A MOBILE APPLICATION TO IMPROVE ONLINE LEARNABILITY TO VISUALLY IMPAIRED ELEMENTARY SCHOOL CHILDREN

Project Id: TMP-23-310

IT20237622

Nayanananda W.A.K.D

BSc (Hons) in Information Technology Specializing in Information Technology

Department of Information Technology

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September 10th

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1. DECLARATION OF THE CANDIDATE AND THE SUPERVISOR

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

Name	Student ID	Signature
Nayanananda W.A.K.D	IT20237622	

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

…….. ……

Signature of the supervisor: Date:

…….. ……...

Signature of the co-supervisor: Date:

2. ACKNOWLEDGEMENT

I would want to use this time to extend my deepest appreciation to everyone who helped bring this study to a successful conclusion. This job would not have been accomplished without their direction, support, and help. First and foremost, I want to thank my supervisor, Ms. Chathurangika Kahandawaarachchi, and my co-supervisor, Mr. Sathira Nimesh Hettiarachchi. Their professional expertise, useful ideas, and consistent assistance throughout the research process have all played a role in molding the direction and quality of this work. I sincerely appreciate their patience, encouragement, and constant support.

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Abstract

The tutor recommendation module within our innovative smart mobile application plays a pivotal role in enhancing the educational experience for visually impaired primary school students. By carefully analyzing students' performance in online examinations and considering their specific disabilities, this module facilitates the selection of highly suitable tutors. Through a meticulous matching process, it ensures that chosen tutors possess the expertise and experience required to cater to the unique needs of visually impaired students. This personalized approach not only fosters a more effective learning environment but also promotes greater confidence and engagement among students, ultimately leading to improved academic outcomes.

Keywords: Tutor recommendation module, Smart mobile application, Visually impaired students, Personalized learning,Academic outcomes

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3. INTRODUCTION

1.1 General Introduction

Today's pupils may access online learning, which has developed as a potent resource in the digital era, transcending traditional educational borders. The need to ensure that all students, including those with visual impairments, can fully engage in and benefit from online education despite this technical advancement cannot be overstated. For visually challenged students, access to course materials and educational resources can frequently cause major problems, restricting their opportunities for study and development.

The topic of this discussion looks into the critical need for primary school pupils who are blind or visually impaired to have access to online learning and examines the methods through which this accessibility might be realized. Our mission is to empower these students to overcome the hurdles they face in pursuing their primary education subjects effectively. To achieve this, we have developed a cutting-edge mobile application tailored specifically to their needs—a digital companion for learning and knowledge enhancement.

This innovative application encompasses a range of features designed to cater to the unique requirements of visually impaired students. It includes a tutor recommendation module, a virtual tutor with voice capabilities, a brain-enhancing gaming module, and a supportive voice bot. The tutor recommendation module, in particular, plays a pivotal role in matching students with the most suitable tutors, considering their individual knowledge levels and disabilities. By conducting online voice-based examinations and leveraging machine learning, we can accurately determine the students' knowledge levels, categorizing them as either advanced, intermediate, or beginner learners.

However, our system goes beyond conventional methods by factoring in the specific disabilities of each student—be it blindness, color blindness, or partial blindness. This factor verifies that the chosen tutor has the necessary expertise and qualifications to meet the special requirements of visually impaired elementary school kids. With this

comprehensive strategy, we hope to create an accessible and efficient online learning environment that not only offers educational material but also encourages these exceptional students to feel empowered and grow.

1.2 Background Literature

It is rare to find a good e-Learning platform to visual impaired primary students. Therefore, the attention of many researchers has been focused on this side.

The incredible advances in assistive technology intended to close the accessibility gap for students who are visually impaired is one noticeable aspect of the modern educational environment. With the help of advancements like screen readers, braille displays, and speech recognition software, these students can interact with the curriculum more successfully.

The availability and observance of accessibility standards and rules have a major impact on how visually impaired pupils learn. It should be examined the methods used by international and national organizations to create standards for educational technology and material that are accessible and evaluated for their effects on publishers and educational institutions.

Accurately evaluating a student's development requires assessment methods that are suited to their particular requirements. It is important to consider the novel assessment techniques, such as oral examinations, tactile tests, and digital platforms, that can accommodate pupils with visual impairments. To conduct this online voice-based examination, our research aligns with similar studies that have recognized the value of oral assessments for visually impaired students.

Regarding conducting an online voice-based examination there is research called “EEG Based Identification of Words on Exam Models with Yes-No Answers for Students with Visual Impairments”. [1] In here they use an oral examination for visual impaired students. The main aim of this research is to propose a new concept of the test model with

Yes-No answers for the visual impaired students. In our research also we conduct an oral examination.

Another research called “Voice-based Online Examination System for Visually Impaired Students” [2] also highly focus on who are unable to see the questions shown on the computer screen. In here the questions which are displayed on the computer screen is read to the visual impaired student and they are responding by using the voice commands. The process in our proposed system will be the same for conducting the online voice-based test. They mainly concentrated on the recommended method, which is to develop and supply a more attractive interface for visually impaired students to take online tests by using voice to text and text to voice technologies.

The research of “VOICE-BASED ONLINE EXAMINATION SYSTEM FOR VISUALLY IMPAIRED” [3] has recommended a fully automated voice based online examination for the visually impaired students. Their aim is to prevent inconvenience for visually impaired pupils during physical examinations. They convert the answers that given by the students by vocally to the text format. After that they stored the answers in a database and give the results after examination is completed.

Despite advancements, there are still significant obstacles and problems in the way of providing visually impaired students with an accessible education. The difficulties that need to be overcome include a lack of suitable resources, a shortage of instructors with the necessary training, and widespread social misunderstandings. This section provides information on ongoing initiatives to address these issues and promote inclusive learning environments.

An online examination for visual impaired students is proposing under “ONLINE EXAMINATION SYSTEM FOR VISUALLY CHALLENGED” [4]. This system has developed to eliminate the problems that visually impaired students experience when writing a exam physically. Therefore, they have introduced a new system. They are using the voice as the input. Voice commands are used to ask the questions, and the visual impaired student responds in the same way. And the system use speech-to-text

conversions to preserve system flow. In here, they have provided a registration to register themselves.

To effectively support primary pupils who are blind or visually impaired, educators must be proficient in the subject. The current segment focuses on professional development opportunities and tools for teachers working in inclusive environments. It emphasizes the importance of receiving training in adaptive teaching techniques and the part instructors play in fostering inclusive school environments.

“FindMyTutor: An Android Application for Matching Students and Private Tutors” [5] is research that has designed as an Android operating system. In here students can be able to select their favorable tutor and vice versa. But in our system tutors are recommended based on the marks that students are gained from an online examination. In this research students are classified based on their location, gender, rating, and age as same as we classify visual impaired students based on the level of marks and disabilities

Together, these studies highlight the growing importance of utilizing technology to create accessible learning environments and resources for visually impaired primary students. Our research synthesizes their findings and innovative approaches, aiming to contribute to a comprehensive understanding of the technological solutions that empower visually impaired students in their educational journey.

1.3 Research Gap

The proposed e-learning system for visually impaired primary students represents a significant advancement in addressing the unique needs of this student demographic. To underscore the distinctive features and advantages of our proposed system, it is essential to conduct a comparative analysis with existing systems and research. This comparison will elucidate the research gap and underscore the need for the comprehensive approach presented in our research.

One of the core differentiators of our proposed system is the inclusion of a Tutor Recommendation System. None of the existing systems examined, including the four referenced research studies [2][3][4][5], offer such a feature. This feature plays a pivotal role in connecting visually impaired students with tutors who possess the expertise and experience required to provide tailored support. By integrating this element, our system acknowledges the importance of personalized learning experiences and the critical role of qualified tutors in the educational journey of visually impaired students.

When it comes to online examination systems, all research studies [2][3][4][and our proposed system incorporate this feature, except for the fourth research study[5]. While online examination systems are common, our system's approach stands out due to its voice-based examination process. This innovative approach caters explicitly to the needs of visually impaired students who may face challenges with traditional text-based examinations. The incorporation of oral assessments ensures a more equitable evaluation method for this demographic, addressing a significant gap in the existing systems.

Our proposed system is the only one among the compared research studies and systems that integrates an Accessibility Mode into its user interface (UI) design. Accessibility modes are crucial for providing visually impaired students with adaptable and user-friendly interfaces. This feature empowers students to adjust settings like contrast modes, font sizes, and text spacing, ensuring a more inclusive and accommodating learning environment. The absence of this feature in other systems underscores the potential for our proposed system to set a new standard in accessible e-learning.

Both the second[3] and fourth[5] research studies, along with our proposed system, offer a mobile application as part of their e-learning platforms. Mobile applications are instrumental in providing flexibility and convenience for students. However, our proposed system extends the advantages of mobile applications further by incorporating features like a Tutor Recommendation System, voice-based examinations, and an Accessibility Mode, making it a comprehensive and versatile tool tailored to the needs of visually impaired primary students.

The table below presents a summary of the comparative features between the novel system and existing system approaches:

Table 1: Research Gap

Research	Tutor recommendation	Online examination system	Accessibility mode in the UI design.	Mobile application
Research 1 [2]	✗	✓	✗	✗
Research 2 [3]	✗	✓	✗	✓
Research 3 [4]	✗	✓	✗	✗
Research 4 [5]	✗	✗	✗	✓
New Research	✓	✓	✓	✓

While existing research and systems have made valuable contributions to e-learning for visually impaired students, a research gap becomes evident when considering the combination of the aforementioned features. Our system bridges this gap by offering a holistic approach that combines tutor recommendation, voice-based examinations, accessibility features in UI design, and a mobile application. This synthesis of features results in a more effective and comprehensive solution that caters to the multifaceted needs of visually impaired primary students.

In conclusion, the comparative analysis demonstrates that our proposed e-learning system for visually impaired primary students stands out as a pioneering and inclusive solution. By integrating a Tutor Recommendation System, voice-based examinations, an Accessibility Mode in UI design, and a mobile application, our system addresses critical gaps in existing approaches. This comprehensive approach recognizes the diverse needs of visually impaired students and strives to create an equitable and accessible e-learning

environment. As such, our research contributes significantly to the ongoing efforts to enhance educational opportunities for this demographic.

1.4 Research Problem

The progressive inclusion of disabled students into higher education represents a vital aspect of promoting inclusive growth and ensuring equal opportunities for all members of society.

The research problem is compounded by the growing enrollment of disabled students in universities and colleges, highlighting the pressing need to accommodate their unique learning requirements. In today's society, where equality for disabled students remains an unfulfilled promise, these individuals often miss opportunities for quality education and access to good job prospects. Such exclusion not only hampers their personal development but also perpetuates social inequality. This issue transcends legal obligations, as it represents a moral imperative and a matter of social justice, where equal opportunities and resources should be extended to all.

In the age of technology-enhanced education, this need extends to utilizing the ability of e-learning, a transformational device, to address the particular difficulties and differences experienced by disabled students. Although admirable efforts have been made to develop the physical accessibility of learning spaces, including the installation of elevators, ramps, and wheelchair access features, these measures have not closed the digital divide that still exists among impaired students.

Among the wide range of impairments, dyslexia and dyscalculia pose significant obstacles to higher education. Likewise, individuals with visual impairments encounter significant obstacles in accessing suitable technologies such as screen readers and magnifiers, essential tools for navigating e-content. This unequal access perpetuates a

disadvantageous gap, particularly affecting students with visual impairments, placing them in a more precarious position compared to their peers with other disabilities.

To address these challenges, there is a pressing need for a comprehensive approach that harnesses assistive technologies to mitigate the complexities of learning faced by disabled students. While assistive technologies have shown promise in granting disabled individuals access to e-learning materials, their efficacy remains inconsistent across different disabilities, and cost considerations pose a significant barrier. Notably, these technologies are not universally affordable, potentially excluding financially disadvantaged disabled students from their benefits.

Another critical dimension of this issue lies in the design of e-learning systems, which often neglect the specific needs and requirements of disabled students. To truly serve as disability-aware e-learning systems, these platforms must be developed with meticulous attention to inclusivity and personalization. Disabled students necessitate information in formats tailored to their unique requirements, emphasizing the crucial role of assistive and adaptive technologies. These technologies must be thoughtfully designed to ensure universal access to knowledge, transcending the limitations of disabilities and promoting equitable learning opportunities for all.

In essence, the research problem at hand revolves around the incomplete realization of inclusive e-learning environments that address the multifaceted needs of disabled students. Despite commendable efforts and some progress, the digital divide persists, and certain impairments, notably those affecting reading and math skills, continue to impede disabled students' access to higher education. This problem extends to the realm of assistive technologies, which, while offering promising solutions, have not proven universally effective and often come with financial barriers.

Furthermore, the design of e-learning systems lacks the requisite consideration for the diverse needs of disabled students, hindering their potential as true disability-aware platforms. We need to implement a fundamental change to the way we think about e-learning, one that prioritizes inclusion and customization. We can fill in the gaps that now

exist and ensure that everyone, regardless of their disability, has equal access to the richness of information available through e-learning by building adaptive solutions that cater to their particular requirements as disable learners.

1.5 Research Objectives

1.1.1 Main objective

The primary aim of this research is to introduce an innovative E-learning platform, specifically designed for visually impaired primary students, to bridge the educational gap and provide them with equal opportunities for learning and knowledge acquisition. In today's digital era, education has become increasingly reliant on technology, and it is imperative that students with visual impairments are not left behind. This comprehensive E-learning platform will be delivered through mobile applications, ensuring that educational content is not only accessible but also engaging and interactive for visually impaired students.

The significance of this main objective lies in its potential to empower visually impaired students, granting them the fundamental right to education and knowledge acquisition. By leveraging the capabilities of mobile applications, this platform aims to revolutionize the learning experience for visually impaired primary students, making it more inclusive and equitable.

A significant aspect of our research revolves around a critical focus: the personalized recommendation of an ideal tutor for each student. It's important to understand that every student possesses a unique knowledge level and specific requirements, primarily influenced by their individual disabilities. Leveraging this knowledge, we've developed a system that carefully matches each student with a tutor perfectly suited to their needs. Think of it as having a dedicated mentor accompany them on their educational journey.

In simpler terms, the core objective of our research is to ensure that visually impaired primary students receive an equitable education. We achieve this by harnessing the power of mobile applications to make learning enjoyable and accessible for these students. Furthermore, we are ensuring they have the ideal tutor to support them at every stage of their educational path. Ultimately, our goal is to provide them with the same opportunities and rights as any other student, ensuring they do not miss out on the educational experience they deserve.

1.1.2 Sub objectives

The first sub objective is to build a proper voice-based online examination for visually impaired students. This system should read the question that is displayed on the screen and obtain the student's response via voice commands. One of the key sub-objectives is to develop a robust voice-based online examination system tailored to the needs of visually impaired students. This innovative system will enable students to interact with the examination interface through voice commands, ensuring a seamless and accessible assessment process. The development of such a system is critical to eliminating the existing barriers that visually impaired students face during examinations.

Analyze student knowledge level based on exam marks also another sub objective in here. To enhance the learning process, it is essential to analyze the knowledge levels of visually impaired students based on their examination performance. This sub-objective involves implementing data analysis techniques to evaluate students' marks and determine their proficiency levels. By gaining insights into their knowledge levels, the platform can provide personalized educational resources and support.

The next sub objective is analyzing the knowledge level of student’s examination and recommend the appropriate tutor automatically. A pivotal aspect of this research is the recommendation system for tutors. By analyzing students' examination results and knowledge levels, the platform aims to automatically match them with the most suitable

tutors. This personalized approach ensures that visually impaired students receive tailored guidance and support, maximizing their learning potential.

The last sub objective is enabling the accessibility mode and include it in the UI design. Accessibility is at the core of this research. To cater to the specific needs of visually impaired students, an accessibility mode will be developed and seamlessly integrated into the user interface (UI) design of the mobile application. This mode will enhance the overall user experience, making it more intuitive and user-friendly for visually impaired students.

These sub-objectives collectively contribute to the main goal of creating an inclusive and effective E-learning platform for visually impaired primary students. By addressing the unique challenges, they face in education, this research aims to empower these students, ensuring that they not only receive equal educational opportunities but also thrive in their academic journeys. The innovative solutions proposed in these sub-objectives have the potential to reshape the landscape of education for visually impaired students, not only in Sri Lanka but also worldwide.

4. METHODOLOGY

4.1 Methodology

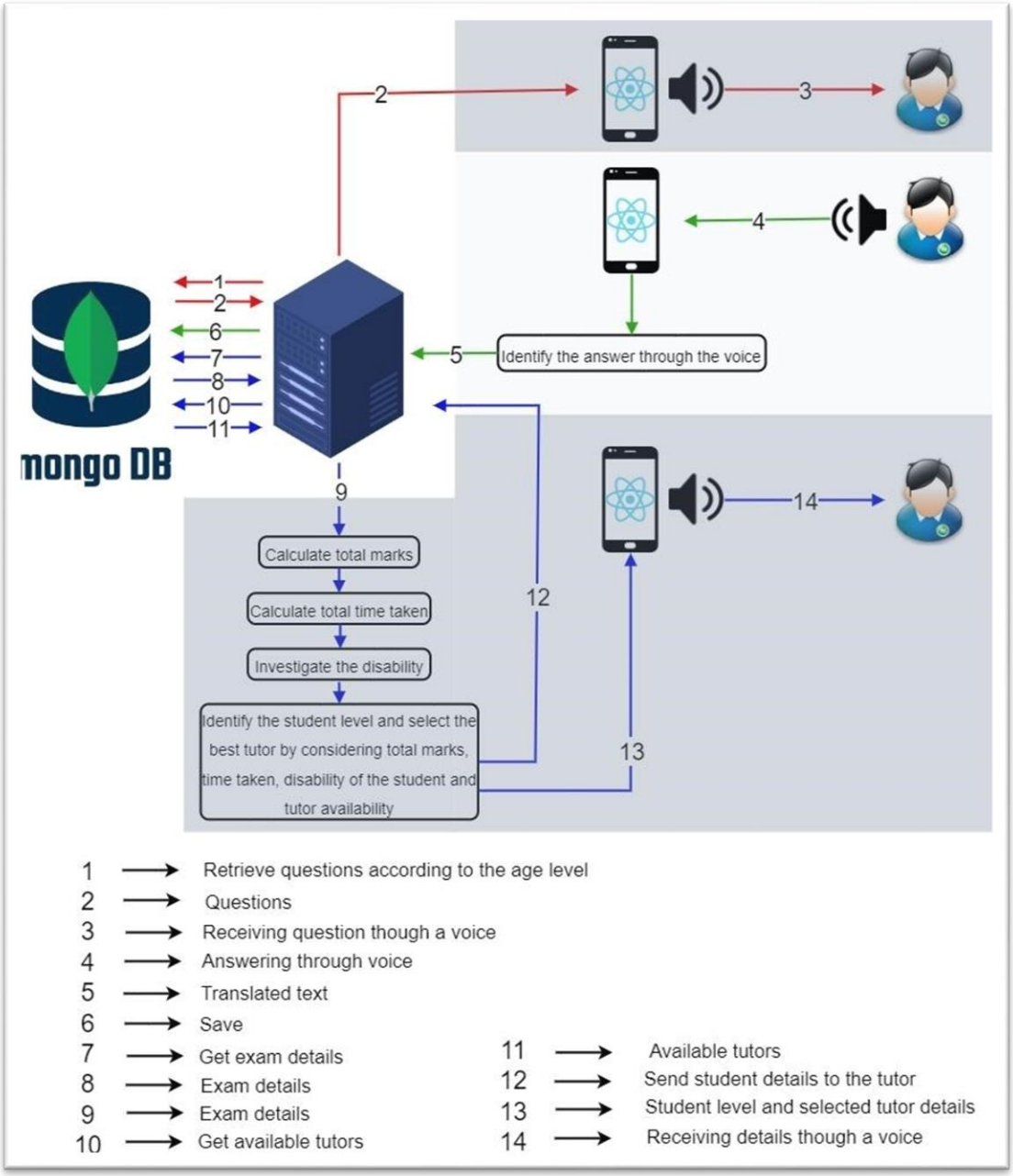

Figure 1: System Overview Diagram

The methodology for the proposed e-learning framework for visually disabled primary school student is organized around a cohesive process designed to give custom-made educational assets and specialized online tutoring. The framework leverages MongoDB for productive database administration and utilizes React Native for the advancement of a user-friendly mobile application and a desktop application for administrative tasks.

The methodology initiates with the student's login and registration process of the student. Once the student successfully logs in, their details are stored in the database, and they can proceed to select their preferred subjects to do the online voice-based examination. Subjects such as mathematics, environmental studies, and English are available for selection.

Then the student will navigate to the online voice-based examination. Based on the registered student's grade level, the framework retrieves subject-specific questions from the MongoDB database. These questions serve as the foundation for the subsequent online voice-based examination.

The method also commences with the administration module, available through the desktop application that has created by utilizing React. This module gives authorized administrators with the capability to create new questions, update questions, delete the questions, and search the questions by their names. The desktop application's interface ensures proficient administration and upkeep of the question bank, in this way guaranteeing the significance and accuracy of the educational content.

These questions are made available to the students through the React Native app, where voice commands are utilized to explore and respond to the online examination. The system's front-end converts the students' given answers into text format, which is in this way stored within the database for examination. The online examination incorporates an accessibility feature that allows students to activate contrast mode, customize font size, and adjust text spacing. These options are particularly significant for students with partial

visual impairments, enabling them to tailor their user experience to their specific needs and preferences.

Once the completion of the online exam, the server retrieves and processes the exam data from the database. it will retrieve the marks, total exam time, the number of questions attempted, and based on these factors, the system predicts and displays the knowledge level in the results page

After the results, the student will be notifying the relevant tutors who are suitable for the relevant knowledge level. Then the student can choose a tutor, The recommended tutor is then informed with relevant student data, and in case the tutor agrees to the assignment, tutoring sessions can commence. The React Native application is employed once again, this time facilitating communication between the student and mentor through the voice commands. This streamlined approach guarantees that visually disabled students get not only custom-made educational resources but moreover specialized mentoring, fostering their academic development and expanding their opportunities. Overall, the technique encompasses a well-defined arrangement of steps to offer a comprehensive and successful e-learning involvement for visually disabled primary school students.

4.1.1 Data collection

I collected data from the blind school in Ratmalana. There is a process to measure the knowledge level by holding various examinations. As they are disabled students, they need to measure their knowledge level from those examinations and see their progress of the students. With the assistance and guidance of the teachers at the school, I successfully collected data from these examinations. In total, I was able to compile and analyze data from 88 students.

4.2 Implementation & Testing

4.2.1 Implementation

To measure the knowledge level, A machine learning model was built. The model was trained using the dataset collected from the Blind School in Ratmalana, containing information such as subject, grade, marks, total time, number of questions, and knowledge levels.

Subject	Grade	Marks	Total_Time_Minutes	No_of_Question	Knowledge Level
Maths	1	45	12	5	Beginner
English	2	65	7	6	Intermediate
Environmental Studies	3	80	4	6	Advanced
Maths	2	55	9	5	Beginner
English	4	90	3	6	Advanced
Maths	1	40	10	5	Beginner
Environmental Studies	3	75	6	6	Intermediate
Maths	5	92	2	5	Advanced
English	1	48	10	6	Beginner
Maths	4	78	5	6	Intermediate
Environmental Studies	2	60	9	6	Beginner
English	3	70	7	6	Intermediate
Maths	2	47	13	5	Beginner
Environmental Studies	5	95	2	6	Advanced
English	1	52	10	6	Beginner
Maths	3	72	7	5	Intermediate
Environmental Studies	4	88	5	6	Intermediate
English	2	58	8	6	Intermediate
Maths	1	49	10	5	Beginner
Environmental Studies	3	82	4	6	Advanced

Figure 2: Raw Dataset

Import Pandas and Nampy libraries

Because of their strong capabilities for managing data and analysis within Python, I decided to use the Pandas and NumPy modules to handle and manipulate the dataset.

A widely used library called Pandas offers strong data structures like Data Frames that are perfect for tabular data like datasets. With Pandas, I was able to easily import the dataset, organize it, conduct data cleaning operations, deal with missing values, and filter or subset the data as necessary. I was able to rapidly examine and get the data ready for machine learning because of its functionally flexible and user-friendly interface.

On the other hand, NumPy is a crucial Python library for numerical computation. It supports a variety of mathematical functions and multi-dimensional arrays. NumPy was crucial for performing numerical calculations and data transformations for creating a machine learning model. It made effective use of statistical procedures, vectorized computations, and array manipulation—all essential elements of many machine learning applications.

When used together, I was able to quickly prepare and format the dataset for the machine learning model's training and evaluation because of the strong foundation provided by Pandas and NumPy

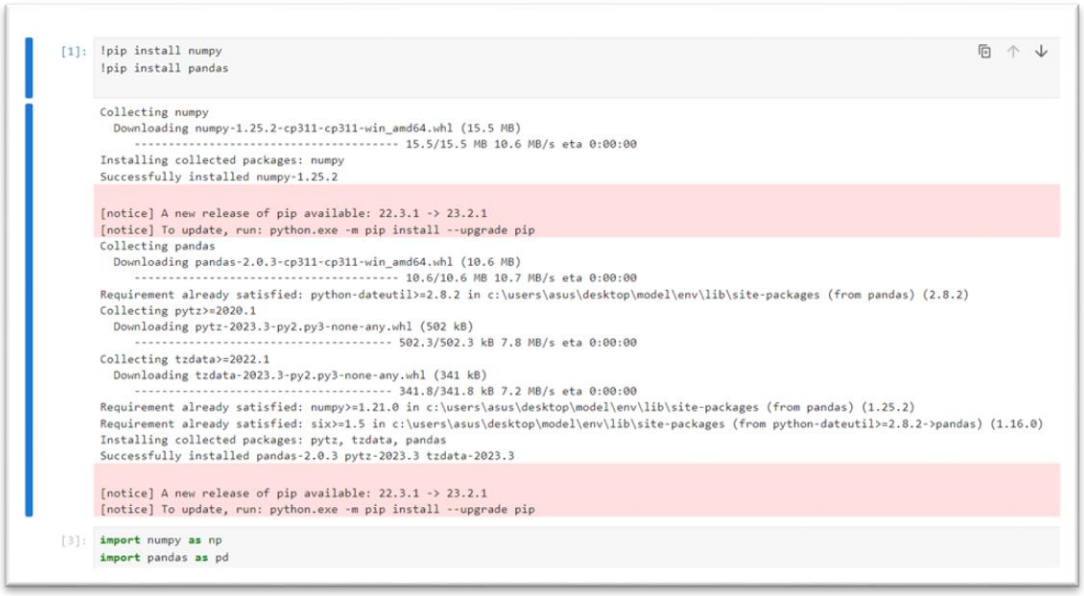

Figure 3: Import Panda and nampy libraries

Building the model

Firstly, the raw dataset was preprocessed. Unnecessary columns were removed and by using 1 hot n coding converted the all the data to numerical.

```
38]: data = pd.get_dummies(data)

39]: data.head()
```

39]:

	Grade	Marks	Total_Time_Minutes	No_of_Question	Subject_English	Subject_Environmental Studies	Subject_Maths	Knowledge Level_Advanced	Knowledge Level_Beginner	Knowledge Level_Intermediate
0	1	45	12	5	False	False	True	False	True	False
1	2	65	7	6	True	False	False	False	False	True
2	3	80	4	6	False	True	False	True	False	False
3	2	55	9	5	False	False	True	False	True	False
4	4	90	3	6	True	False	False	True	False	False

Figure 4: Dataset After One hot Encoding

The resulting dataset consisted of ten columns, including grade, marks, total time, number of questions, subject-specific columns (e.g., subject_english, subject_environmental studies, subject_maths), and knowledge level columns (knowledge level_advance, knowledge level_beginner, knowledge level_intermediate).

Selecting the Algorithm

In our exploration to find the best method for classifying data in this prediction, we tested several classification algorithms. Since this was a classification process, relevant multiple algorithms such as Lasso, Decision Tree Regressor, and Random Forest were tried to determine the algorithm with the highest accuracy percentage.

```
[46]: def model_acc(model):
          model.fit(X_train,Y_train)
          acc = model.score(X_test, Y_test)
          print(str(model)+'-->' +str(acc))

[53]: from sklearn.linear_model import Lasso
      lasso = Lasso()
      model_acc(lasso)

      from sklearn.tree import DecisionTreeRegressor
      dt = DecisionTreeRegressor()
      model_acc(dt)

      from sklearn.ensemble import RandomForestRegressor
      rf = RandomForestRegressor()
      model_acc(rf)

      Lasso()-->0.36123848477501364
      DecisionTreeRegressor()-->0.29487179487179466
      RandomForestRegressor()-->0.6685396011396011
```

Figure 5: Selecting the most suitable Algorithm

After thorough testing, the Random Forest algorithm stood out as the top performer. It achieved the highest level of accuracy in our model evaluation. What makes Random Forest special is its ability to handle complex datasets and prevent overfitting. This is important for our task, which involves categorizing data accurately.

To enhance the performance of our Random Forest model, we conducted the hyper parameter tuning, resulting in a notable accuracy rate of 74.9%. Parameter tuning involves optimizing the model's settings to maximize its effectiveness.

```
[56]: from sklearn.model_selection import GridSearchCV

      parameters = {'n_estimators': [100, 200, 300, 400, 500],
                    'criterion': ['squared_error', 'absolute_error', 'poisson']}

      grid_obj = GridSearchCV(estimator=rf, param_grid=parameters)

      grid_fit = grid_obj.fit(X_train,Y_train)

      best_model = grid_fit.best_estimator_
      best_model

[56]: RandomForestRegressor
      RandomForestRegressor(criterion='absolute_error', n_estimators=500)

[57]: best_model.score(X_test,Y_test)

[57]: 0.7492875925925926
```

Figure 6: Hyper Parameter Tuning

To facilitate practical application, we encapsulated the potent Random Forest algorithm within a pickle file. This file simplifies the process of applying the model to new data, ensuring swift and consistent predictions.

In summary, our selection of the Random Forest algorithm stems from its proficiency in handling complex tasks, its ability to prevent overfitting, and its capacity to deliver highly accurate results following fine-tuning. This decision plays a pivotal role in the development of a dependable system for effectively classifying knowledge levels among visually impaired primary school students.

Once checked the prediction by giving relevant inputs, The desired output was generated as an array. The highest value was considered as the knowledge level of the student. Then the ML model was deployed to an API.

Deploy server to API

The integration of a machine learning model deployed as an API with the React Native application. This integration facilitates the assessment of knowledge levels among visually impaired primary school students, a cornerstone of personalized education. It initiates a POST request to the API, imitating knowledge level assessments for visually impaired primary school students using input parameters. Subsequently, it retrieves and showcases the first three knowledge level values from the API response within the mobile application's user interface, enabling customized and accessible educational experiences for students.

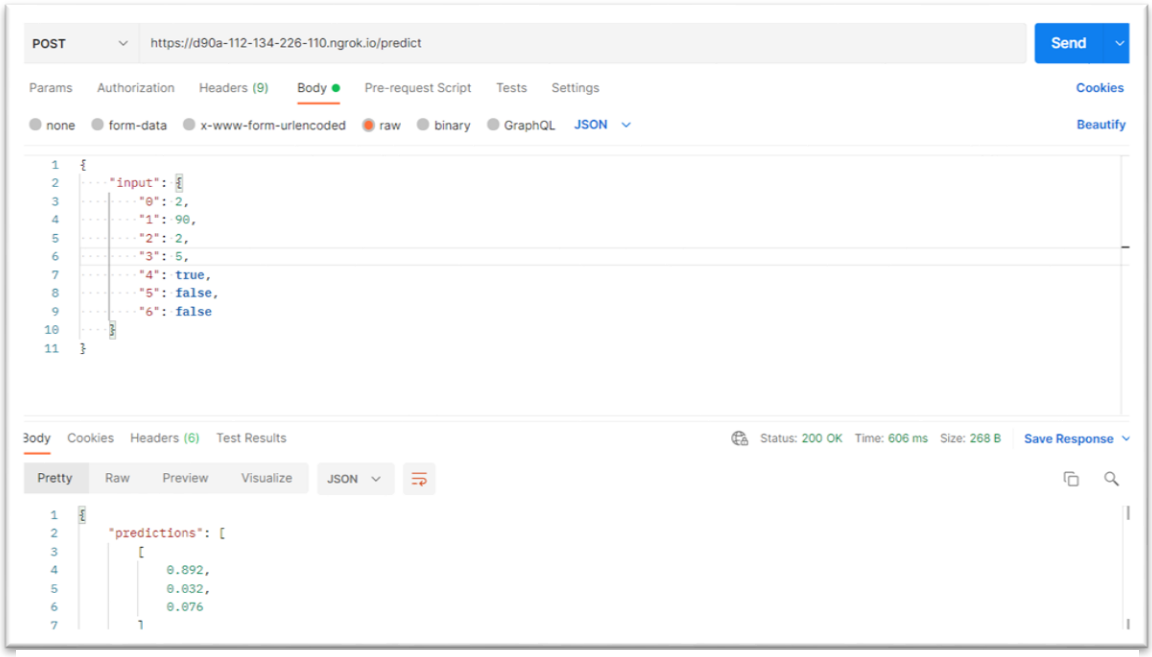

Figure 7: Deploy ML Model to an API

The deployment of the machine learning (ML) model to an API in the context of this e-learning system for visually impaired primary school students holds significant importance. This step bridges the gap between a complex ML model and the user-friendly React Native mobile application, facilitating seamless communication and interaction. The API acts as an intermediary, allowing the ML model to run on remote servers, reducing the burden on users' devices. This guarantees that the system is capable of

handling an increasing user base without compromising performance. Additionally, the ML model may be updated and improved on the server side, making maintenance easier.

Then the real-time knowledge level was predicted and displayed on the results page based on the exam performance such as marks, total time the student spent in the exam, number of questions.

Deployment of server to Heroku

The e-learning system's deployment process involves hosting the server on the Heroku cloud platform, a pivotal step in ensuring its accessibility and reach. By deploying the server to Heroku, the system becomes globally accessible, allowing users from diverse geographical locations and IP addresses to connect seamlessly. This process involves configuring the application, establishing it on the Heroku platform, and making it available through a unique web address.

The deployment of the server to the Heroku cloud platform holds profound significance within the methodology. To ensure that primary visually impaired children, their teachers, parents, guardians, and organizations supporting the visually impaired community may use the e-learning system from any location in the globe, it acts as a bridge that crosses geographical borders.

This inclusiveness is in line with the methodology's main objective, which is to give visually impaired primary pupils access to a thorough and convenient online learning environment. The method enables visually impaired students to access educational materials and support, independent of their actual location, by removing geographic boundaries.

This democratization of access fosters a more equitable learning environment and extends the system's impact beyond local boundaries, ultimately contributing to the academic development of visually impaired students on a global scale.

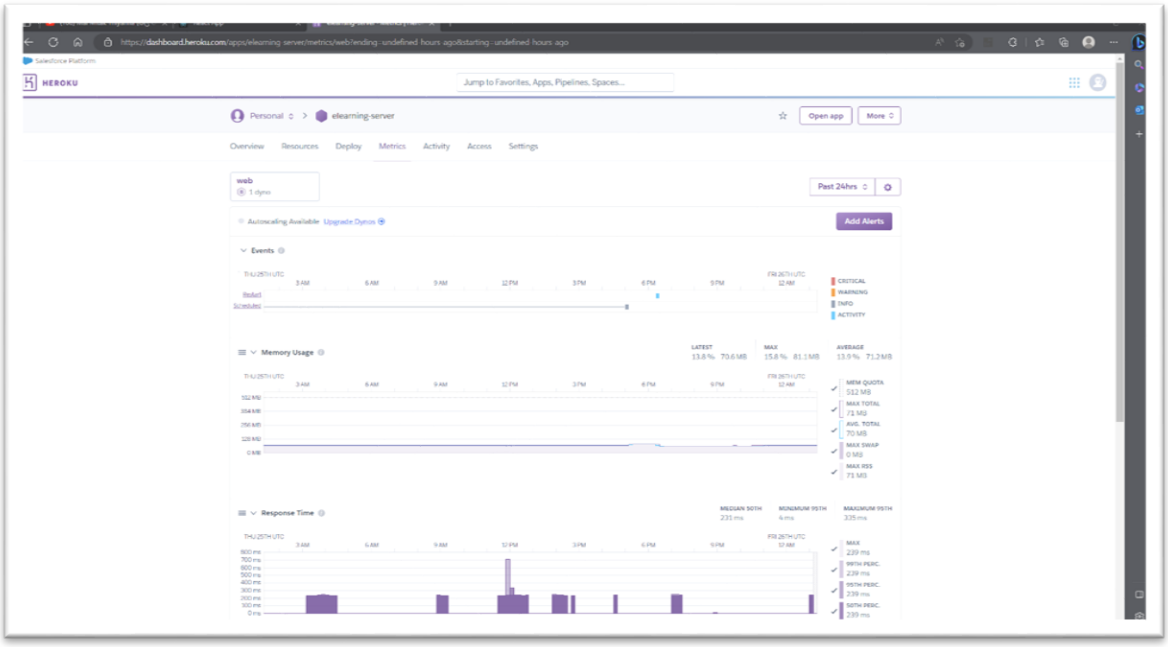

Figure 8:Deployment of server to Heroku

2.2.2. Testing

To evaluate our app's usability and impact with visually impaired students, we conducted a physical survey at Ratmalana Blind School, involving ten primary students. Our objective was to collect in-depth insights and valuable feedback for the purpose of improving our application.

The following test cases also display the test results for the functionalities.

Admin module Testing

Table 2: Admin module Testing 1

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Add Questions	1.Launch the Questions page 2.Click on the (+) button which is in the top of the screen 3.Navigate to the Add new Questions page 4. Fill in the relevant fields (Question, Option 1, Option 2, Option 3, Answer, select subject, select grade) 5.Click on the Save button	1. Navigate to the Questions page 2.An alert message should be displayed as "Successfully added" 3. The added question should be displayed in the top of the questions list. 4. The Delete and Edit button should be displayed with the question	1. Navigated to the Questions page 2.An alert message was displayed as "Successfully added" 3. The added question was displayed in the top of the questions list. 4. The Delete and Edit button were displayed with the question	**Pass**

Table 3: Admin module Testing 2

Test Case ID	**Test Scenario**	**Test Steps**	**Expected Result**	**Actual output**	**Status**
TC002	Edit Questions	1.Launch the Questions page 2.Click on the Edit button which is with the relevant question 3.Navigate to the Edit Questions page 4.Edit the required field 4. Click on the “Save changes” button	1. Navigate to the Questions page 2.The fields (Question, Option 1, Option 2, Option 3, Answer, select subject, select grade) should be automatically filled with the relevant inputs. 3.An alert message should be displayed as “Successfully updated” 3. The updated question should be displayed with the updated inputs. 4. The Delete and Edit button should be displayed with the question	1. Navigated to the Questions page 2.The fields (Question, Option 1, Option 2, Option 3, Answer, select subject, select grade) were automatically filled with the relevant inputs. 3.An alert message was displayed as “Successfully updated” 3. The updated question was displayed with the updated inputs. 4. The Delete and Edit buttons were displayed with the question	**Pass**

Table 4: : Admin module Testing 3

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC003	Delete Questions	1.Launch the Questions page 2. Click on the Delete button associated with the relevant question 3.Click on the Yes option in the alert message	1An alert message should be displayed as “Are you sure do you want to delete?” 2.The alert message should be contained 2 options as “Yes” and “No” 3. If the admin clicks on ‘Yes’ option the question should be deleted. 4. If the admin clicks on ‘No’ option the question should not be deleted.	1An alert message was displayed as “Are you sure do you want to delete?” 2.The alert message was contained 2 options as “Yes” and “No” 3. When the admin clicks on ‘Yes’ option the question was deleted. 4. When the admin clicks on ‘No’ option the question was not deleted.	**Pass**

Table 5: : Admin module Testing 4

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC004	Search Questions	1.Launch the Questions page 2.Search field should be available at the top of the page 3.The question should be search by the Question's name	1. The searched questions should be filtered and displayed in the questions list. 2.If the admin gives an unavailable question name, a message should be displayed as no search results found	1. The searched questions were filtered and displayed in the questions list. 2.When the admin gave an unavailable question name, a message was displayed as no search results found	**Pass**

I. Activating the screen reader Testing

Table 6: Activating the Screen Reader Testing

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Activating the screen reader	1.Launch the Subject page. 2.Touch the screen once 3.Touch the screen twice	1.When the user clicks on the screen once the screen reader should be activated 2.When the user clicks on the screen twice the screen reader should be repeating the same thing	1.When the user clicks on the screen once the screen reader was activated 2.When the user clicks on the screen twice the screen reader was repeating the same thing	**Pass**

II. Accessibility mode Testing

Table 7: Accessibility mode Testing 1

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Enabling the Contrast mode	1.Launch the Exam page 2.Click on the accessibility icon 3.Click on the Contrast Mode	1.The background of the question should be changed to black color 2.The text of the question should be changed to white color 3.If the user again clicks on the Contrast Mode the changes should be disappeared.	1. The background of the question changed to black color 2.The text of the question changed to white color 3.If the user again clicked on the Contrast Mode the changes were disappeared.	**Pass**

Table 8: Accessibility mode Testing 2

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC002	Change the text size	1.Launch the Exam page 2.Click on the accessibility icon 3.Click on the Increase Text Size	The size of the text should increase when the user clicks on the 'Increase Text Size' button.	The size of the text increased when the user clicked on the 'Increase Text Size' button.	**Pass**

Table 9: Accessibility mode Testing 3

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC003	Change the text space	1.Launch the Exam page 2.Click on the accessibility icon 3.Click on the Increase text Spacing	The size of the text space should increase when the user clicks on the 'Increase Text Spacing button.	The size of the text space increased when the user clicked on the 'Increase Text Spacing button.	**Pass**

III. Online voice-based examination Testing

Table 10: Online voice-based examination Testing1

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Selecting the subject for the exam	1.Launch the Subject page 2.Touch the screen once 3.Listen to the voice commands 4. Select the subject according to the voice-based guidelines. 5.Click on the 'Get the Exam' button using support of the voice commands	1.The voice commands should be activated 2.The required subject can be selected with the support of voice-based guidelines. 3.The screen reader should be telling the selected subject. 4. The screen reader should be telling to "click on the Get the Exam button which is in the bottom of the page". 5.It should be navigated to the online voice-based examination page	1.The voice command was activated 2.The required subject could be selected with the support of voice-based guidelines. 3.The screen reader told the selected subject. 4. The screen reader told to "click on the Get the Exam button which is in the bottom of the page". 5.It was navigated to the online voice-based examination page	**Pass**

Table 11: Online voice-based examination Testing2

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC002	Getting the online examination	1.Launch the Exam page 2.Touch the screen once 3.Listen to the voice commands 4.Give the answer as a voice input 5.Click on the 'Save & Next' button using support of the voice commands	1.The first question should be displayed according to the relevant subject and the grade. 2.The voice commands should be activated 3.Once gave the answer, the screen reader should be activated again and should be telling 'your answer is K and click on the save & next button which is in the bottom of the page to navigate to the next question' 4.It should be navigated to next question 5. The screen reader should be telling 'your answer is saved' 6.At the last question the screen reader should be telling	1.The first question displayed according to the relevant subject and the grade. 2.The voice commands were activated 3.Once gave the answer, the screen reader was activated again and told 'your answer is K and click on the save & next button which is in the bottom of the page to navigate to the next question' 4.It was navigated to next question 5. The screen reader told 'your answer is saved' 6.At the last question the screen reader told	**Pass**

			‘Congratulations! the exam is finished’ 7.The timer should be activated during the whole exam	‘Congratulations ! the exam is finished’ 7.The timer activated during the whole exam	

IV. Results

Table 12: Results Testing1

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Predicting the Advance knowledge level.	1.Launch the Results page after completing the exam.	1. Marks should be displayed as 100 2.Time taken should be displayed as 10 s 3.Total number of questions should be displayed as 3 4.The knowledge level should be displayed as Advance	1. Marks were displayed as 100 2.Time taken was displayed as 10 s 3.Total number of questions displayed as 3 4.The knowledge level displayed as Advance	**Pass**

Table 13: Results Testing 2

Test Case ID	Test Scenario	Test Steps	Expected Result	Actual output	Status
TC001	Predicting the Intermediate knowledge level.	1.Launch the Results page after completing the exam.	1. Marks should be displayed as 67 2.Time taken should be displayed as 12 s 3.Total number of questions should be displayed as 3 4.The knowledge level should be displayed as Intermediate	1. Marks displayed as 67 2.Time taken displayed as 12 s 3.Total number of questions displayed as 3 4.The knowledge level displayed as Intermediate	**Pass**

4.3 Commercialization

The need for specific e-learning platforms designed to satisfy the particular requirements of visually impaired primary school pupils is expanding in the field of education. These solutions serve not just conventional primary schools but also online learning platforms and special education institutes.

The primary audience for such e-learning platforms comprises the visually impaired schoolchildren themselves, their dedicated teachers, and their caring parents or guardians.

What sets these e-learning systems apart is their unwavering commitment to accessibility. They are thoughtfully designed to empower visually impaired students by incorporating a range of features specifically crafted to enhance their learning experience. These features include audio explanations to aid comprehension, a high Contrast Mode for improved readability, text-to-speech functionality to convert text into spoken words, and a magnified mode for closer examination of content. These accessibility features are pivotal in ensuring that visually impaired students can engage with educational materials effectively.

However, the impact of these e-learning systems extends beyond the students themselves. Recognizing the importance of a holistic approach to education, these platforms also place a significant focus on teachers and parents or guardians. Teachers play a vital role in guiding and supporting the academic journey of visually impaired students, while parents or guardians offer crucial encouragement and reinforcement of learning outside the classroom.

In essence, the target market and audience for e-learning systems tailored to visually impaired elementary students encompass the entire visually impaired community. This includes primary schools dedicated to their education, the students who strive for knowledge and growth, educators who champion their learning, and the parents, guardians, and organizations that collectively contribute to the betterment of visually impaired society. These e-learning systems serve as a beacon of inclusivity and empowerment, fostering a brighter future for visually impaired students and enriching the entire community.

5. SOFTWARE SPECIFICATIONS, RESEARCH REVIEW OR DESIGN COMPONENTS

3.1 Software Solution

Agile project management is a dynamic and adaptive approach initially designed for software development but now embraced across various industries. At its core, Agile places paramount importance on flexibility, collaboration, and ensuring customer satisfaction. It operates under the fundamental principle of valuing people and their interactions over rigid processes and tools. This philosophy underscores the significance of effective communication and teamwork in Agile projects.

A hallmark of Agile is its commitment to delivering tangible results swiftly and consistently. This is achieved through rapid prototyping and continuous feedback loops, enabling project teams to promptly adjust to evolving requirements while upholding the standard of producing high-quality products or services. Agile's work structure typically involves breaking down projects into manageable components and working on them in short, well-defined iterations referred to as sprints. This iterative approach ensures that teams provide incremental value throughout the project's lifecycle.

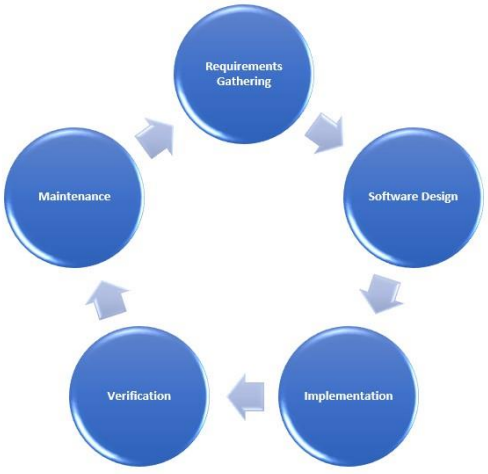

Figure 9: Agile Methodology

The Agile Manifesto encapsulates the core values and principles that guide Agile management practices. These principles include:

1. Individuals and Interactions over Processes and Tools: Agile recognizes that the success of a project hinges on the collaboration and synergy of team members. Emphasizing human connections and teamwork fosters a conducive environment for innovation and problem-solving.

2. Working Software over Comprehensive Documentation:While documentation is important, Agile prioritizes delivering functional software or tangible outcomes. This approach ensures that the end product meets the customer's needs effectively.

3. Customer Collaboration over Contract Negotiation: Agile values ongoing engagement with customers or stakeholders. Instead of adhering to rigid contracts, Agile encourages open dialogue and collaboration to better understand and meet evolving requirements.

4. Responding to Change over Following a Plan: Agile acknowledges that change is inevitable. Rather than adhering strictly to an initial plan, Agile projects remain adaptable and responsive to changing circumstances, customer feedback, and emerging priorities.

In an Agile project, the journey begins with Requirement Gathering, where the focus is on understanding the customer's needs and expectations. This iterative process allows for continuous refinement of requirements as new insights emerge. Next comes Software Design, where Agile teams create flexible, adaptable design structures that can accommodate changes as the project progresses.

The heart of Agile lies in Implementation, where development teams work in short iterations or sprints to build and deliver increments of the project. The emphasis here is on producing a working product that can be demonstrated to stakeholders.

Verification in Agile entails rigorous testing and validation to ensure that the software meets quality standards and customer requirements. However, Agile doesn't stop there; it encourages continuous feedback and adjustments.

Lastly, Maintenance is an ongoing process in Agile. Instead of treating maintenance as an afterthought, Agile teams proactively address issues, incorporate enhancements, and adapt to changing needs to ensure the product remains valuable and relevant.

In essence, Agile project management is a customer-centric and iterative approach that thrives on adaptability, collaboration, and a relentless commitment to delivering value. Its principles enable teams to navigate complexity and uncertainty effectively, ensuring that projects stay on course and align with evolving needs and goals. This methodology's widespread adoption beyond software development attests to its effectiveness in helping teams deliver successful outcomes in an ever-evolving business landscape.

5.2 Tool and Technology

3.2.1. React Native

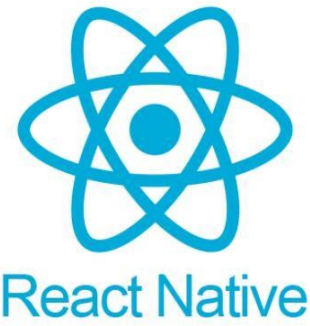

Figure 10: React Native logo

React Native was chosen as the core programming language primarily because of its cross-platform capabilities. Building a mobile application that accommodates visually impaired students necessitates compatibility across various devices and operating systems. React Native offers a compelling solution by enabling the development of a single codebase that can seamlessly run on both iOS and Android platforms. This ensures a consistent and accessible user experience, irrespective of the students' choice of devices.

Furthermore, React Native boasts robust support for accessibility features, a critical requirement for visually impaired users.For integrating crucial features like voice commands, screen readers, and adjustable font sizes and contrasts, it offers a complete range of tools and components. These elements are perfect for the project's goal of developing an inclusive online learning environment that is adapted to the requirements of students who are blind or visually impaired

3.2.2. Mongo dB

Due of its scalability and adaptability, MongoDB was chosen as the database solution. MongoDB's NoSQL architecture is well-suited to handle the diverse data structures and types associated with educational content and student records. This adaptability enables efficient storage and retrieval of data, encompassing everything from questions and student profiles to educational materials.

Furthermore, MongoDB's capacity to manage substantial datasets and scale horizontally positions it as an ideal choice for accommodating potential growth in the student population and educational resources. Its document-oriented data model simplifies data organization and retrieval, ensuring that the e-learning platform can efficiently deliver personalized content to each student.

Figure 11: Mongo db. logo

5.2.3 Visual Studio Code

Microsoft created Visual Studio Code, popularly known as VS Code, a source-code editor for Windows, Linux, and macOS that makes use of the Electron Framework. Among the features are debugging assistance, syntax highlighting, intelligent code completion, snippets, code refactoring, and integrated Git.

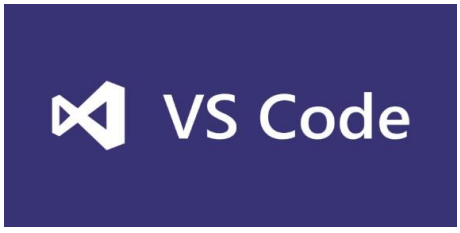

Figure 12: VS code logo

5.2.4 Jupyter Notebook

Due to its adaptability and interactive features, Jupyter Notebook worked as my main working environment for creating the machine learning model. Jupyter Notebook is especially well-suited for data exploration and model creation since it allows seamless integration of code, documentation, and visualizations. Its capability to execute code iteratively enables real-time evaluation and prompt feedback, which are essential in the iterative process of model generation. Jupyter Notebook also supports a variety of computer languages, including Python, which is commonly used in the machine learning industry. This adaptability and interactivity gave me a flexible workspace where I was able to easily test out various methods, preprocess data, view the outcomes, and adjust model parameters.

Figure 13: Jupyter logo

5.2.5 Python

Python was chosen as a programming language for this study because to its adaptability, simplicity, and availability of many libraries and frameworks for different applications. Additionally, Python offers strong support for data analysis and machine learning, two crucial aspects of our research, particularly for developing the knowledge level prediction model. Overall, Python's adaptability and wide environment make it a good choice for building the E-learning platform.

Figure 14: Python logo

5.3 Functional Requirements

The functional requirements of the proposed mobile application for visually impaired primary students encompass a multifaceted approach to ensure a comprehensive and inclusive learning experience.

1. Cross-Platform Compatibility: The mobile application must be compatible with Android devices, specifically those running Android version 6.0 (Marshmallow) or higher. This choice is grounded in the widespread prevalence of Android devices in Sri Lanka, representing approximately 89% of the mobile operating system market. This ensures that a vast majority of potential users can access the application seamlessly.

2. Voice Recognition Technology: The application should incorporate advanced voice recognition technology to facilitate voice-based interactions between visually impaired students and the platform. This includes the ability to read out questions, capture and transcribe students' responses accurately, and enable voice-activated commands throughout the application.

3. Customized Knowledge Level Predict Algorithm: The "Customized Knowledge Level Prediction Algorithm" is a specialized machine learning model designed to cater to the unique needs of visually impaired primary students within the proposed e-learning platform. This algorithm serves as the backbone for assessing and predicting the knowledge levels of individual students, thereby facilitating a personalized and tailored educational experience.

The algorithm is built on machine learning principles, which involve the analysis of historical data from students with similar characteristics and learning patterns. Through a combination of data preprocessing, feature engineering, and model training, it identifies intricate patterns and relationships within the data, enabling it to make informed predictions regarding a student's knowledge level.

One of the key advantages of this algorithm is its adaptability and scalability. It continuously learns from new data inputs, refining its predictions over time to align with each student's evolving learning journey. As a result, it provides ongoing insights that empower educators and students alike to make informed decisions about curriculum adaptation and personalized support.

Ultimately, the "Customized Knowledge Level Prediction Algorithm" is a pivotal component of the e-learning platform, ensuring that visually impaired primary students receive precisely tailored educational content and support. It epitomizes the commitment to inclusivity and equitable educational opportunities, enabling these students to thrive academically and reach their full potential.

4. Accessibility Mode: An integral feature, the accessibility mode, should be seamlessly integrated into the application's user interface (UI). This mode will cater to the unique needs of visually impaired users, offering features such as high contrast, text-to-speech capabilities, adjustable font sizes, and voice-guided navigation, ensuring an inclusive and user-friendly experience.

5. Secure User Authentication: Robust security measures should be in place to safeguard user data and ensure secure user authentication. This includes password encryption, two-factor authentication (2FA) options, and stringent data protection protocols to guarantee the privacy and confidentiality of user information.

6. Interactive Learning Resources: The application should provide a diverse range of interactive learning resources, including audio explanations, tactile learning modules, and gamified content designed to engage and educate visually impaired students effectively.

7. Data Analytics Dashboard: A comprehensive data analytics dashboard should be accessible to administrators and educators. This dashboard will offer insights into students' performance, progress, and areas for improvement, allowing for informed decision-making and personalized support.

8. Offline Access: To accommodate users with limited internet connectivity, an offline access mode should be available, allowing students to download learning materials and assessments for offline use and later synchronization.

9. Regular Updates and Maintenance: The platform must undergo regular updates and maintenance to ensure optimal performance, security, and compatibility with evolving Android operating system versions and assistive technologies.

These functional requirements collectively shape the capabilities and features of the mobile application, guaranteeing a user-centric and accessible learning environment for visually impaired primary students.

5.4 Nonfunctional requirements

1. Usability: The application should be able to achieve user's required goals efficiently and effectively. And the application should have a user-friendly interface that is easy to navigate and understand.
2. Reliability: The application output accuracy should be error free, and the code should be bug free.so the translation output could be reliable.
3. Performance: The application should be able to respond to user requests quickly and efficiently, without lag or delays.
4. Security and privacy: The administrative application, the database should be protected from unauthorized access. And the interface should be protected from attacks. All passwords should be stored as a secure hash of the administrator password.
5. Scalability: The application should be able to handle a large number of users and requests without crashing or experiencing downtime.
6. Maintainability: The application should be designed in a way that makes it easy to maintain, update, and fix bugs over time.
7. Availability: The application should be able to access and play games at any given time.
8. Portability: The application should be able to run on multiple platforms and devices, without requiring major modifications or changes.
9. Social Integration: Integration with social media platforms and sharing functionalities should be considered, allowing users to easily share their achievements or learning progress with their peers.

These non-functional requirements collectively contribute to the development of a robust, reliable, and user-friendly e-learning platform that caters to the specific needs of visually impaired primary students while ensuring a secure and efficient user experience.

6. RESULTS AND DISCUSSION

6.1 Results

The research component that examined the tutor recommendation module has given us important knowledge about how well our system works. The prototype successfully matched qualified instructors with visually impaired students throughout our study, indicating the opportunity for our platform to dramatically enhance these students' educational experiences.

The system's ability to properly connect students with tutors based on their knowledge levels and particular limitations was one of the most significant achievements. The system's UIs were user-friendly, making it accessible and simple to use, according to users. The voice-based assessment tool has got praise for its accessibility and practicality.

Despite the positive nature of our findings, a few tutor-student mismatches were found. These difficulties show that the recommendation algorithm has to be improved. This will be fixed by optimizing the system's settings and algorithms to improve accuracy. We hope to make a number of platform improvements in the future. First, we want to increase its accessibility by creating an iOS version, ensuring a wider audience among students who are blind or visually impaired. Additionally, we want to offer premium features that might improve both students' and tutors' educational experiences. Additionally, we are considering implementing monitoring of individual growth. This function will enable us to monitor and assess each student's academic growth on a regular schedule, giving us insightful information about their learning process.

4.2 Discussion

The tutor recommendation module is a important component of our proposed E-learning platform for visually impaired primary students. This module addresses a critical need by ensuring that students receive personalized and tailored guidance throughout their educational journey.

One of the key objectives of this module is to provide visually impaired students with individualized tutoring based on their specific knowledge levels and limitations. In contrast to traditional one-size-fits-all approaches, our system assesses students' exam marks, levels of knowledge, and individual requirements before choosing the appropriate instructor. This personalized approach is vital in ensuring that students receive targeted support, allowing them to enhance their knowledge effectively.

Visual impairment comes with its set of challenges, which can vary significantly among students. Some students may have partial blindness, color blindness, or other specific disabilities that impact their learning experience. The tutor recommendation module takes these challenges into account when suggesting tutors. It ensures that the selected tutor possesses expertise in teaching methods tailored to specific disabilities, thus providing students with the support they need to overcome their unique obstacles.

Accessibility is a cornerstone of our E-learning platform. By recommending tutors who are well-versed in accessible teaching techniques, we aim to make educational content more readily available to visually impaired students. Tutors recommended through this module will have the knowledge and skills necessary to deliver content effectively through audio, tactile, or other accessible formats, further enhancing the accessibility of our platform.

We eliminate the educational gap and ensure that visually impaired students have the same possibilities as their sighted colleagues by pairing students with tutors who are aware of their unique requirements. This inclusivity extends beyond academic content,

encompassing emotional support and motivation from experienced tutors who understand the challenges of visual impairment.

The tutor recommendation module aligns seamlessly with our research objectives. It plays a central role in creating an inclusive and effective E-learning platform for visually impaired primary students. By addressing the unique challenges these students face, our research aims to empower them with equal educational opportunities. The tutor recommendation module is a vital component in achieving this goal.

In conclusion, the tutor recommendation module represents a significant stride toward achieving our research objectives.

7. CONCLUSION

In conclusion, the proposed E-learning platform for visually impaired primary students represents a significant stride toward inclusive and equitable education in the digital age. This innovative platform, designed as a mobile application, has been meticulously developed to cater to the unique requirements of visually impaired students, offering them not just access to educational content but also a personalized and engaging learning experience.

The research objectives, outlined in detail, underscore the platform's commitment to providing students with the support they need, from a tailored tutor recommendation system to a voice-based online examination system. By analyzing students' knowledge levels and disabilities, the platform ensures that each student receives the guidance that best aligns with their individual learning journey.

Moreover, the non-functional requirements emphasize the importance of usability, reliability, performance, security, and scalability. These elements collectively contribute to the platform's robustness, ensuring an accessible, efficient, and secure learning environment for all users.

The significance of this research and the resulting platform extends beyond the digital realm. It addresses a fundamental issue of unequal access to education faced by visually impaired students in Sri Lanka and, by extension, globally. By providing an inclusive and accessible platform, we are not only bridging the educational gap but also promoting equal opportunities for these students.

In essence, this research and the E-learning platform it introduces aim to empower visually impaired primary students, granting them their rightful place in the educational landscape. It is a step toward a brighter, more inclusive future, where education knows no boundaries and where every student, regardless of their visual impairment, can access knowledge, engage with learning, and unlock their full potential.

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Turnitin Report

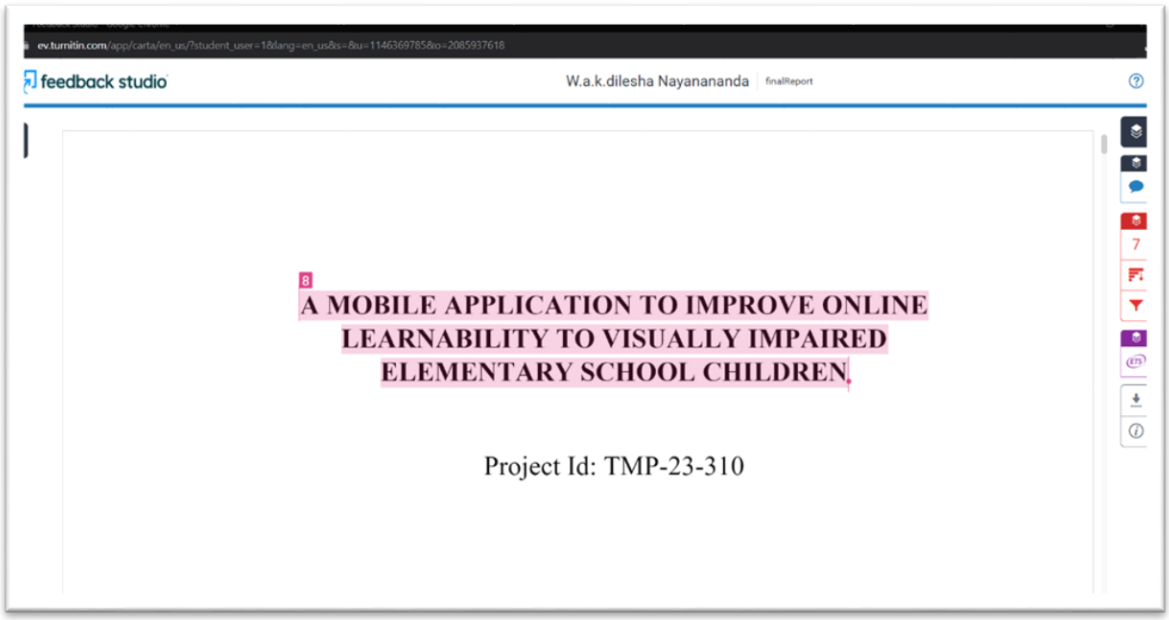

Figure 15: Turnitin Report