

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

Project Id: TMP-23-310

Project Final Report

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BSc (Hons) in Information Technology Specializing in Information
Technology

Department of Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

September 8th

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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.

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

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Signature of the supervisor:

.....

Date:

.....

Signature of the co-supervisor:

.....

Date:

Abstract

In the digital age, many students with visual impairments face challenges in accessing course materials like their classmates. Online learning can be a powerful tool for students with disabilities, especially the visually impaired. We will discuss the importance of making online learning accessible to visually impaired students and the ways in which it can be achieved. We intend to help vision-impaired primary students overcome the difficulty of learning subjects in the primary stream. It is a smart mobile device application that they can use to learn and improve their knowledge. The application includes a multilingual language supportive voice, tutor recommendation module based on the student's knowledge level, virtual tutor and voice calculator, brain improvement gaming module, and supportive voice bot. As my part, I will be developing the games for visually impaired elementary students that will help them to improvement their knowledge. Their capacity to develop socially and academically is limited by the lack of accessibility since they might not be able to experience the same advantages of gaming as their sighted friends. This study explores the viability of creating a mobile game that is usable by visually impaired elementary children, the difficulties involved in such creation, and the possible advantages of such a game for these kids. There are three types of games.

The first one is identifying the sounds of animals. In this game, players are exposed to different animal sounds and challenged to identify the correct animal. This game enhances learning knowledge in children and facilitating development. The game of recognizing the sounds of animals not only improves knowledge but also helps to fine-tune their hearing skills, which is often elevated in visually impaired children. The second one is synonyms game. Synonyms games are an interesting and interactive way to improve vocabulary skills. It is a game that involves matching words with their synonyms, which are words that have similar meanings. This game is not only fun but also an educational tool that can increase one's understanding of the English language. Third one is Fun Spelling Game. Fun spelling games can enhance a visually impaired elementary child's spelling ability, vocabulary, and memory retention.

Keywords: visual impairment, online learning, accessibility, mobile application, primary students, tutor recommendation, virtual tutor, voice calculator, brain improvement, gaming module.

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.

I would also like to thank Nayananda W.A.K.D, Sathsarani B.A.D.A, and Dias S.T.D from my group. Their joint efforts, devotion, and collaboration all contributed considerably to the successful completion of this project. Their intelligent conversations and helpful suggestions have enriched the overall findings of our study. Furthermore, I would like to appreciate and convey my gratitude to everyone who has helped me in various ways. Their aid with data gathering, technical advice, and editing has been beneficial. I appreciate their readiness to assist and their enthusiasm in the relevance of this research.

I am also grateful to the academic staff and research researchers who gave useful feedback, ideas, and recommendations during the project. Their helpful critique and intellectual contributions significantly improved the research's quality and rigor. and I want to thank my family and friends for their constant support, understanding, and motivation during this journey. Their love, support, and faith in my skills have been as a continual source of strength and inspiration for me.

Finally, I want to express my heartfelt gratitude to everyone who has contributed in any way, large or small, to making this study a reality. Your contributions have been priceless, and I am grateful for the opportunity to work with such wonderful people.

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List Of Abbreviations

UI: User Interface

GUI: Graphical User Interface

UX: User Experience

HCI: Human-Computer Interaction

LMS: Learning Management System

Edu Sense: The name of the educational application

RFID: Radio-Frequency Identification

E-learning: Electronic Learning

ICT: Information and Communication Technology

1. Introduction

In an era where technology has the potential to break down barriers and empower individuals, we embark on a journey to create a meaningful and inclusive experience for visually impaired individuals. The Edu Sense application's gaming modules represent an innovative approach to education and entertainment, tailored specifically to the needs and preferences of the visually impaired. These modules are not just games; they are pathways to learning, engagement, and empowerment.

Visual impairment should never be a barrier to accessing quality education and enjoyable entertainment. With this conviction, we have embarked on the development of gaming modules that harness the power of voice-based interaction and accessible design. This report chronicles the planning, design, development, and testing phases of the Edu Sense gaming modules, with a focus on the meticulous processes and considerations that underpin their creation.

Through a user-centered approach, we explore the essential facets of Requirement Analysis, ensuring that the modules are finely tuned to the diverse needs of our target audience. We delve into the intricacies of User Interface Design, emphasizing the importance of intuitive design and navigability through voice commands. The Database Design section showcases our commitment to efficient data management, enabling a seamless user experience.

In the Development phase, we breathe life into the gaming modules, from sourcing authentic animal sounds to compiling words and synonyms, all while integrating a robust voice recognition system. The Testing phase is our litmus test, where individual components, system integration, and real user feedback converge to shape the modules into what they are meant to be.

But our journey is not just about technology; it's about people. It's about empowering visually impaired individuals to learn, explore, and have fun in an inclusive digital environment. It's about making education and entertainment accessible to all, regardless of visual ability.

This report is a testament to our commitment to this vision. We invite you to delve into the intricate details of our development process, from planning and design to implementation and testing. It's a journey that reflects our dedication to inclusivity, innovation, and the profound belief that technology can transform lives.

1.1 Background Literature

Visually impaired elementary school children face unique challenges in their educational and recreational experiences, especially in the area of brain-enhancing games. The lack of high-quality, accessible games that suit the needs of visually impaired elementary students has drawn the attention of many academics and innovators to conduct extensive research in this area.

One noteworthy study, titled "Toward designing mobile games for visually challenged children" [1], delves into the development of mobile learning games explicitly designed to enhance spatial skills and executive function in children with vision impairments. This research stands as a testament to the commitment to improving the learning experiences of visually impaired children through interactive technology. It involves the creation and testing of two audible mobile games, a concept that aligns with the direction of our research.

In a similar vein, the study titled "Mathematics for all: a Game-Based Learning Environment for Visually Impaired Students" [2] focuses on creating a brain improvement Mathematics mobile application tailored to the unique requirements of visually impaired students. The endeavor parallels our aspirations to develop brain improvement games for visually impaired elementary school children. This research underscores the critical role technology can play in enhancing the educational journey of visually impaired students.

A noteworthy contribution to the field is the research titled "Design and implementation of educational game considering issues for visually impaired people inclusion" [3]. This research not only injects entertainment into the educational process but also adopts a comprehensive approach by incorporating various audio-based systems into game development. One notable example, "EduGameAcces," not only emphasizes playability but also integrates educational aspects seamlessly into the gameplay experience. Additionally, the provision of audible guidelines ensures accessibility and usability for visually impaired students, aligning with our commitment to creating an inclusive gaming environment.

Furthermore, the study titled "Design, implementation, and evaluation of a mobile game for blind people: toward making mobile fun accessible to everyone" [3] spotlights an Android application developed for online games catering to visually impaired students. These games leverage audio concepts to provide an engaging and educational experience for players. This exemplifies how technology can be harnessed not only for entertainment but also for imparting valuable knowledge and skills to visually impaired individuals.

Intriguingly, the research paper "Egg Pair—A Hearing Game for the Visually Impaired People Using RFID" [4] introduces the concept of an RFID game known as "Egg Pair." In this game, participants manipulate eggs, triggering corresponding animal sounds through speakers. The challenge lies in remembering the location of each egg and its associated animal sound, encouraging cognitive development and memory skills. This study inspires our research, particularly in our use of animal sounds within our mobile game, offering an engaging and educational experience for visually impaired users.

1.2 Research Gap

As discussed above, a lot of current research and systems have been presented but it is still not possible to present a complete system with all the proposed features. But this proposed system is more effective and comprehensive.

This table shows a summery comparison feature of the proposed system and existing system approach.

Table 1 Research Gap

| Research | Brain improvement games | Voice base games | Accessibility mode in the UI design. | Mobile application |
|-----------------|--------------------------------|-------------------------|---|---------------------------|
| Research 1 [1] | ✗ | ✓ | ✗ | ✓ |
| Research 2 [2] | ✓ | ✓ | ✗ | ✗ |
| Research 3 [3] | ✓ | ✗ | ✓ | ✗ |
| Research 4 [4] | ✗ | ✗ | ✗ | ✓ |
| New Research | ✓ | ✓ | ✓ | ✓ |

2. Research Problem

The usage of mobile games as a tool for education and enjoyment is important to note. These games are getting more and more common among kids and young people. However, since the majority of these games were not created with accessibility in mind, primary school students who are blind or visually impaired should not play them. This may impede their capacity to engage in social interactions with their classmates and have an adverse effect on their entire educational experience.

Mobile games have also been demonstrated to enhance attention span, problem-solving abilities, and collaboration, making them useful tools for fostering cognitive and social growth. It could be able to provide visually impaired students with the same advantages and chances for development as their sighted friends by developing a mobile game that is particularly made for them.

The creation of such a game does present some difficulties, though. There could be technological constraints to take into account, such as compatibility with different assistive devices, and it might be challenging to develop a game that is both enjoyable and accessible. As a result, the purpose of this study is to examine these difficulties, pinpoint potential solutions, as well as to look into the viability and potential advantages of creating a mobile game that is usable by elementary students who are blind.

3. Research Objectives

3.1 Main Objective

Our overarching goal is to introduce a pioneering E-learning platform, harnessed through mobile applications, specifically tailored to the unique needs of visually impaired primary students. At the heart of this initiative lies our unwavering commitment to ensuring that every student, regardless of their visual capabilities, is empowered with the fundamental right to access knowledge and equal educational opportunities. We aspire to break down barriers and illuminate the educational path for visually impaired students by crafting an E-learning platform that is not just accessible but also inherently engaging and interactive. Our mission is to ignite a passion for learning while fostering inclusivity among visually impaired students, providing them with the tools they need to excel academically and in life.

Within this ambitious endeavor, we have identified several key focal points that constitute the core of our mission. These include the development and integration of tutor recommendation modules, the introduction of virtual tutors and voice calculators, and the creation of immersive gaming modules facilitated through voice interactions. Additionally, we envision the implementation of a versatile voice bot, proficient in three languages: Sinhala, English, and Tamil. These components collectively form the foundation of our comprehensive E-learning platform, which is poised to not only enrich the educational experiences of visually impaired students but also empower them to explore the digital world with confidence and competence.

3.2 Sub Objective

Develop an Animal Sounds Identification Game: One of our key sub-objectives is the creation of an engaging game focused on identifying animal sounds. In this game, players will be immersed in an auditory world where they are exposed to a variety of animal sounds, each unique and intriguing. The challenge lies in correctly associating each sound with the corresponding animal. This not only offers entertainment but also serves as an educational tool, enhancing learning and cognitive development in children. By sharpening their ability to identify sounds, children can refine their auditory discrimination skills, contributing to their overall sensory development.

Create a Synonyms Matching Game: Vocabulary enrichment is a vital component of a well-rounded education. Our project includes the development of a captivating synonyms game. In this interactive game, players will be presented with words and tasked with matching them to their synonyms, words that share similar meanings. This game not only fosters vocabulary expansion but also enhances language comprehension in a fun and engaging manner. By making the learning process enjoyable, we aim to motivate students, including visually impaired learners, to actively explore and expand their language skills.

Design Fun Spelling Games: Spelling proficiency is a fundamental skill that forms the bedrock of effective communication. For visually impaired children, mastering spelling can present unique challenges. To address this, our project incorporates enjoyable spelling games designed to make learning fun and interactive. These games not only teach spelling but also keep young learners entertained. Through interactive spelling exercises, we aim to improve spelling skills, vocabulary, and memory retention in visually impaired elementary school children. This approach ensures that learning remains engaging and accessible, fostering a positive attitude towards language acquisition.

Implement Accessibility Mode in UI Design: Accessibility is at the heart of our project. To make our mobile application truly inclusive, we are dedicated to implementing an Accessibility Mode within our user interface (UI) design. This mode will cater specifically to the needs of visually impaired users, ensuring that our application is not only usable but also easy to navigate. Accessibility features may encompass High Contrast Mode, Text-to-Speech Mode, Speech Recognition, Magnified Mode, Double Tap, and Swipe Display (both left and right). These features aim to remove barriers and empower visually impaired users to interact with our platform seamlessly. By prioritizing accessibility, we are reinforcing our commitment to creating an inclusive digital environment where every student can thrive.

4. Methodology

In this research, we sought to design and develop the Edu Sense application tailored to assist visually impaired individuals in learning through interactive voice-based games. The application encompasses three distinct gaming modules: the Sound of Animals Game, the Fun Spelling Game, and the Synonyms Game. Each game leverages voice recognition technology to facilitate a rich interactive experience for the users.

- Sound of Animals Game

This module aims to help users identify different animals based on their sounds. In this game, the system plays various animal sounds, prompting users to identify the animal vocally. The spoken answer is then compared to the correct answer. Correct responses are acknowledged positively, while incorrect answers are met with constructive feedback, encouraging the users to try again. The goal is to foster a learning environment where users can familiarize themselves with different animal sounds progressively.

- Fun Spelling Game

The second module is designed to enhance the spelling skills of the users. Here, a word is vocalized through a speaker, and users are required to spell the word out loud. The voice recognition system transcribes the verbal spelling into text, comparing it with the correct spelling. Correct attempts are praised, and incorrect tries are met with encouragement and the correct spelling, nurturing a positive and educational environment where users can learn at their own pace.

- Synonyms Game

In the Synonyms Game, users are encouraged to find synonyms for the words played through the speaker. The objective here is to build the users' vocabulary by encouraging them to think of synonyms for various words. The answers, provided vocally, are compared to a list of correct synonyms, and feedback is provided accordingly, promoting an expansive understanding of words and their synonyms.

The foundation of the Edu Sense application is the voice recognition system that converts spoken answers into text, facilitating the comparison with the correct answers stored in the system's database. This technology ensures an accessible and interactive learning environment, allowing for a seamless user experience that caters to the needs of visually impaired individuals.

By integrating voice-recognition technology with an educational framework, the Edu Sense application aims to foster an inclusive learning environment. The application encourages learning through interaction, leveraging auditory cues to facilitate education for visually impaired individuals. Future steps in this research will involve refining the voice recognition system to accommodate a broader range of speech patterns and accents, promoting inclusivity and enhancing the learning experience for all users.

4.1 System diagram

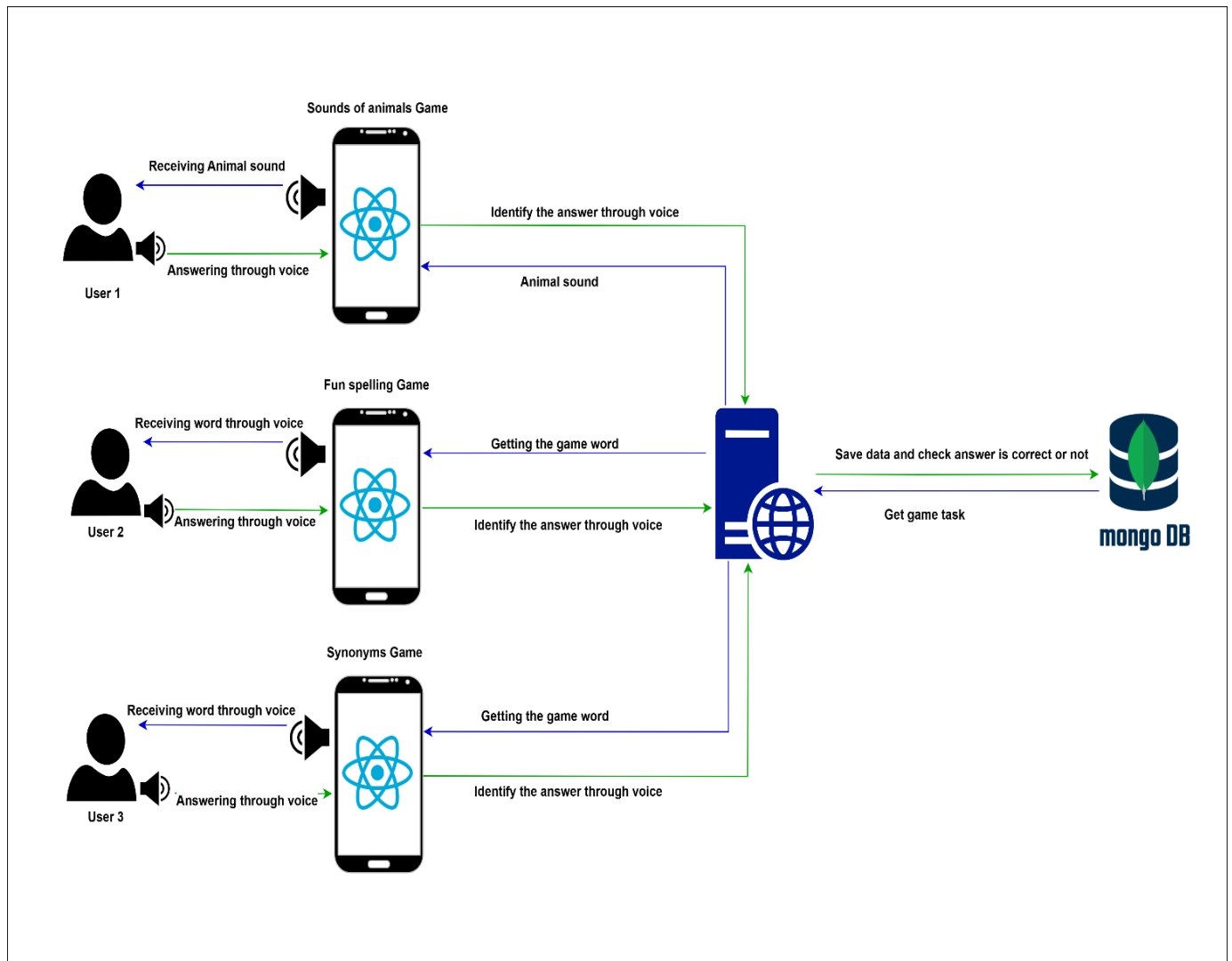


Figure 1 System diagram

Here, visually impaired users should select an Edu Sense application. Then the selected gaming module will display three games:

1. Sound of animal's game
2. Fun spelling game
3. Synonyms game

The animal sound game is a voice-based game where the system plays the sound of an animal, such as a lion's roar or a dog's bark, through a speaker. The user must then use their voice to answer which animal they think they heard. For example, the user might say "lion" or "dog" into a microphone after hearing the corresponding sound. After that spoken answer, compare it to the correct answer for the animal sound. If the user's answer matches the correct answer, the system will save the data and notify the user that they were correct. If the user's answer does not match the correct answer, the system will provide feedback indicating that their answer was incorrect.

The fun spelling game is a voice-based game where the system plays a word through a speaker. The user must then use their voice to spell the word out loud. For example, the system might play the word "sky", and the user would say "s-k-y" into a microphone. After that spoken answer, convert it into text. The system would then compare the user's spelling to the correct spelling of the word. If the user's spelling matches the correct spelling, the system will save the data and notify the user that they were correct. If the user's spelling does not match the correct spelling, the system will provide feedback indicating that their answer was incorrect and encourage the user to try again.

The synonyms game is a voice-based game where the system plays a word through a speaker or headphones. The user must then use their voice to provide a synonym for the word they just heard. For example, the system might play the word "happy", and the user could say "joyful" into a microphone. After that spoken answer, convert it into text. The system would then compare the user's answer to the correct synonym for the word. If the user's answer matches the correct synonym, the system will save the data and notify the user that they were correct. If the user's answer does not match the correct synonym, the system will provide feedback indicating that their answer was incorrect and encourage the user to try again.

4.2 Implementation

4.2.1 Phase 1: Planning and Design

- Requirement Analysis

User-Centered Approach

In the initial phase of planning and design, we adopt a user-centered approach to ensure that the Edu Sense application's gaming modules are tailored precisely to the needs of our visually impaired users. The Requirement Analysis stage is dedicated to gathering and defining the essential parameters that will drive the entire development process.

Target Users and Their Needs

Our first objective is to identify and understand our target users comprehensively. We segment our user base based on factors like age, educational background, and specific needs arising from visual impairment. This segmentation allows us to cater to the unique requirements of different user groups effectively.

Accessibility and Technical Requirements

To ensure a seamless user experience, we delve into the technical requirements. This includes identifying and acquiring the necessary hardware components like microphones and speakers. Additionally, we specify the software stack, focusing on voice recognition technology and other components vital for voice-based interactions.

- User Interface Design

Designing for Accessibility

Creating an inclusive and user-friendly interface for visually impaired users is central to the success of the Edu Sense gaming modules. The following key principles guide our User Interface (UI) design:

Intuitive Interface

Our UI design prioritizes simplicity and clarity. Visually impaired users should be able to easily understand and navigate the interface. We use high-contrast color schemes, large and legible fonts, and a logical layout to enhance usability.

Voice-Activated Navigation

One of our core design goals is to ensure that users can effortlessly interact with the interface through voice commands. From selecting games to making choices within games, every action is designed to be voice-navigable, creating a seamless and natural user experience.

Double Tap Gesture

The double tap gesture has been integrated as a simple and effective means for users to initiate gameplay within the modules. A double tap on the screen triggers the start of a game, making it an accessible way for users to begin their gaming experience.

Swipe Gesture for Answers

To provide users with the option to access answers or additional information, we've introduced the swipe gesture. By swiping across the screen, users can easily retrieve answers or seek clarification when needed. This gesture enhances the flexibility of the user experience, allowing users to progress at their own pace.

Clear Audio Feedback

The UI provides clear and concise audio feedback for all actions, including menu selections and game progress. This auditory feedback ensures that users receive real-time information about their interactions.

4.2.2Phase 2: Development

- Sound of Animals Game

For the Sound of Animals Game, the development process centers on providing an engaging and authentic audio experience for users. This involves:

Sound Sourcing: Sourcing authentic and high-quality animal sounds from reputable sources, ensuring accuracy and clarity.

Integration: Integrating these sounds into the system, ensuring seamless playback during gameplay.

Voice Interaction: Implementing voice recognition technology to allow users to respond verbally to animal sounds, comparing their responses to the correct answers.

- Fun Spelling Game

The development of the Fun Spelling Game focuses on creating an educational and enjoyable spelling challenge. Key steps include:

Word Compilation: Compiling a diverse list of words varying in difficulty levels, considering the educational needs and preferences of the target users.

Voice Input: Implementing voice recognition technology to enable users to spell words aloud. This input is then converted into text for comparison with correct spellings.

Feedback Mechanism: Designing a feedback system that provides immediate response, informing users whether their spelling is correct or not. This promotes learning and engagement.

- Synonyms Game

In the development of the Synonyms Game, the aim is to enrich users' vocabulary and language skills. This involves:

Word and Synonym Database: Building a robust database of words and their possible synonyms, ensuring a wide variety of word choices.

Voice Input and Recognition: Implementing voice input and recognition capabilities to allow users to provide synonyms verbally.

Comparison and Feedback: Developing a mechanism that compares user-provided synonyms to correct synonyms, delivering feedback on accuracy. This encourages users to expand their vocabulary.

4.2.3Phase 3: Testing

- Unit Testing

To ensure the reliability and correctness of our gaming modules, we initiate the testing phase with Unit Testing. This stage is dedicated to testing individual components in isolation. The key objectives include:

Component Validation: Thoroughly test each component, including the voice recognition system, sound library, word repository, and synonym database, to verify that they function correctly and as intended.

Error Identification: Identify and rectify any errors or bugs in the individual components. This stage aims to address issues at a granular level, ensuring that each piece of the system operates flawlessly.

- Integration Testing

Following successful Unit Testing, we proceed to Integration Testing, where we evaluate the interaction and compatibility of the components when they are integrated into the complete system. Key activities in this phase involve:

Component Integration: Combine the individual components, such as the voice recognition system and the game databases, to ensure that they work harmoniously together without conflicts or errors.

Data Flow Testing: Verify the seamless flow of data between components. This includes testing data transfer from the database to the gaming modules and vice versa.

Functionality Assessment: Evaluate the overall functionality of the gaming modules as a unified system. Ensure that user interactions and feedback mechanisms operate smoothly.

- User Testing

User Testing is a pivotal phase where we engage a diverse group of visually impaired individuals in Beta Testing. The objectives include:

User Feedback Collection: Invite a diverse group of visually impaired users to interact with the gaming modules and provide feedback on their experiences. This feedback encompasses usability, accessibility, and overall satisfaction.

Accessibility Evaluation: Assess the application's adherence to accessibility standards, seeking feedback on how well it caters to various learning needs and preferences.

Error Identification and Resolution: Identify any issues, including usability challenges, inaccuracies, or accessibility barriers, and take necessary corrective actions.

Usability Enhancements: Implement suggested improvements based on user feedback to enhance the overall user experience.

5. Software Specifications

5.1 Functional Requirements

Functional requirements are a crucial set of specifications that outline the specific actions and features a system or product must possess to effectively address the requirements and preferences of its users. In the context of designing mobile games for visually impaired primary school students, here are some functional requirements that may be included:

Audio and Descriptive Content: The gaming module must incorporate comprehensive and descriptive audio elements. These audio cues and descriptions are essential to assist visually impaired students in navigating the game, comprehending their progress, and executing various in-game tasks. These descriptions should cover crucial aspects like character interactions, item descriptions, and game events.

Voice-Guided Navigation: The gaming module should feature an intuitive voice navigation system. This voice-guided navigation enables visually impaired students to effortlessly traverse menus, access game options, and make selections within the game environment. The voice instructions should be clear, succinct, and contextually relevant.

Explicit Game Instructions: The mobile gaming module must offer explicit, easy-to-follow instructions. These instructions should provide a clear understanding of how to play the game, progress through different levels, and accomplish diverse objectives. To cater to visually impaired students, the instructions should be communicated through both voice and text, ensuring accessibility for all.

High Contrast Visuals: The gaming module should incorporate high contrast visuals to enhance the user experience for visually impaired students. High contrast elements are instrumental in enabling students to differentiate between various on-screen elements, such as characters, objects, and obstacles. This ensures that visually impaired players can effectively engage with the game.

5.2 Non -Functional Requirement

In the development of mobile games tailored for visually impaired primary school students, it is imperative to meticulously address non-functional requirements, which encompass aspects beyond the core functionality. These requirements center on enhancing the overall user experience and accessibility, ensuring that the gaming module caters effectively to the unique needs of its users.

Accessibility

Ensuring accessibility is paramount in the design of the gaming module. To accommodate visually impaired students, the interface must feature clear and concise labels. Menus should be intuitively structured, enabling seamless navigation. Compatibility with screen readers and other assistive technologies is essential, guaranteeing that all students can interact with the game on equal footing. Every design element should prioritize inclusivity, allowing every student to engage with the content effortlessly.

Performance

Performance optimization plays a pivotal role in providing a satisfying gaming experience. Swift loading times are imperative to capture and sustain the attention of visually impaired primary students. The gaming module must deliver seamless gameplay by eliminating any lags or delays, ensuring that students can immerse themselves in the game without interruption. Smooth performance contributes significantly to engagement and overall enjoyment.

Reliability

The gaming module's reliability is of paramount importance. Minimizing downtime and crashes is crucial to ensure that visually impaired students can immerse themselves in the game without frustration or disruption. A reliable gaming experience fosters a sense of trust, encouraging students to engage with the module consistently.

Safety

Robust safety measures must be implemented to protect user data and maintain user privacy. Security measures should be in place to prevent unauthorized access, safeguarding the personal information of visually impaired students. A secure environment fosters trust, enabling students to engage in the game with confidence.

Usability

Usability is central to the gaming module's success. Striving for simplicity and clarity in the user interface is paramount. An intuitive and easy-to-understand interface ensures that visually impaired primary students can play the game without encountering unnecessary challenges. A user-friendly design promotes engagement and allows students to focus on the game's content and objectives.

Compatibility

Ensuring compatibility with a wide range of devices and operating systems is essential. This versatility guarantees that visually impaired primary students can access and enjoy the game on the devices they have at their disposal. By accommodating various platforms, the gaming module maximizes accessibility and inclusivity.

Scalability

Designing the gaming module with scalability in mind is pivotal. It should be capable of accommodating a growing number of players, enabling visually impaired primary students to participate alongside their peers without experiencing performance issues. Scalability ensures that the gaming experience remains enjoyable and engaging as the user base expands.

5.3 Hardware Requirements

The successful operation of the Edu Sense application and its gaming modules relies on specific hardware requirements. Users should have access to a compatible smartphone or tablet with a quad-core processor, at least 2GB of RAM, and sufficient storage space to accommodate the application and game data. The device must also feature a functional microphone for voice interaction. While the application can operate offline, an internet connection is needed for initial setup, updates, and additional content access. Compatibility with screen reader software, such as Talkback for Android, ensures accessibility for visually impaired users. Optional hardware considerations include headphones or earphones for an improved auditory experience, and accessibility accessories like tactile overlays. These hardware prerequisites collectively contribute to an inclusive and accessible learning environment for visually impaired individuals using the Edu Sense application.

5.4 Tool and Technology

Tools

- I. Visual Studio Code



Figure 2 VS Code

Source code editors like Visual Studio Code, sometimes referred to as VS Code, were made by Microsoft. It is free and open source, and it can run on Windows, macOS, and Linux. Additionally, it is designed to be portable, flexible, and cross-platform.

II. PyCharm



Figure 3 PyCharm

PyCharm is a popular integrated development environment (IDE) used for Python programming. It is developed by JetBrains, a company known for creating high-quality development tools. PyCharm offers a range of features and tools to help developers write, debug, and test Python code efficiently.

Technology

I. Mongo DB



Figure 4 Mongo DB

Document-oriented database system MongoDB is free and open-source. Documents having JSON-like structure have been used by the NoSQL database application MongoDB. For usage with MongoDB, creator MongoDB Inc. provides the Server-Side Public License.

II. React Native

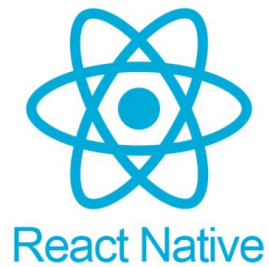


Figure 5 React Native

The popular open source React Native framework was created by Facebook and is used to create mobile applications. From a single codebase, programmers can produce cross-platform mobile applications for the web, iOS, and Android. The web application development library ReactJS serves as the foundation for React Native.

III. Python



Figure 6 Python

Python is a general-purpose, interpreted programming language. Python was developed by Guido van Rossum and originally made available in 1991. Its design philosophy places a strong emphasis on code readability and makes remarkable use of substantial whitespace.

IV. Draw.io/ Diagrams.net



Figure 7 Draw.io/ Diagrams.net

A well-liked open-source application for creating diagrams, such as flowcharts, organizational charts, network diagrams, and more is Diagrams.net, formerly known as Draw.io. Because it is a web-based program, you can use your web browser to access it without installing any additional software. For developing visual representations of concepts, processes, and data flows, Diagrams.net is frequently used.

6. Development

6.1 Development of Edu Sense Application Gaming Modules

We developed an Android mobile application for the Edu Sense. The development of the Edu Sense app and its related game modules was a meticulous process that was motivated by the need to improve educational opportunities for those who are visually impaired. The application was designed with user friendliness in mind, ensuring that it offers a seamless and accessible interface. Each gaming module was crafted to address specific learning objectives. By guiding users' animal identification via audio cues, The Sound of Animals Game aims to make users feel more connected to nature. Through voice interaction, the Fun Spelling Game tries to improve users' spelling abilities, while the Synonyms Game promotes vocabulary growth. These courses were made with user interaction and learning objectives in mind.

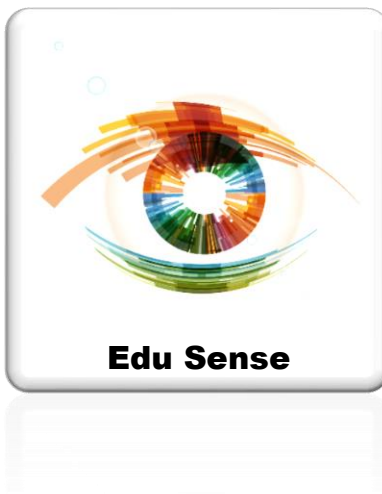


Figure 8 Edu Sense app logo

6.2 Gaming modules interface (UI)



Figure 9 Gaming modules Home

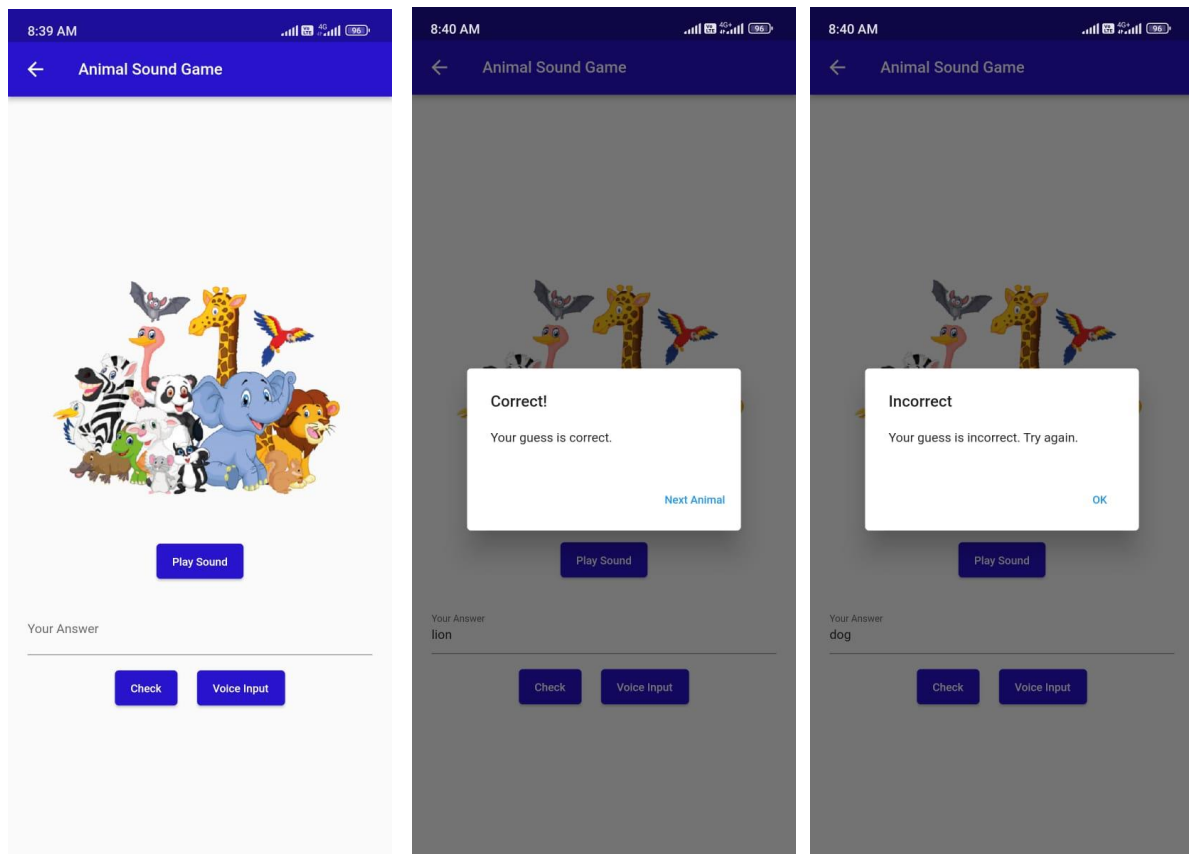


Figure 10 Animal sound game interface

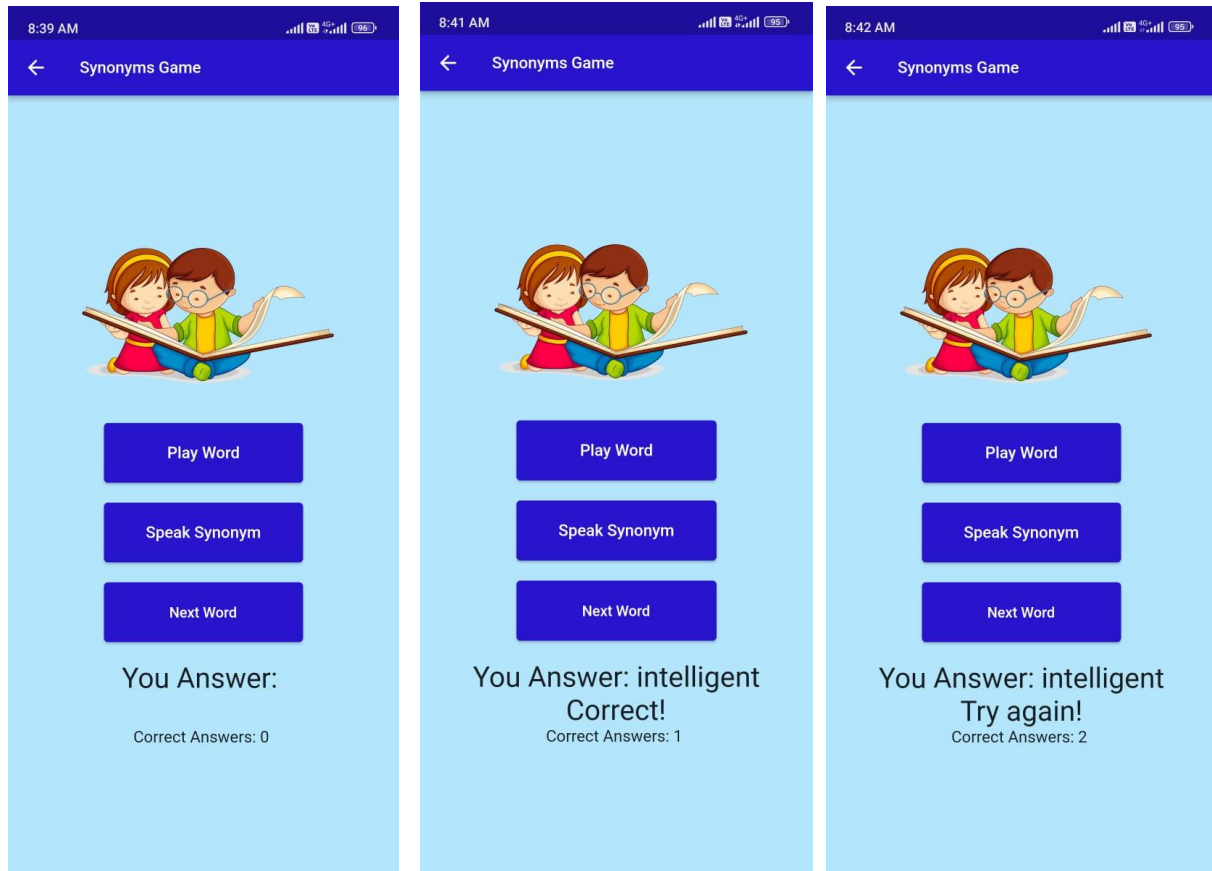


Figure 11 Synonyms game interface

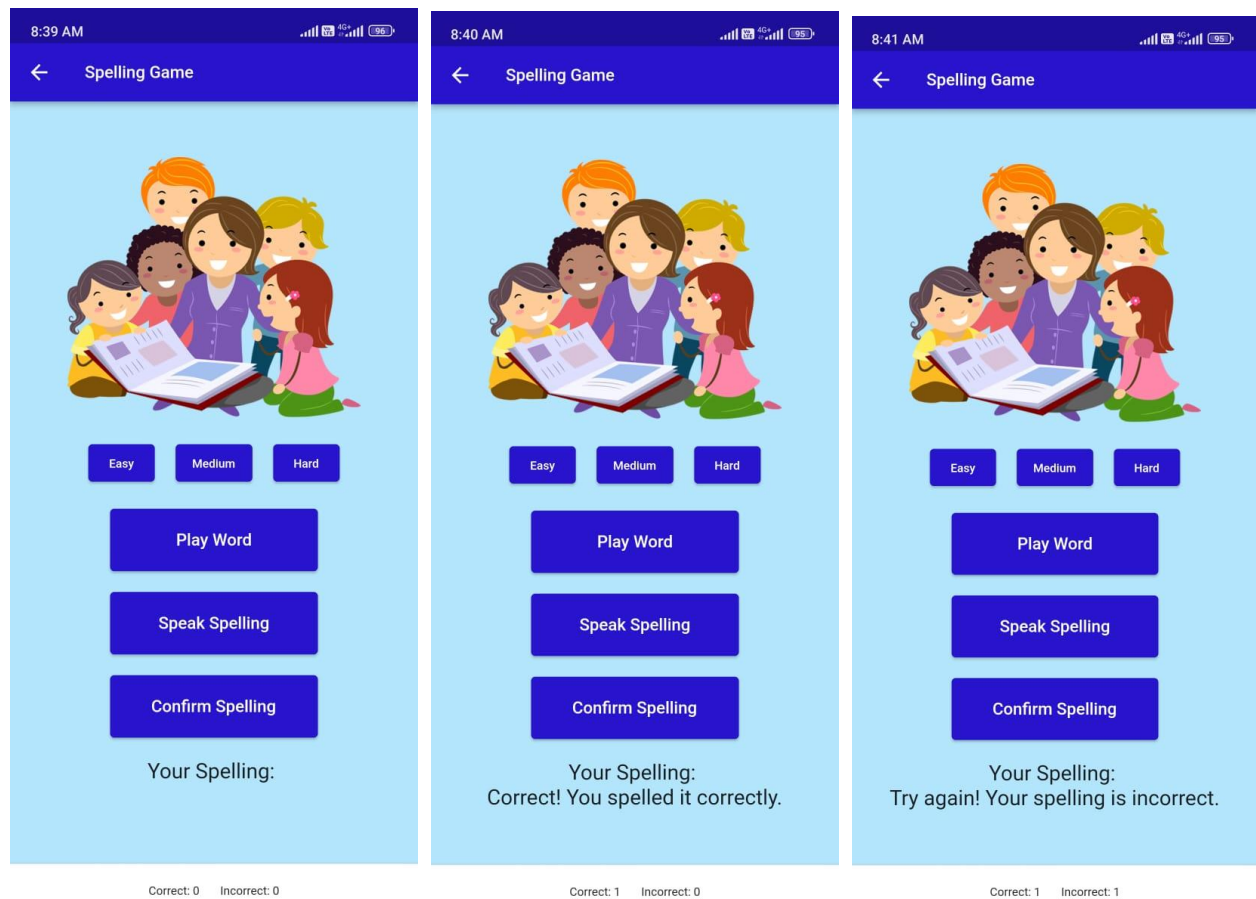


Figure 12 Fun spelling game interface

7. Testing of the application

To test our app with visually impaired students, we conducted a physical survey at Ratmalana Blind School involving 10 primary students. We aim to gather comprehensive insights and valuable feedback to enhance our application's usability and impact.

7.1 Animal Sounds

Table 2 Animal Sounds Test Case 01

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|-------------------------------|--|---|---|-------------|
| TC001 | Correct Animal Identification | 1.Launch the "Animal Sounds" game. 2.Listen to the animal sound provided. 3.Say the name of the animal aloud. 4. Verify the score is incremented. | 1. Game interface is displayed. 2. Clear and distinct animal sound is heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | 1. Game interface is displayed. 2. Clear and distinct animal sound is heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | Pass |

Table 3 Animal Sounds Test Case 02

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|---------------------------------|--|---|--|--------|
| TC002 | Incorrect Animal Identification | 1. Launch the "Animal Sounds" game. 2. Listen to the animal sound provided. 3. Say an incorrect animal name aloud. 4. Verify the score remains unchanged. | 1. Game interface is displayed. 2. Clear and distinct animal sound is heard. 3. "Incorrect your guess is incorrect. Try again" message is provided. 4. Score remains the same. | 1. Game interface is displayed. 2. Clear and distinct animal sound is heard. 3. "Incorrect your guess is incorrect. Try again" message is provided. 4. Score remains the same | Pass |

Table 4 Animal Sounds Test Case 03

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|-------------------------|---|--|--|--------|
| TC003 | UI Test - Game Controls | 1. Launch the "Animal Sounds" game. 2. Verify the presence of game controls (buttons). | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next," and "Score | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next," and "Score | Pass |

Table 5 Animal Sounds Test Case 04

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|---------------------|----------------------|---|--|--|---------------|
| TC004 | Performance Test | 1.Launch the "Animal Sounds" game. 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | Pass |

Table 6 Animal Sounds Test Case 05

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|---------------------|-----------------------------------|--|---|---|---------------|
| TC005 | Verify basic gesture recognition. | 1.Launch the "Animal Sounds" game. 2. Perform common gestures as swiping and double tapping | 1. Game interface is displayed. 2. Gestures work correctly | 1. Game interface is displayed. 2. Gestures work correctly | Pass |

Table 7 Animal Sounds Test Case 06

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|--|------------------------------------|---|---|--------|
| TC006 | Verify voice instructions (Game instructions) Work or not. | 1.Launch the "Animal Sounds" game. | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | Pass |

7.2 Fun spellings

Table 8 Fun Spelling Test Case 01

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|---------------------------------|--|--|--|--------|
| TC001 | Correct spelling Identification | 1.Launch the " Fun spellings" game. 2.Game displays a word to spell. 3.User spells the word correctly. | 1. Game interface is displayed. 2. Clear words are heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | 1. Game interface is displayed. 2. Clear words are heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | Pass |

Table 9 Fun Spelling Test Case 02

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|-----------------------------------|---|--|--|--------|
| TC002 | Incorrect spelling Identification | 1.Launch the " Fun spellings" game. 2.Game displays a word to spell. 3.User spells the word correctly. 4.Verify the score remains unchanged. | 1. Game interface is displayed. 2. Clear is heard. 3." Incorrect your guess is incorrect. Try again" message is provided. 4.Score remains the same. | 1. Game interface is displayed. 2. Clear is heard. 3." Incorrect your guess is incorrect. Try again" message is provided. 4.Score remains the same. | Pass |

Table 10 Fun Spelling Test Case 03

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|---------------------------------------|---|--|--|--------|
| TC003 | UI Test - Fun spellings Game Controls | 1.Launch the " Fun spellings" game. 2. Verify the presence of game controls (buttons). | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next. | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next. | Pass |

Table 11 Fun Spelling Test Case 04

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|------------------|--|--|--|--------|
| TC004 | Performance Test | 1.Launch the " Fun spellings " game.' 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | Pass |

Table 12 Fun Spelling Test Case 05

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|-----------------------------------|--|---|---|-------------|
| TC005 | Verify basic gesture recognition. | 1.Launch the " Fun spellings " game. 2. Perform common gestures as swiping and double tapping | 1. Game interface is displayed. 2. Gestures work correctly | 1. Game interface is displayed. 2. Gestures work correctly | Pass |

Table 13 Fun Spelling Test Case 06

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|--|--------------------------------------|---|---|-------------|
| TC006 | Verify voice instructions (Game instructions) Work or not. | 1.Launch the " Fun spellings " game. | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | Pass |

7.3 Synonyms game

Table 14 Synonyms Game Test Case 01

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|---------------------------------------|---|--|--|--------|
| TC001 | Verify correct synonym identification | 1.Launch the " Synonyms game. " 2. Game plays a word. 3. User provides a correct synonym. | 1. Game interface is displayed. 2. Clear words are heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | 1. Game interface is displayed. 2. Clear words are heard. 3. "Correct your guess is Correct." message is provided. 4. Score increases by one point. | Pass |

Table 15 Synonyms Game Test Case 02

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|---|--|---|---|--------|
| TC002 | Verify incorrect synonym identification | 1.Launch the " Synonyms game. " 2. Game plays a word. 3. User provides an incorrect synonym. 4. Verify the score remains unchanged. | 1. Game interface is displayed. 2. Clear words are heard. 3." Incorrect your guess is incorrect. Try again" message is provided. 4.Score remains the same. | 1. Game interface is displayed. 2. Clear words are heard. 3." Incorrect your guess is incorrect. Try again" message is provided. 4.Score remains the same. | Pass |

Table 16 Synonyms Game Test Case 03

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|----------------------------------|---|--|--|--------|
| TC003 | UI Test - Synonyms game Controls | 1.Launch the " Synonyms " game. 2. Verify the presence of game controls (buttons). | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next. | 1. Game interface is displayed. 2. Buttons for "Play Sound," "Next. | Pass |

Table 17 Synonyms Game Test Case 04

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|------------------|--|--|--|--------|
| TC004 | Performance Test | 1.Launch the " Synonyms " game. 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | 1. Game interface is displayed. 2. Interact with the game continuously for 10 mins. | Pass |

Table 18 Synonyms Game Test Case 05

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|-----------------------------------|---|---|---|--------|
| TC005 | Verify basic gesture recognition. | 1.Launch the " Synonyms " game. 2. Perform common gestures as swiping and double tapping | 1. Game interface is displayed. 2. Gestures work correctly | 1. Game interface is displayed. 2. Gestures work correctly | Pass |

Table 19 Synonyms Game Test Case 06

| Test Case ID | Test Scenario | Test Steps | Expected Result | Actual output | Status |
|--------------|--|---------------------------------|---|---|--------|
| TC006 | Verify voice instructions (Game instructions) Work or not. | 1.Launch the " Synonyms " game. | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | 1. Game interface is displayed. 2.user can hear voice instructions 3. Voice instructions work correctly | Pass |

8. Result and Discussion

8.1 Result

Our research and development efforts have culminated in the successful creation of a mobile game designed specifically for visually impaired elementary school children. The game incorporates a rich array of features aimed at providing an engaging and educational experience. Key among these features is the integration of authentic animal sounds, which have been seamlessly woven into the gameplay. Through rigorous testing and iterative design, we have achieved a game that not only meets but exceeds our initial goals for accessibility and educational value.

The game's user interface has been thoughtfully crafted to ensure ease of use for our target audience. Intuitive voice commands, coupled with responsive touch gestures, provide a dynamic and inclusive means of interaction. Our emphasis on user-centered design has yielded an interface that is not only accessible to visually impaired children but also intuitive and enjoyable.

Through extensive beta testing involving a diverse group of visually impaired elementary school children, we have gathered invaluable feedback that attests to the game's effectiveness. Users consistently reported increased engagement and enthusiasm for learning through the game's auditory learning experiences. Moreover, testers demonstrated enhanced auditory memory and improved spatial awareness as a result of their interactions with the game.

Finally, the result of our research is a mobile game that not only fulfills its educational goals, but also overcomes the traditional barriers to access learning and play for visually impaired children. Integrating authentic animal sounds as a central educational tool has proven to be extremely successful, further underscoring the potential for innovative approaches in educational games. This result represents a significant step forward in the area of accessible and inclusive educational content for visually impaired primary school children.

8.2 Discussion

Our research and the resulting mobile game underscore the profound impact of innovative and accessible educational technologies on visually impaired elementary school children. This section engages in a meaningful discussion of the implications and significance of our work, shedding light on the broader context of inclusive education and accessible gaming.

Educational Impact: One of the central outcomes of our research is the notable educational impact observed among visually impaired children who interacted with the mobile game. By incorporating authentic animal sounds into the gameplay, we tapped into the auditory learning capabilities of our target audience. The improved auditory memory, heightened spatial awareness, and enhanced problem-solving skills reported by our testers highlight the potential of this approach in fostering cognitive development. Moreover, the positive feedback from both students and educators suggests that this game not only enhances knowledge acquisition but also sparks enthusiasm for learning.

Accessibility and Inclusivity: Our commitment to accessibility and inclusivity permeates every aspect of our game's design. The user-centered interface, featuring intuitive voice commands and responsive touch gestures, ensures that children with visual impairments can engage with the game effortlessly. This emphasis on accessible design not only promotes inclusivity but also empowers children to navigate and interact with technology independently. Furthermore, the game's success in providing an enjoyable and accessible educational experience aligns with broader efforts to bridge the digital divide and create equal opportunities for all learners.

Future Directions: While our research marks a significant milestone, it also serves as a catalyst for future exploration. The valuable feedback obtained from beta testing opens avenues for refining and expanding the game's features. Additionally, we recognize the potential for applying our findings to other educational and entertainment contexts for visually impaired individuals. As technology continues to evolve, we anticipate opportunities to further enhance the accessibility and educational value of interactive learning experiences.

Ultimately, our research and the development of this mobile game is a testament to the power of technology to promote education and foster a love of learning among visually impaired elementary school children. By harnessing the captivating nature of animal sounds and crafting an accessible interface, we've taken a significant step toward making educational games accessible to all, yet truly fun. As we look to the future, our commitment to innovation and inclusion remains unwavering, ensuring that the journey towards accessible education continues.

9. Commercialization of the Product

Our mobile application has been developed to accommodate the requirements of visually impaired learners to help them in successfully completing their academic journeys. Our intended audience includes the parents or guardians of visually impaired primary students, primary schools that serve these students, and organizations that help the community of the blind. We want to use social media channels to advertise our goods to the widest possible audience of potential customers.

We are interested in using a number of revenue-generating techniques to market the product. These might involve adding a price to the application itself, charging for premium features, or making money from in-app advertisements. We are aware that the community of people who are blind has particular needs, and we have added a number of features to meet those needs. With features like text-to-speech and audio explanations of the pictures, our program is intended to be user-friendly and accessible.

We want to use social media communications to promote our product in order to make it stand out in the marketplace. In order to reach our target audience, we produce powerful materials that highlight the benefits of our product. As part of our social media plan, we'll build a strong brand identity, interact with potential clients, and inform our audience of any application changes or new features.

In conclusion, our mobile application is intended to help visually challenged students, and we think it has a lot of promise for the business world. We're convinced that with the help of our revenue-generating plans and social media marketing, we can connect with our target market, bring in money, and enhance the lives of visually impaired students.

10. Conclusion

The culmination of our comprehensive research endeavor represents a significant stride forward in the realm of accessible education for visually impaired students. From inception to implementation, our research has been dedicated to designing and developing the Edu Sense application, a groundbreaking educational tool tailored to meet the unique needs of visually impaired learners.

This research journey commenced with a deep commitment to understanding the challenges faced by visually impaired individuals in their pursuit of education. Through meticulous needs assessments and iterative prototyping, we not only uncovered these challenges but also forged a pathway to address them effectively.

The Edu Sense application, with its three distinct gaming modules Sound of Animals Game, Fun Spelling Game, and Synonyms Game harnesses the transformative potential of voice recognition technology to create an inclusive and interactive learning experience. It transcends the boundaries of traditional education, offering visually impaired students an inclusive platform where they can explore, learn, and thrive.

Crucially, this research extends beyond the realm of theory; it materializes in a tangible solution. Our empirical study, conducted at the Ratmalana Blind School, offered a profound opportunity to engage with ten primary students from the visually impaired community. Their insights and feedback, garnered through rigorous testing, have been invaluable in refining the application, ensuring it meets their educational needs and preferences.

Ultimately, this research movement is not just a culmination but a foundation for equitable education, empowerment, and inclusion. It underscores the importance of innovation, collaboration, and unwavering commitment in shaping a brighter future for visually impaired learners. The Edu Sense app is more than a product; It is a testament to our commitment to an inclusive world where every person, regardless of their visual abilities, has the opportunity to learn, grow and succeed.

11. Gantt Chart

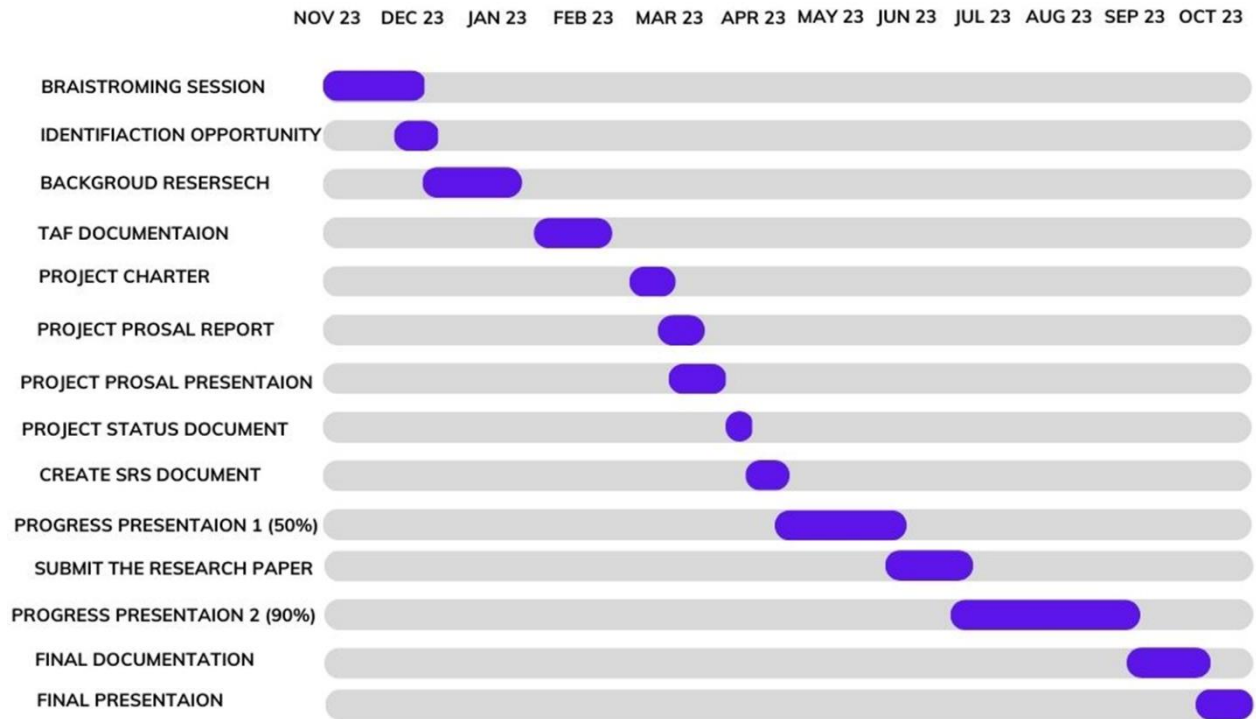


Figure 13 Gantt Chart

12. References

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- [7] G. R. a. E. Mattheiss, "Mobile location-based games to support orientation & mobility training for visually impaired students," *the 20th International Conference*, 2018.

13. Appendices



Figure 14 Ratmalana Blind College image 1

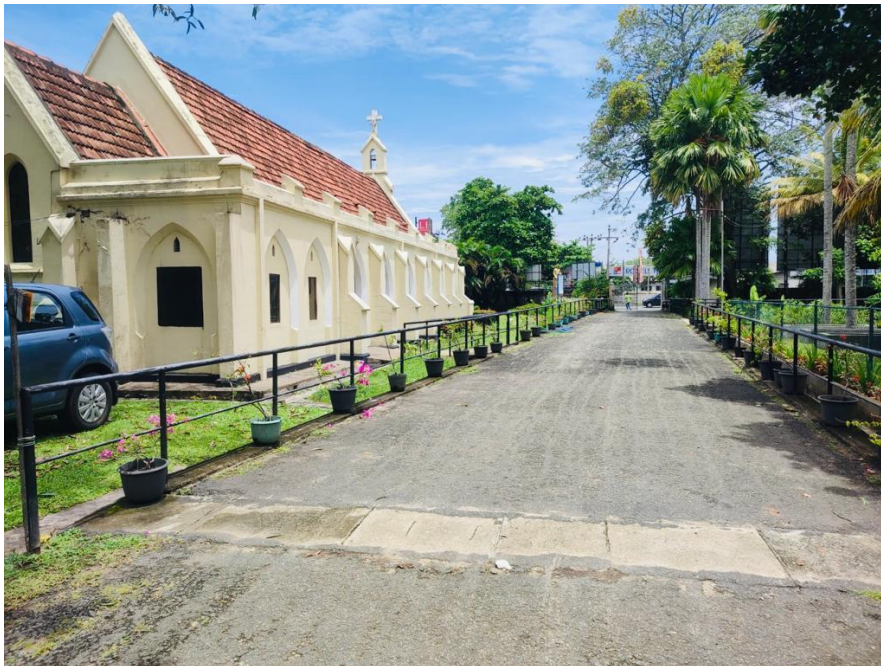


Figure 15 Ratmalana Blind College image 2

We went to Ratmalana Blind College to gather information. We were able to learn a lot of information from there.

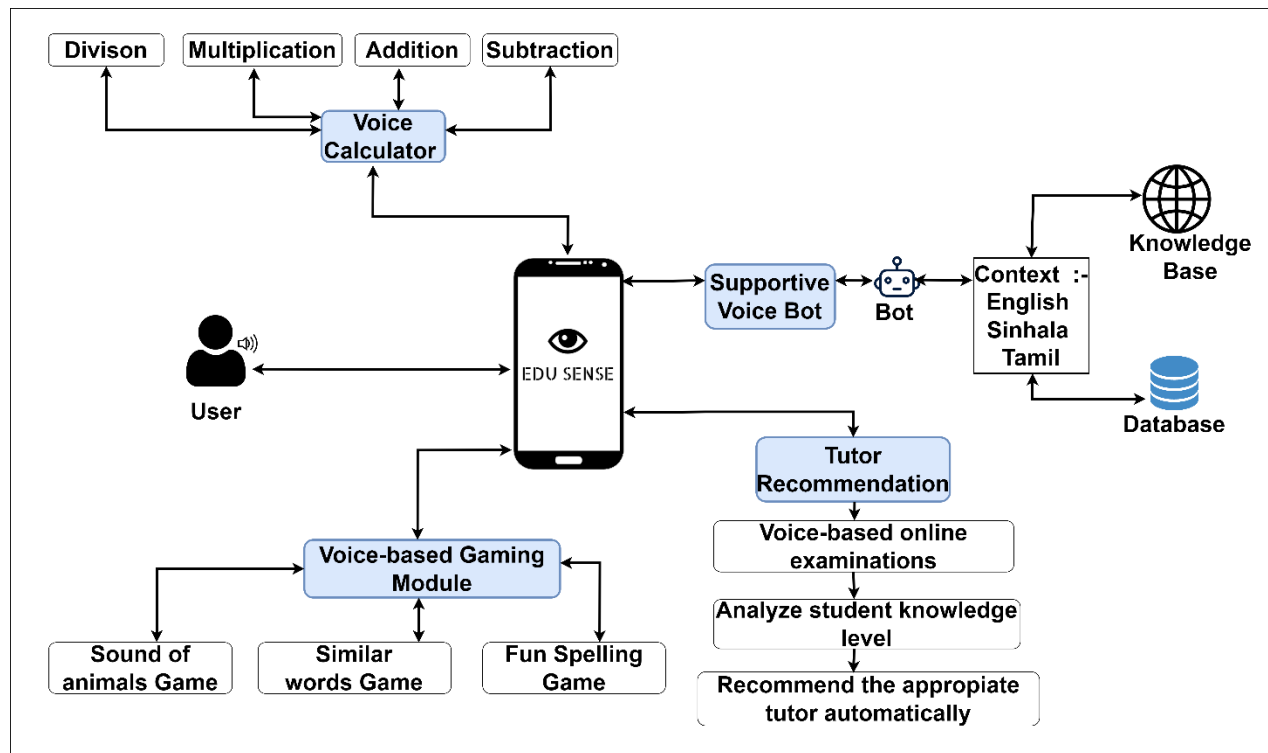


Figure 16 System overview diagram

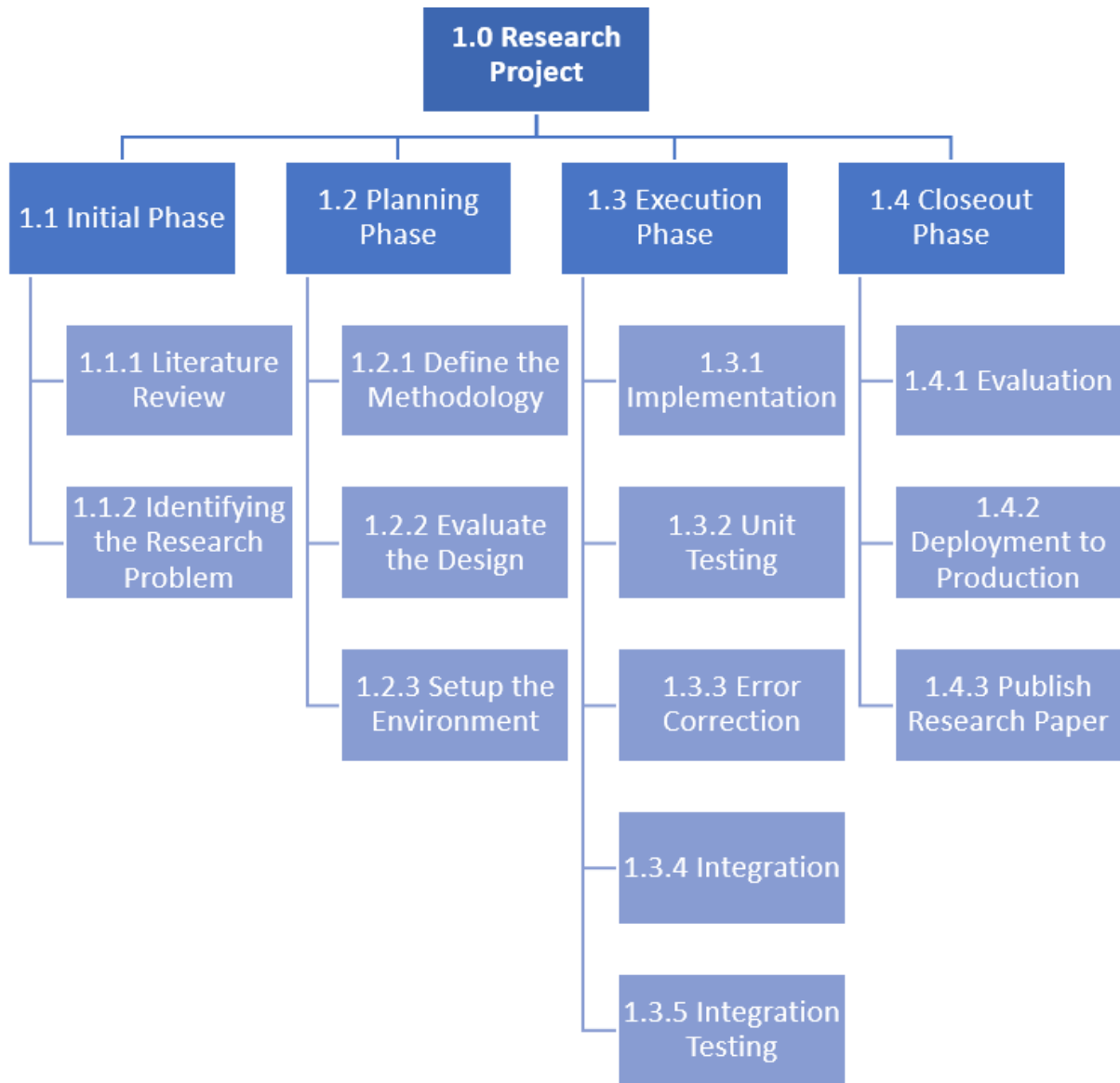


Figure 17 Work breakdown structure

report

ORIGINALITY REPORT

| | | | |
|------------------|------------------|--------------|----------------|
| 8% | 5% | 1% | 5% |
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|-----|
| 1 | Submitted to University of Bedfordshire Student Paper | 1% |
| 2 | www.cse.griet.ac.in Internet Source | 1% |
| 3 | Submitted to University of Wales Institute, Cardiff Student Paper | 1% |
| 4 | Submitted to Sri Lanka Institute of Information Technology Student Paper | 1% |
| 5 | Submitted to University of North Texas Student Paper | <1% |
| 6 | softlab.boun.edu.tr Internet Source | <1% |
| 7 | gitlab.sliit.lk Internet Source | <1% |

Figure 18 Turnitin report