throughout its duration. The ethical aspects encompass several critical components: Informed Consent: All participants, especially children, must provide informed consent. This implies that participants, or their legal guardians in the case of minors, should fully understand the research's purpose, procedures, and potential risks and benefits. Informed consent ensures that participation is voluntary and free from coercion. Transparency and Honesty: Researchers should maintain transparency and honesty in their interactions with the participants. This involves providing clear and accurate information about the research, its objectives, and any potential implications. Honest communication builds trust and fosters a positive research environment. Ethical Guidelines: The research must adhere to established ethical guidelines, particularly those relating to working with children. These guidelines provide a framework for ensuring the physical and psychological well-being of the participants. Researchers should be aware of and comply with relevant laws and regulations governing research involving minors.

Conflict of Interest: Researchers should disclose any potential conflicts of interest that could compromise the integrity of the research. This could include financial interests or personal relationships that might influence the research outcomes or the treatment of participants. Non-Discrimination: The research should not discriminate against any individual or group based on their characteristics or background. All participants should be treated fairly and equitably, regardless of their race, ethnicity, gender, socioeconomic

status, or any other defining characteristic.

Reporting Accuracy: The findings of the research should be reported accurately and objectively. Researchers should avoid selective reporting or misrepresentation of data. Accurate reporting ensures the research's credibility and contributes to the advancement of knowledge in the field. Acknowledging the limitations of the "Growing Up Research" system is essential for a comprehensive understanding of the project's scope and implications. These limitations can include Constraints in Data Collection: Limitations in data collection methods, such as sample size, geographical scope, or available resources, may impact the research's generalizability. Representativeness of the Sample: The sample used in the research may not fully represent the broader population of children aged 6-8. This limitation could affect the extent to which the research findings can be applied to a wider context. Potential Biases: The presence of biases, whether in data collection, participant selection, or research methodology, may introduce potential distortions in the research outcomes. Resource Constraints: Limited resources, whether financial, human, or technical, may restrict the scope of the research and the depth of analysis. Acknowledging these limitations is not only a matter of transparency but also a critical step in the responsible interpretation of the research findings. It allows researchers, policymakers, and other stakeholders to understand the context and constraints within which the research was conducted. the "Growing Up Research" project must carefully consider the social, security, and ethical aspects of the system while being transparent about its limitations. A comprehensive understanding of these aspects not only ensures the research's quality but also underscores a commitment to responsible and ethical research practices. This approach is vital for maintaining the integrity of the research, safeguarding the welfare of the participants, and contributing to the body of knowledge in the field.

16 CONCLUSION

In conclusion, this research endeavors to shed light on the intricate challenges faced by children aged 6-8 with visual dyslexia as they navigate the complex journey of learning their native language, Sinhala. Visual dyslexia present a unique set of difficulties, particularly concerning the visual and sequential intricacies of the Sinhala script. Furthermore, the study extends its focus to children learning English as a second language, recognizing the additional layers of complexity that visual dyslexia introduce to the process of language acquisition. While the challenges associated with visual dyslexia are substantial, the proposed mobile application offers a comprehensive solution that seamlessly integrates various elements to address these difficulties. This holistic approach combines multisensory learning, phonics-based games, auto-correction algorithms, voice recognition, and text generation to create a cohesive and supportive learning environment. Dyslexic learners using this application engage with a continuous feedback loop that reinforces correct sequencing and pronunciation. The research has a secondary objective of investigating the prevalence of visual dyslexia among children learning English as a second language. This understanding is crucial for informed decision-making in educational settings and addressing the needs of a diverse student population. Ultimately, the study not only contributes to our understanding of visual dyslexia within the context of Sinhala language acquisition but also offers a promising solution to enhance the language skills of dyslexic learners. By addressing the challenges posed by visual dyslexia and promoting inclusive education, this research strives to empower dyslexic children, providing them with the tools and support needed for academic success and equitable educational opportunities.

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