

# **INTERACTIVE, VISUAL LEARNING-BASED TOOL FOR HEARING IMPAIRED CHILDREN TO IMPROVE LANGUAGE SKILLS**

22\_23-J 18

## **Project Proposal Report**

Modeesha Kalani Priyanka

(Priyanka P.D.M.K.)

B.Sc. (Hons) Degree in Information Technology Specialized in Software  
Engineering

Department of Computer Science and Software Engineering

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## DECLARATION

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

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Date :-----

## **ABSTRACT**

This is a learning tool which will provide the ability to use visual based materials from the surrounding environment which makes it easier to understand and practice the language more interestingly. The proposed system will initially discover the status of the student. Frequent and meaningful usage will be the primary focus to improve language acquisition and proficiency. Along with teaching alphabet pronouncing, improving vocabulary, forming phrases and speech therapy is also provided as features to help reintegrate students who have a cochlear implant, hearing-aid or students who are partially hearing impaired and getting recovered from that condition. Primary functions of the system can be identified as, Explore what's around the child through the camera, which enables seamless and effective learning experience for the child to interact with his surrounding environment and learn based on them, Generate meaningful sentences and phrases from the objects that observed previously and the words they have learnt, Lip reading training which basically involves with training lip movements for the alphabet and that gives visual feedback while monitoring the mouth movements of the learner and Detecting initial status of the student and monitor the progress of the learner throughout usage of the tool. A reinforcement learning based adaptive learning system will be implemented to first determine the initial status of the learner, then update the progress of the student based on the determined status and the evaluation of using above mentioned functions and finally reward the learner for the progress that has been shown by them. A quiz river which is dynamically updating will be implemented to determine the initial status and finally a map with the rewards will be displayed to the user with the intention of presenting the outcome in an interesting method.

**Keywords:** Reinforcement Learning, Adaptive Learning, Visual Based

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## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Description</b>
ISDPM	Initial Status Determination and Progress Monitoring
ISD	Initial Status Determination
PM	Progress Monitoring
RL	Reinforcement Learning
TD	Temporal Difference Method
ML	Machine Learning
SL	Sri Lanka
dB	Decibel
DBRC	Daily Behavior Report Card
AI	Artificial Intelligence

*Table 1 List of Acronyms and Abbreviations*

# 1. Introduction

## 1.1 Background and Literature Survey

Hearing impairment is a sensory disability that hinders linguistic development. As per world health organization records, more than 5% of the population in the world, that means about 430 million people are requiring rehabilitation to address hearing losses. And it is estimated that by the year 2050, more than 750 million people will have some kind of disabling hearing loss.[1]

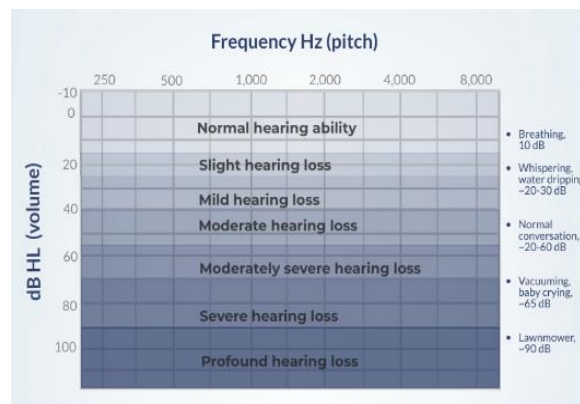


Figure -1.1 Hearing Loss in Children

Hearing impaired children can be identified using a simple test. If the child is unable to hear sounds around 15-20 dB they are identified as having hearing issues. [8]

Most of the children who are identified as “hearing impaired” are not completely deaf. They have some hearing. [8] [9] And also most of the children who are deaf and the others with some hearing can be treated with hearing aids, cochlear implants, brainstem implants or bone-anchored hearing aids [8][7] By the time these treatments are taken the children are well behind vocabulary wise compared to children who were not having any hearing disability in their early age.[10]



Language development is a key area of child development, and it starts with sounds and gestures at first and then words and sentences will be learnt. [7] Hearing impaired children who have recovered later has completely or partially lost this starting stage. So, the child's ability to communicate is very low and that affects [12]

- Ability to express feelings
- Ability to understand other people
- Ability to solve problems
- Ability to initiate and maintain relationships

This has a huge negative impact on the cognitive abilities of a child which are memory, reasoning, visualization and perceptual functioning [19] Early exposure to language sets the foundation for cognitive ability, literacy, school readiness and, ultimately, educational achievements.

There are mainly 5 stages of a child learning language. [11] Those stages are

1. Pre-Production
2. Early Production
3. Speech Emergence
4. Intermediate Fluency
5. Advance Fluency

Pre-Production is the basic level and during that stage the child is mostly silent and listen to others. They are learning word by word and understanding the meanings. [11] In Early Production Stage, the child starts to use the words that they learnt in the pre-production stage. [11] Other stages come next with each stage with more usage of language.

As children who did not have any hearing ability in their early childhood and children who had slight hearing has lost these fundamental stages and they will need to learn new words and improve their vocabulary in order to develop their cognitive abilities and other related abilities discussed above.

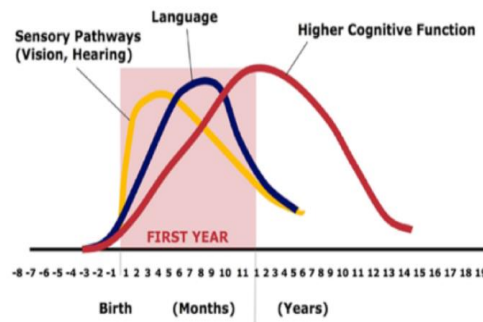


Figure 1-2 Human Brain Development

It is both the quality and quantity of words a baby hears that brings richness to the child's vocabulary and has a profound impact on his school performance, IQ and life trajectory.

As an example, even though it can be assumed that the children who are having a hearing loss might be having better reading skills as they have vision, that is proved not to be true. Overall, the results in [21] reports that young children who are deaf have inferior reading skills than children with normal hearing group. They were particularly slower and less precise while reading single words and phrases.

An online learning tool can be considered as a solution to solve this problem. Studies show that 77% of academic leaders believed that online education offerings were just as good, if not better, than classroom-based educational offerings. [16] Recent COVID-19 pandemic also pushed many traditional teaching and learning practices to divert into online learning. [11]

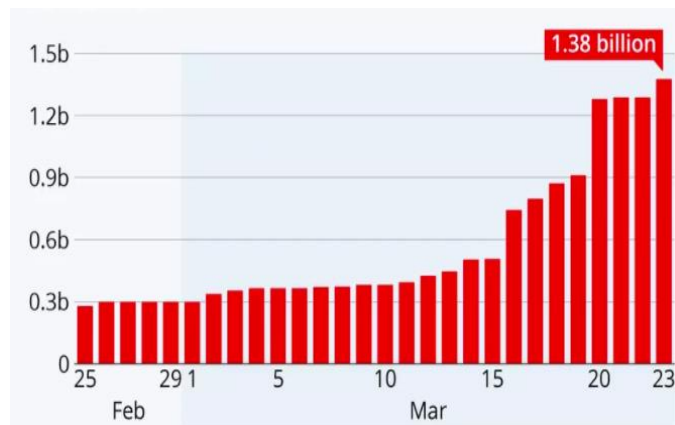


Figure 1-3 Growth of People using Online Learning Tools

Children will have to visit an audiology center after paying for each session to receive training in hearing activities. Those are not always provided as the cost can be high and it is not convenient for parents or guardians to accompany the child to visit the audiology centers more often. Hence, children tend to learn slowly because there's no constant training and evaluations. (Based on the information gathered from Ratmalana Audiology Center)

If there was an online learning tool it can provide many benefits to children.

- Easy to have more engaging content
- Ability to work at their own pace
- Allow to learn at own speed
- Can have customized learning experience

are to name a few of those. [5]

This proposed tool comes to use in solving all these issues mentioned above. The aim is to improve the vocabulary of the child in their normal surrounding environment while monitoring the child's progress including pronunciation and lip movement.

The implemented solution should be a gamified one. Internet computer games are proven to be more attractive in the context of technology enhanced learning, as the attraction of a child can be appealed into a game and if they can also gain rewards that will be more interesting and addictive as well. [4][17] Playfulness is orthogonal to learning theory and the child will be unknowingly adding a lot of words into their vocabulary using the application.

Gamification is applying game-like technique to encourage specific behaviors. [5] It makes sense to be used to provide encouragements to a specific behavior as response, engage effectively with children and help users to track their own progress.



Figure 1.4 Gamification Requirement in E-Learning

Above Figure 1.4 states study reports of a research done with e-learning users. [5]

The ISDPM component determine the initial status of the learner at the beginning. Then it will detect the progress of the student throughout learning through this tool. Rewards will be given with the progress that is shown by the learner as well.

Reinforcement learning will be used mainly in the Initial Status Determination (ISD) part. A quiz needs to be displayed at the beginning in gamified manner and the initial status can be recognized and confirmed.[2][3] Reinforcement learning, Q-Learning algorithm can be used for this with modifications [3] The accuracy rate of the answers provided by the user, the response time and the difficulty of the quiz will be taken into consideration as dynamic factors and those will be analyzed to determine the initial status of the learner.

Progress monitoring is also crucial to any learning system. Gamified learning systems always come with a reward mechanism, but it is only analyzing the expected responses given by the user to a general quiz. [5][14] This contributes to improving teaching methods, suggesting suitable materials, and enhancing learner's growth. [14][15] The progress will be determined based on the individual dynamic data and rewards will be given as per the detected progression shown by the learner.

## 1.2 Research Gap

In order to start teaching a child, the system will figure out the initial status of the child. And then the status will be updated according to the usage of the tool and the responses taken by the system in learning procedures.

Research A states a system where reinforcement learning will be used to develop an adaptive learning system which has initial state determination based on static and dynamic factors and then recommending a learning material or path. Then a reward for the action of the user will be given. This is not taken analyzing any factor and it just directly takes a satisfaction level from the user.[2]

Research B states a solution where a student's progress being determined using the accuracy rate of the answers given by a student.[20] Gamification and Reward Mechanism are used in here. This is mainly a solution proposed to communicate the progress of the child with their parent or any guardian and. This works as a Daily Behavior Report Card (DBRC). Individualized Education Program is suggested, and the progress of the student will be updated by rewarding positive values and negative values.[22]

As reference applications, "Hopster", "Early Learn" and "ABC Kids" were studied. "Hopster" is a British media service provider aiming preschool aged children. It is available for both Android and iOS users. It works on improving the vocabulary of children and it does not have any reward mechanism. "Early Learn" is an app designed for preschool kids and kindergarten kids. Student can learn alphabet, rhymes, numbers and fruit names using this. The third application referenced was "ABC Kids". This app provides a simple app focusing on teaching alphabet to children. This plays an audio pronouncing the letter, but it does not have any mechanism to detect the child's pronouncing. Basically, all these does not have any personalized filtering and mainly focused on teaching alphabet and introducing new words to children.

Application Reference	Initial State Determination	Progress Monitoring	Analyzing Answer Accuracy Rate	Analyzing pronunciation accuracy	Analyzing lip movement accuracy	Reward Mechanism
Research A	✓	✓	✗	✗	✗	✓
Research B	✗	✓	✓	✗	✗	✓
Existing Learning Tools	✓	✓	✓	✗	✗	✓
Proposed System	✓	✓	✓	✓	✓	✓

*Table 2.1 Comparison with existing solutions*

Since there is no report of a mobile based learning tool which analyzes the progress of a learner using the pronunciation accuracy and the lip movement accuracy of hearing-impaired children, in this case I aim to build that solution. Furthermore, in the initial status determination set of dynamic factors which are response time and quiz difficulty will be analyzed along with the answering accuracy. Based on these, the learner can have an idea about the progress and the overall experience of using this application for learning will also become an interesting one.

### 1.3 Research Problem

According to the studies reported in [6], [7], [9] a child's language literacy and vocabulary are mostly impacted in their early age. For the children who has weak hearing and children who had to go for implants and hearing aids must be treated with speech therapy constantly for them to increase their language proficiency and vocabulary to be aligned with children who did not have any hearing disabilities. Improving the language proficiency not only helps in speaking, reading and writing, but also helps developing cognitive functionalities as well. [19]

Determining the initial status (ISD) of a learner is important to track the progress them. And considering as many factors as possible to determine that status can benefit significantly to the accuracy of the identified status. When the quiz is concerned, the quiz should be implemented not as a regular quiz, but a gamified one which grabs attention.[17] This is the first impression of the user about the system and the initial point as everything that will be done after this in the learning process will be using this status to track the progress.

Progress monitoring (PM) is where the progression of the user is determined and shown to the user using a reward mechanism. Furthermore, because the user in this scenario is a child, it would be efficient if the progress is shown to the user in an animated way. .[13] This can benefit the whole system as the user begins to be enthusiastic towards using the system with the intention of seeing their progress being shown in the progress map.

There are no reports of a learning tool which determines the progress of a child increasing their vocabulary considering all following factors which are pronunciation accuracy, lip movement accuracy and the vocabulary increasing rate. In addition to this, there is no one tool which uses all the factors like accuracy rate, quiz model difficulty and the response time to determine the initial status of the user. They tend to use answer accuracy using pre-defined materials for every user.



## 2. Objectives

The main objective of this solution is to develop a system to help children who are identified as hearing impaired and has a little chance of functioning as normal and children who can hear after adapting hearing aids and implants. The main components include providing the ability to capture objects in the child's surrounding environment and explore them, analyzing lip movement and pronunciation of the child to detect the accuracy, generate meaningful sentences and phrases with the reference of the words learnt by the child and determining the initial status of the student at the beginning and monitor and display the progress of the user with reference to the user interactivity factors.

### 2.1 Main Objectives

The main objective of the ISDPM component is to first determine the initial status of the child when they are first visiting the application This uses a gamified quiz. After that the system is monitoring the progress of the child throughout the learning experience. In addition to that, it will display the progress of the child using a progress map.

### 2.2 Specific Objectives

There are four specific sub-objectives that must be reached in order to achieve the overall objective described above.

#### **Implementing a dynamic quiz river**

- As the user logs in to the system, a quiz river will be displayed to them in a gamified environment. The quiz will initially have the simplest words and it will change dynamically with the responses given by the user.

### **Determine the Initial Status**

- This analyzes the accuracy rate of the answers given by the user in the quiz, the time taken by the user to answer to the quiz and the difficulty level of the quiz to determine the initial status of the user.

### **Detect the Progress of the Learner**

- The user's progress will be evaluated based on the factors that are crucial for a child who had hearing losses. Those factors are pronunciation accuracy and lip movement accuracy.

### **Display the Progress of the User**

- A reward mechanism will be used in here and the child's progress will be displayed in an attractive way which will reward starts along the way in a map. The main motive of this part is to encourage the child to gain more stars, which will unknowingly encourage them to learn more words.

## 3.Methodology

### 3.1 System Diagram

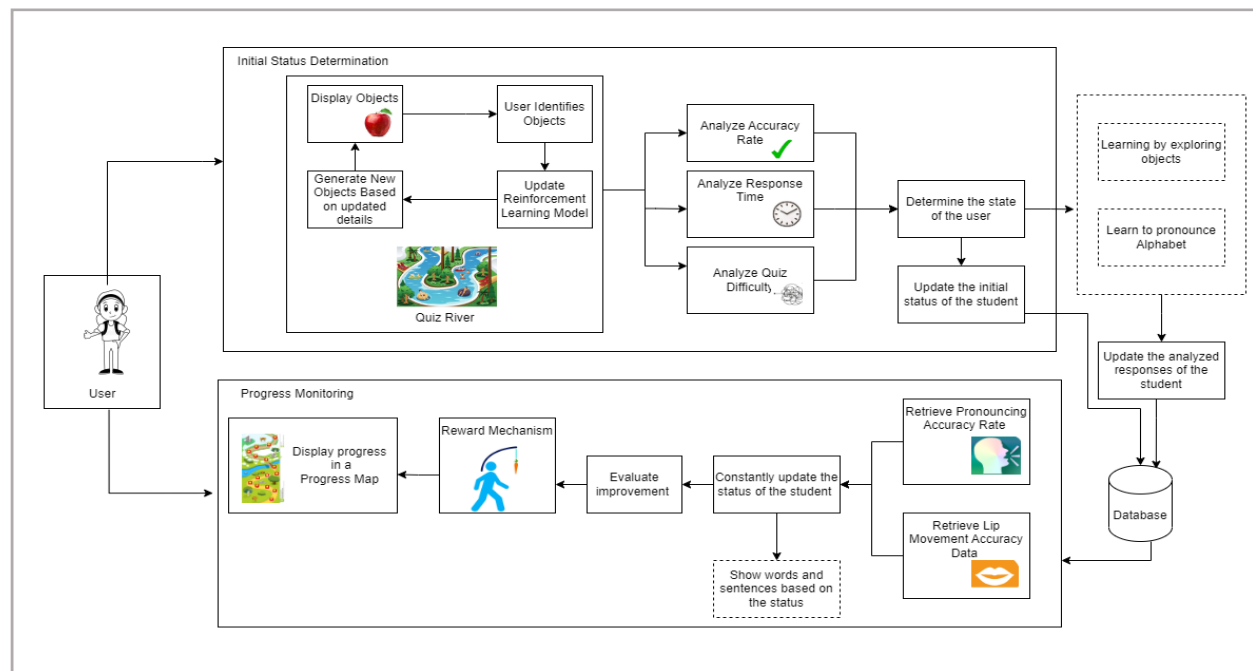


Figure 3.1 Component Architecture Diagram

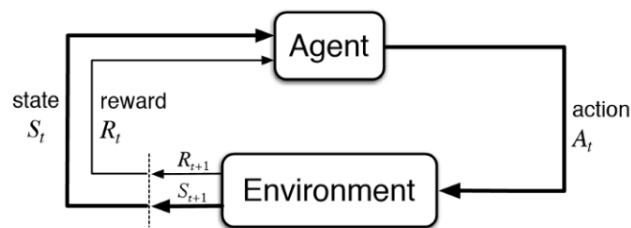
The proposed component will have two main subcomponents. The first subcomponent is to determine the initial status of the user. That will have two sub-tasks. The first sub task is to implement a quiz river will be used for this. Initially basic simple words will be displayed and a reinforcement learning based model will dynamically evaluate the answers provided by the user and decide on the complexity of the quiz objects to display next. Then as the second sub-task, the response accuracy, response time and the final quiz difficulty will be analyzed and evaluated to determine the initial status of the user and it will be saved in the database.

The second subcomponent of the study is to monitor the progress of the user. This also has two sub tasks. The first sub-task is to detect the progress using the pronunciation accuracy and the lip movement accuracy factors. Then as the second sub-task, reward mechanism will be implemented, and it will allocate positive and negative values based on the above analyzed progress and a map will be implemented which can grab attention of the user and motivate user to perform well.

## 3.2 Technology Usage

### 3.2.1 Reinforcement Learning

Reinforcement Learning is one of the basic machine learning paradigms. An RL problem usually involves a scenario where the subject has to achieve a goal in an unknown environment. RL is different from supervised learning because it does not need labeled input and output pairs to be received. [23] RL is studied in many forms such as in game theory, control theory and simulation-based optimizations. RL generally figures out predictions through trial and error. The algorithm is trained through rewards, and it can change the response by adapting continuous feedback. The reward signal can be interpreted as a function of calculating the value of an action performed. The end goal of an RL algorithm is to discover a certain methodology which will maximize the benefit from the state of the system environment.



*Figure 3.2 Basic Architecture of Reinforcement Learning*

The system should base upon the Reinforcement learning. RL is considered to be an alternative approach to applications which have challenging objectives involving traditional methods. Since personalized systems can vary on each one's favours they must be high dynamic. RL would be an effective tool to model the features of the system. This is mainly because RL has the potential of dynamically approximating a changing model. [2]

### 3.2.2 Usage of Reinforcement Learning

The challenge of these type of learning is that a learning agent must be able to examine the environment and make the choice of the action taken at the next step. Regarding this system, when the user is responding to the quiz, the system should be able to learn user's comfort area and check their status in levels in that area. As an example, if the user is correctly identifying names of fruits, the system needs to check their knowledge in synonyms and phrases next. After that the system needs to update the state accordingly.

The main reason RL is suitable for adaptive learning platform is that it builds environment information through exploring. As the above Figure 3.1, environment can be characterized by configuration or it's features. The reinforcement learning problem is usually solved by dynamic programming, Monte Carlo methods, or temporal difference methods (TD) which is a combination of Monte Carlo and dynamic programming [3]. In TD learning, no model is used for mimicking the environment, however the learnt rewards are updated. [3]

The Q-learning technique is yet another strategy that is often used to resolve RL challenges. Based on the past interactions between the system and its environment, this method enables learning the best policy to implement. This algorithm is an off-policy algorithm, as opposed to TD, because no policy is utilized to suggest the actions.

### 3.2.3 Regression Analysis

Regression uses one or more independent variables to describe the relationship between a dependent (target) and independent (predictor) variables. More specifically, regression analysis enables us to comprehend how, while other independent variables are held constant, the value of the dependent variable changes in relation to an independent variable. [23]

A model using regression algorithm can be implemented to determine the progress level of the user based on the values retrieved by the factors which are pronunciation accuracy and lip-reading accuracy.

In case of where we have data, which does not have linear relationships between each, we need a method to evaluate them. Pronunciation accuracy data and lip-reading accuracy data are data like that. Polynomial Regression comes in this scenario (where we have more complex data). Polynomial Regression is a regression algorithm that models the relationship between a dependent( $y$ ) and independent variable( $x$ ) as  $n$ th degree polynomial. Polynomial Regression is sensitive to outliers so the presence of one or two outliers can also badly affect the performance.

Mostly personalized user's data doesn't have linear relationships with one another this method can be used in measuring the two factors to evaluate the progress level of the user. [24]

So, a gamified e-learning system will be implemented with the use of Regression to analyze the data to implement the PM sub-component.

### 3.3 Project Requirements

#### 3.3.1 Functional Requirements

1. The quiz river in the system should be able to dynamically update its complexity level when the user is responding to the quiz.
2. The quiz will have to provide feedback to the user each time the user engages with the quiz and answers.
3. The system should be able to correctly identify the response time and accuracy rate of each question in the quiz and final quiz difficulty.
4. The system should use response time, accuracy rate and the final quiz difficulty factors to process and determine the initial status of the user.
5. The system should be able to retrieve bulk pronouncing accuracy rates and lip-reading accuracy rates from the database regarding each individual user.
6. The system should be able to detect the progress of the user with regards to their pronouncing accuracy and lip movement accuracy.
7. The system should be able to display the progress of the user by giving rewards to each progress level they showcase.

### 3.3.2 Non-Functional Requirements

1. Usability

The system should be easy to use. Since this is an application for small children this requirement is critical. The User Interfaces should not be complex and exhausting to learn. The games that are used should be easy to figure out how to play and provide suitable responses to the user.

2. Reliability

The probability of the system functioning without failures is Reliability. The system should not get stuck or fail throughout the process. It can cause users to lose interest in the system and leave.

3. Performance

The system should be able to perform the intended tasks effectively by providing accurate and quick responses to the user.

4. Accuracy

The system should show accurate results to the user as well as the system should retrieve accurate results from the user to be analyzed in personalized learning.

5. Recoverability

Recoverability is the ability of the system to be recovered after any kind of error or a failure and it needs to avoid data that were existing before the failure being lost after the failure recovery.

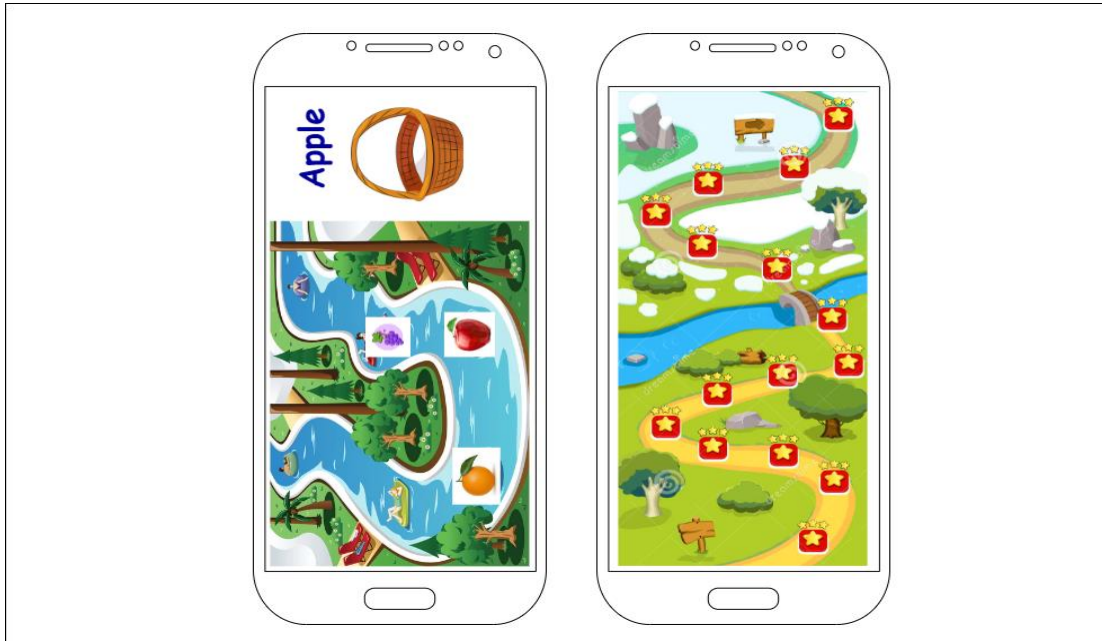


### 3.3.3 User Requirements

The application can be used by various types of users.

1. Children who have hearing losses, but they can slightly hear. As they were treated as deaf students, they lost the chance of improving the language over time. Those children can use this system with the use of hearing aids or headphones and improve their vocabulary.
2. Children who were hearing impaired and had gone through cochlear implants, brainstem implants or bone-anchored hearing aids can also use this system. These children spent some years of their life without hearing experience and they will be able to learn fast while practicing speaking using this tool.
3. Parents or Guardian will require to monitor the progress of the child using the progress map and understand the status of the child easily.
4. Centers that are existing to treat children with speech therapy will be able to use this tool to be recommended to use by child at home to continue learning and speaking. This will keep the child engaged in learning.

### 3.3.4 Wireframes



*Figure 3.3 Wireframes*

The first wireframe is for the quiz river. Different types of objects will be coming in the river and the user has to drag and drop the object to the basket which is matching to the text shown above the basket. In the first user visit to the application, an example will be shown to the user so they can understand what needs to be done.

The second wireframe shows the progress map. When the user continues to learn using the app, the progress will be evaluated, and the user will be able to collect stars. This can motivate the user as well as give feedback the user is progressing.

### 3.3.5 Tools and Technologies

#### 1. Python

Python is A high-level, all-purpose programming language. Code readability is prioritized in its design philosophy, which makes heavy use of indentation. Can use garbage collection and has dynamic typing. It supports a variety of paradigms for programming, including functional, object-oriented, and structured programming.

#### 2. React Native

This is used to create the client application. React native comes with native modules and components that improve performance. It provides smooth and responsive user interfaces, improves user experience and the load time is significantly lower compared to other technologies.

#### 3. REST API

Request and response model of our application will be supported by RESTful api's. This is an application programming interface that conforms to the constraints of REST (Representational State Transfer) architectural style and allows for interaction with RESTful web services and mobile applications

#### 4. Reinforcement learning

This is a machine learning training method based on rewarding desired behaviors. Adaptive learning environment will be created based on reinforcement learning. A modification of reinforcement Learning Q-Learning Algorithm will be used in the proposed system component.

#### 5. Regression Analysis

Regression uses one or more independent variables to describe the relationship between a dependent (target) and independent (predictor) variables.

#### 6. Gamified E-Learning

Gamification is applying game-like technique to encourage specific behaviors. [5] It makes sense to be used to provide encouragements to a specific behavior as response, engage effectively with children and help users to track their own progress.

#### 7. GitLab

GitLab, a DevOps software package that integrates the capacity to develop, secure, and operate software in a single application, is offered by GitLab Inc., an open-core business.

#### 8. Cloud Services (Azure)

An on-demand cloud computing platform will be used to host the final product. Azure is easy to use, flexible, cost-effective, reliable, scalable, and suits for our application.

#### 9. Mongo DB

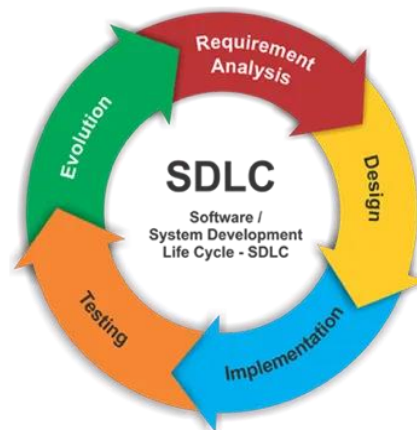
Mongo DB is a No-SQL database which is a document oriented. It is cross-platform, and it uses JSON-like documents. Mongo DB is more flexible, and it is ensuring high data availability compared to SQL databases.

#### 10. Visual Studio Code

This is common referred as VS Code. VS Code is a source editor, and it works with Windows, Linux and macOS. Some of the main features include supporting for debugging, highlight syntaxes, snippets and code completion intelligence.

### 3.4 Software Solutions

This section specifies how the system will be planned and developed. As a practice, the SDLC will be used to develop this component. The Software Development Life Cycle (SDLC) is a methodical approach to software development that ensures code accuracy and consistency. [25] Agile software development cycle model is used for the implementation. SDLC provides a framework for the developers to design, create, and produce high quality software product. SDLC, which is known as Software Development Life Cycle, is a well-known efficient way of building computer programs that guarantees the quality and rightness of the program built. This helps developers to create high-quality programs that meet client expectations. The system improvement ought to be total within the pre-defined time outline. SDLC comprises of a detailed plan which clarifies how to arrange, construct, and keep up a particular computer program. Each stage of the SDLC has its own process and deliverables that feed into the next stage of the procedure. This procedure is divided into several main stages as follows:



*Figure 3.4 Software Development Lifecycle*

### 3.4.1. Requirement Gathering and Analysis

The stage of requirements collecting may provide a comprehensive image of the scope of the entire proposed method as well as the anticipated problems, opportunities, and requirements that may arise throughout implementation.

The issues that deaf children encountered and the potential ways to address them will be evaluated.

In addition to compiling a list of requirements that would be required to build the system, research will be done to determine if existing systems are connected to the suggested solution. The list of requirements will also be analyzed to ensure that no misleading or unclear statements are there. In order to determine the vital aspects that need sufficient attention, comparable systems would be compared to the proposed system.

The team also considered how the system would work when the targeted tools and technologies were used. Additionally, lecturers and other experts in the field of ML were contacted to see whether the current approach is suitable. The architecture of the system was specified at this point. It was clear on the research gap that this system is supposed to fill.

The success or failure of a system depends on the results of the requirement analysis. It is quite important to thoroughly evaluate the research field in order to become the product successively. We will be able to determine through this evaluation whether the suggested approach will provide the required resolution for the raised research problem. The main steps in the requirement analysis for our study are listed below.

- Applies to the previous research papers on research field
- Studying about existing systems related to the field
- Visiting Ratmalana audiology center to gather requirements and analysis those things with current world
- Visiting deaf students' school to identify requirements and gather more information

### 3.4.2 Feasibility Study

The proposed solution will be evaluated at this stage to determine if the project is feasible or not. The useability of the envisioned notion will be investigated using the technologies that are already available. In addition, it is necessary to evaluate the cost of designing and making the solution available to the end user, the time required to build such a system, and the compatibility with other components. It was discovered that ML, NLP, and other mobile-related tools and features may be used to develop the system in the manner intended.

- **Schedule Feasibility:**

The project must be completed as planned within the allocated time, with each stage achieving respectable outcomes and maintaining on schedule. Additionally, make every effort to deliver the final product by the deadline.

- **Economy Feasibility:**

Even if the project's intended outcome, the final product, performs as anticipated and produces the desired results without any mistakes, it cannot be deemed successful if it is expensive. The components used have to be more dependable and cost-effective. As a result, the resources and necessary components were limited by financial restrictions.

### 3.4.3 Implementation

After requirement analysis process, the specifications gathered will be used as an input to the system and derived the software architecture to be used. Technical details of the design are addressed here such as threats, technologies to be used, time and budget. System designing refers to sketching the plan of the proposed approach to clarify the flow of the sub objective which needs to implement. Once the designing of the approach is completed, the next plans of the SDLC is the implementation. This is the phase where the proposed service rating algorithm starts to build. The following functions will be implemented during this phase:

1. Determine the user's initial status and monitor the progress
2. Given the chance to the user to explore the surrounding environment and learn from that
3. Analyzing lip movements and pronunciation and teach child to pronounce alphabet
4. Suggest similar words learn by the user previously and improve vocabulary

Under ISDPM component, following sub-tasks need to be completed. Those are,

- Implementing a dynamic quiz river
- Determine the Initial Status
- Detect the Progress of the Learner
- Display the Progress of the User

Datasets will be collected from both deaf students' school and audiology center at Ratmalana. And the application will be tested using real-world users and changes will be done before it is released.

The user reviews and comments will be constantly assessed when the app is in use and different versions will be released with future requirements.



#### 3.4.4 Testing

Iterative testing procedures will be used when designing the system. The system will be tested after the design of each significant sub-component to ensure that it produces the desired outputs and is compatible with the other sub-components. The system will be thoroughly tested once it has been fully integrated with the other parts to ensure that everything is working as it should and that it is safe and dependable enough for end users to utilize. Testing will be done under several steps as follows.

- Unit Testing - The developer of the functions will test each sub-functionality individually.
- Component Testing - To safeguard the consistency of the suggested strategy, multiple bug-free sub functionalities will be integrated and evaluated when unit testing is complete.
- Integration Testing - Developers are in charge of this testing phase's correctness of the planned method as well as the connections between its many sub-functionalities.
- System Testing - The developers will test the whole technique with all sub-functionalities combined into a single function to confirm its effectiveness.
- User Acceptance Testing - The suggested method will be made available to system users when developer-side testing is complete to determine user satisfaction.

### 3.4.5 Commercialization

This system is proposed as a solution to the problem which was mainly raised at the visits to the Ratmalana Audiology Center and Deaf Student's school on our field visit. Once developed, the application can be introduced to the doctors and speech therapists at Ratmalana audiology center and teachers at island wide deaf schools. Then the system can be recommended by them to be used by children.

Then children who are identified as hearing impaired and has a little chance of functioning as normal and children who can hear after adapting hearing aids and implants can use this system to improve their language proficiency.

The systems come in two versions.

- Free version will determine the initial status of the user and track the progress and then show it in a map.
- The premium version will show the progress map for pronunciation and lip movements separately and it will suggest online tutorials to improve their pronunciation and lip movements according to their weak areas. This feature will be added as a future implementation.

## 4. Work Breakdown Chart

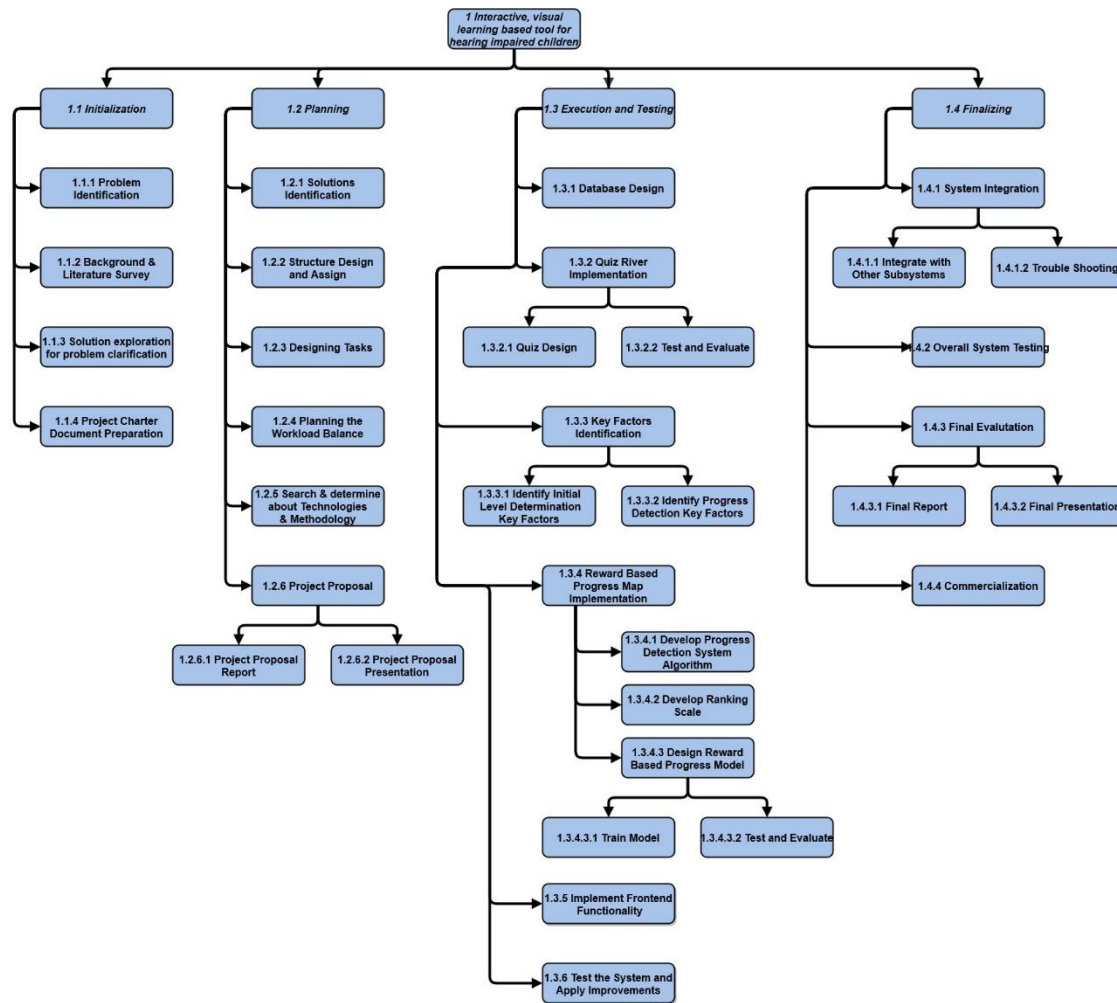


Figure 4.1 Work Breakdown Chart

## 5. Gantt Chart

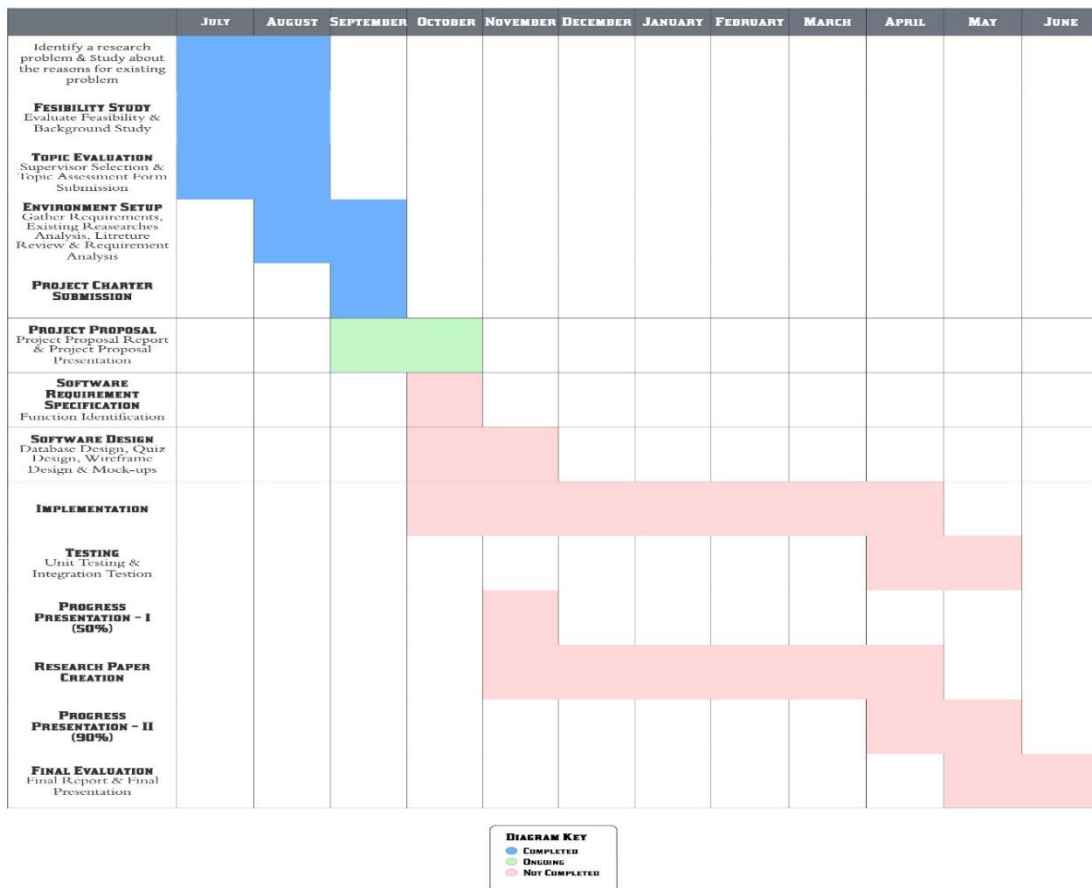


Figure 5.1 Gantt Chart

## 6. Budget and Budget Justification

The below table 5.1 showcases the overall budget evaluated for the implementation of the proposed system.

Expenses	
Requirement	Cost (Rs.)
Travelling cost to gather information	10,000.00
Travelling cost to gather data sets	10,000.00
Cost of Deployment	8000.00/Monthly
Cost of Hosting in App Store	13,500.50/Monthly
Cost of Hosting in Play Store	29,207.52/Monthly
Total Cost	70,708.02

*Table 5.1 Expected Expenses*

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## Appendices

### Appendix – A – Plagiarism Report

INTERACTIVE, VISUAL LEARNING-BASED TOOL FOR HEARING  
IMPAIRED CHILDREN TO IMPROVE LANGUAGE SKILLS

22\_23-J-18

Project Proposal Report














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October 2022

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