# Non-Verbal Learning Disability (NVLD) In age 10 - 13 Children

Project Id: TMP- 24-25J-150

Project Proposal Report

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# Improve Visual-Spatial Skills and Cognitive Flexibility

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# DECLARATION

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

| Name | Student ID | Signature |
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The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

2024/08/21

Signature of the supervisor                           Date

2024/08/21

Signature of the Co - supervisor                      Date

## ABSTRACT

To give educational support for children with Non-Verbal Learning Disorder (NVLD), our study introduces the function " Improve Visual-Spatial Skills and Cognitive Flexibility," a vital component of a comprehensive application designed specifically for NVLD children aged 10-13. This function addresses the unique learning needs of these children by offering adaptive and engaging gaming experiences. Through real-time feedback, such as positive reinforcements and partial prompts, this feature aids in displaying wrong answers, helping children through suggested activities based on their performance. By targeting specific challenges in visual-spatial skills and cognitive flexibility, this study aims to create intelligent mobile application for interactive and personalized assessments to identify and improve the ability to identify missing items between two images in order to enhance the cognitive skills of children with NVLD.

*Keywords—Nonverbal Learning Disability (NVLD), Visual-Spatial Skills, Personalized Learning Paths, Adaptive Learning, Interactive Learning, Real-Time Feedback, Positive Reinforcement, Partial Prompts, Cognitive Development, Missing Item Identification*

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# 1. INTRODUCTION

Children with Non-Verbal Learning Disorder (NVLD) face unique challenges in visual-spatial skills and cognitive flexibility. These difficulties can significantly impact their academic performance and overall quality of life. To address these challenges, the proposed research focuses on developing a "Improve visual-spatial skills and cognitive flexibility" function designed to enhance cognitive development in children with NVLD.

This function presents children with an interactive game: identifying missing parts between two ai generated images, progressively challenging them as they advance through various levels. The function adapts to the child's input and performance, offering real-time feedback, and personalized learning paths.

By integrating these features, the system aims to provide a tailored gaming experience that promotes continuous engagement and supports the cognitive growth of children with NVLD.

## 1.1 Background

Non-Verbal Learning Disorder (NVLD) is a neurological condition that affects various cognitive functions, particularly those related to visual-spatial skills, motor coordination, and non-verbal communication. However, making an interactive gaming experience to improve visual-spatial skills and cognitive flexibility potential area to support their overall cognitive development.

Traditional educational approaches may not adequately address the specific needs of children with NVLD, as these methods often fail to provide the personalized support and adaptive gaming paths required to foster effective visual-spatial skills. In recent years, technology has emerged as a powerful tool in gamification, and interactive digital platforms to enhance gaming experience of children while increasing their educational background. These advancements provide opportunities to create specialized tools tailored to the needs of children with disabilities like NVLD.

The proposed system builds on these technological advancements by offering a personalized, interactive, and adaptive gaming platform specifically designed for children with NVLD. By focusing on their strengths in verbal skills, the system aims to improve their visual-spatial skills, and cognitive development.

## 1.2 Literature Survey

Numerous studies have investigated methods to improve visual-spatial skills and cognitive flexibility, specifically focusing on tasks such as identifying missing items between two images. The following literature provides insight into this area of research:

**Gaggi, O., Barisic, I., & Palazzi, C. E. Invalid source specified.** [2] explore the use of interactive games to enhance visual-spatial skills. Their research demonstrates that tasks involving the identification of differences between two images can significantly improve cognitive flexibility in children with learning disorders. The study emphasizes the importance of personalized and adaptive gaming experiences, which are crucial for children with Non-Verbal Learning Disorder (NVLD) who often struggle with these tasks.

**Rodriguez, J., Casado-Muñoz, R., & García-Peñalvo, F. J.** [3] discuss the development of adaptive learning technologies aimed at improving visual-spatial skills through targeted exercises. Their research highlights the effectiveness of using tasks that require finding missing or different items between images, showing that these activities can enhance cognitive processing speed and accuracy in children with NVLD.

**Cheng, L., & Wang, X.** [4] examine the impact of real-time feedback in tasks that involve identifying differences between images. The study finds that providing immediate feedback, such as highlighting incorrect choices and offering hints, can significantly improve performance in visual-spatial tasks. This approach is particularly beneficial for NVLD children, as it helps them develop the necessary cognitive flexibility to succeed in these activities.

**Kumar, R., & Sharma, P.** [5] present a mobile application designed to improve cognitive skills in children with learning disabilities through interactive games. One of the key features of this application involves tasks that require users to identify missing items between two images. The research shows that this type of activity not only engages children but also helps in developing their visual-spatial skills and cognitive flexibility.

**Singh, A., & Gupta, M.** [6] investigate the use of gamified learning platforms to enhance cognitive abilities in children with developmental disorders. Their study focuses on games that involve finding differences between images, demonstrating that such tasks can improve visual-spatial skills and cognitive flexibility. The findings support the idea that incorporating these types of exercises into educational tools can be particularly effective for children with NVLD.

## 2. RESEARCH GAP

While significant progress has been made in improving visual-spatial skills and cognitive flexibility through interactive tasks, there are still gaps in research specifically targeting children with Non-Verbal Learning Disorder (NVLD). The proposed system aims to address these gaps by integrating adaptive gaming experiences, real-time feedback, and personalized interactive tasks into a platform designed to enhance visual-spatial skills and cognitive flexibility for children with NVLD. This system provides a tailored learning experience that addresses the unique challenges faced by this population, aiming to improve their cognitive development.

The following table compares existing research with the proposed system:

| Features | R1 | R2 | R3 | R4 | R5 | Proposed System |
|---|---|---|---|---|---|---|
| AI-Driven Image Generation | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Personalization | ✓ | ✓ | ✗ | ✓ | ✗ | ✓ |
| Adaptive Learning | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| Real-Time Feedback | ✗ | ✗ | ✓ | ✗ | ✗ | ✓ |
| Gamification and Engagement | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ |
| Cognitive Development and Visual-Spatial Skills | ✗ | ✗ | ✓ | ✗ | ✓ | ✓ |
| Error Navigation and Partial Prompts | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Focus on NVLD Children | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |

[2] Gamification in Education: Improving Visual-Spatial Skills through Interactive Games by O. Gaggi, I. Barisic, and C. E. Palazzi (2019). This study highlights the effectiveness of gamification in improving visual-spatial skills but does not specifically address NVLD children or incorporate features like real-time feedback and touch-screen interaction.

[3] Adaptive Learning Technologies for Special Education: A Systematic Review by J. Rodriguez, R. Casado-Muñoz, and F. J. García-Peñalvo (2021). This research demonstrates the benefits of adaptive learning technologies but lacks focus on NVLD children and does not include real-time feedback or touch-screen interaction.

[4] Real-Time Feedback in Interactive Learning Environments for Visual-Spatial Tasks by L. Cheng and X. Wang (2022). This study explores the impact of real-time feedback on visual-spatial tasks but does not specifically target NVLD children or incorporate features like touch-screen interaction.

[5] Mobile Applications for Cognitive Skill Enhancement in Children with Learning Disabilities by R. Kumar and P. Sharma (2021). Focuses on mobile applications for cognitive skill enhancement but lacks features like real-time error navigation and partial prompts which are crucial for NVLD children.

[6] Gamified Learning Platforms for Cognitive Flexibility in Children with Developmental Disorders by A. Singh and M. Gupta (2020). Investigates gamified learning platforms for cognitive flexibility but does not address NVLD-specific challenges or include real-time feedback and touch-screen interaction.

## 3. RESEARCH PROBLEM

1. What are the challenges faced by children with Nonverbal Learning Disorder (NVLD) in recognizing and processing visual-spatial information?

How do these challenges impact their cognitive development and daily functioning?

2. How can an AI-driven, interactive mobile application be developed to improve the visual-spatial processing and cognitive skills of children with NVLD?

What tasks involving the identification of missing items in images would be most effective?

The research problem focuses on addressing the challenges faced by children with Nonverbal Learning Disorder (NVLD) in recognizing and processing visual-spatial information. Specifically, these children struggle with identifying differences and missing elements in images, which affects their cognitive development and daily functioning. The research aims to develop an AI-driven, interactive mobile application that improves the visual-spatial processing and cognitive skills of children with NVLD by engaging them in tasks that involve identifying missing items in images. This application seeks to provide personalized, adaptive learning experiences that cater to the unique needs of each child, ultimately helping them to overcome their difficulties and improve their overall quality of life.

The main research challenges include:

1. Personalization and Adaptation: Developing an AI system that can effectively personalize and adapt the complexity of tasks based on each child's unique learning needs and progress.
2. Accuracy in Image Processing: Ensuring the AI accurately generates and modifies images, removing objects in a way that is challenging yet appropriate for the child's cognitive level
3. Engagement and Motivation: Designing the game to be engaging and motivating for children with NVLD, incorporating elements of gamification without overwhelming or frustrating the user.
4. Usability and Accessibility: Creating an intuitive and user-friendly interface that accommodates the specific needs of children with NVLD, including accessibility features that cater to various levels of ability.
5. Scalability and Performance: Ensuring the system can scale to accommodate multiple users while maintaining high performance and minimal latency during image processing and interaction

The goal is to address these challenges by leveraging technology to create a customized and interactive platform that supports NVLD children in developing essential cognitive skills and improving their educational outcomes.

# 4. OBJECTIVES

## 4.1 Main Objectives

The main objective of the AI-driven game is to enhance the cognitive skills of children with Nonverbal Learning Disorder (NVLD) by improving their ability to identify missing items in images through an engaging and interactive user interface that adapts to their individual learning needs.

## 4.2 Specific Objectives

A. Integrate gamified elements into the platform to enhance motivation and engagement while preventing cognitive overload.
B. Incorporate various levels of difficulty within the games to progressively build Visual-Spatial Skills.
C. Design and implement real-time feedback systems that offer immediate, constructive support during learning activities.
D. Design a user-friendly interface that accommodates the needs of NVLD children, ensuring that the application is accessible and easy to navigate

# 5. METHODOLOGY

## 5.1 System Architecture

The proposed system is designed to be a comprehensive platform that integrates adaptive gaming paths, interactive Visual-Spatial Skills, and real-time feedback mechanisms to support children with Non-Verbal Learning Disorder (NVLD).
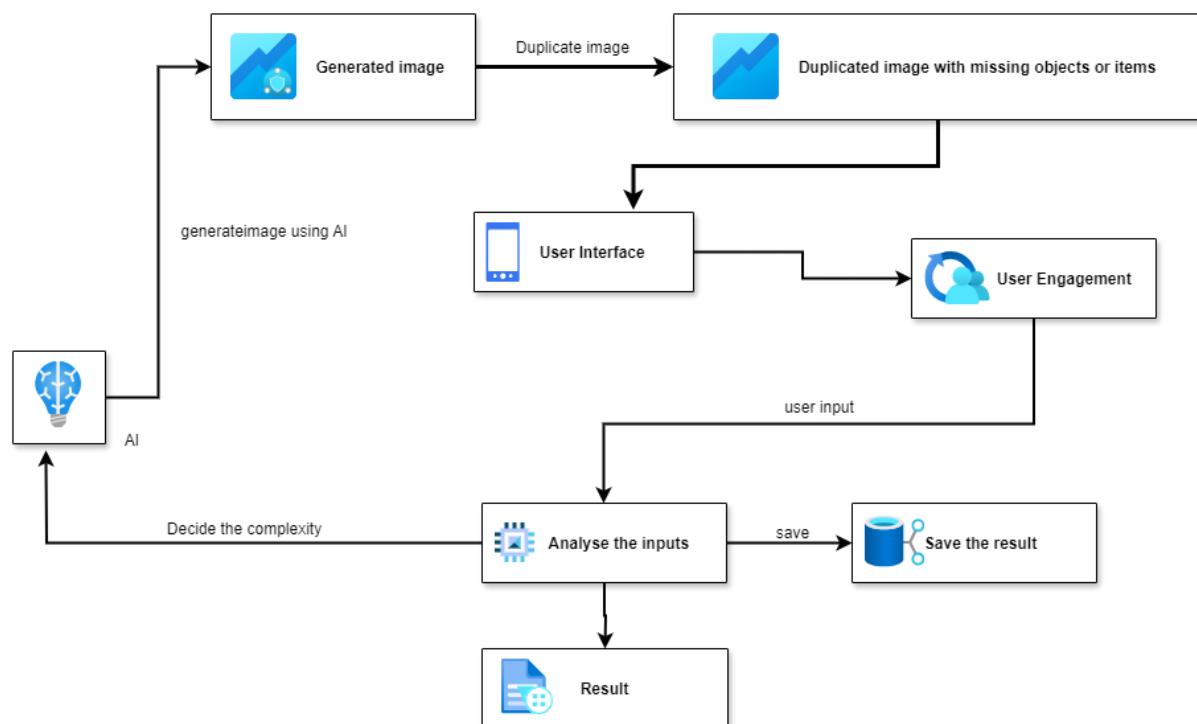


## 5.2 Software Solution

**Tools and techniques**

Programming Languages: Python for backend logic, Dart for frontend development.
Frameworks: Django or Flask for the backend; Flutter for the frontend.
Database: Firebase for storing user data and managing adaptive learning paths.
Machine Learning: TensorFlow for developing adaptive learning algorithms.
Gamification Libraries: Flame or similar Flutter-compatible libraries for creating interactive vocabulary games.

API Services: RESTful APIs for communication between frontend and backend, and for integrating third-party educational tools.

# 6. PROJECT REQUIREMENTS

6.1 Functional requirements

- AI Image Generation: The system shall generate a complete image using AI based on predefined parameters.

- Image Duplication with Missing Objects: The system shall duplicate the generated image and remove specific objects to create a challenge.

- User Interface Display: The system shall display the complete and modified images side by side for comparison.

- Touch Interaction for Identification: The system shall allow touch-based identification of missing objects with immediate feedback.

- Feedback Mechanism: The system shall provide instant feedback on whether the identified object is correct or incorrect.

- Progressive Difficulty Adjustment: The system shall adapt the difficulty level based on the child's progress.

- Performance Tracking: The system shall track and securely store the child's performance data for personalized adjustments.

- Gamification Elements: The system shall incorporate rewards and achievements to motivate the child.

- Error Guidance: The system shall guide the child through errors with hints and suggestions.

- Data Storage and Management: The system shall securely store all images, interactions, and performance data.

- Accessibility Features: The system shall include features like adjustable touch sensitivity to accommodate children with NVLD.
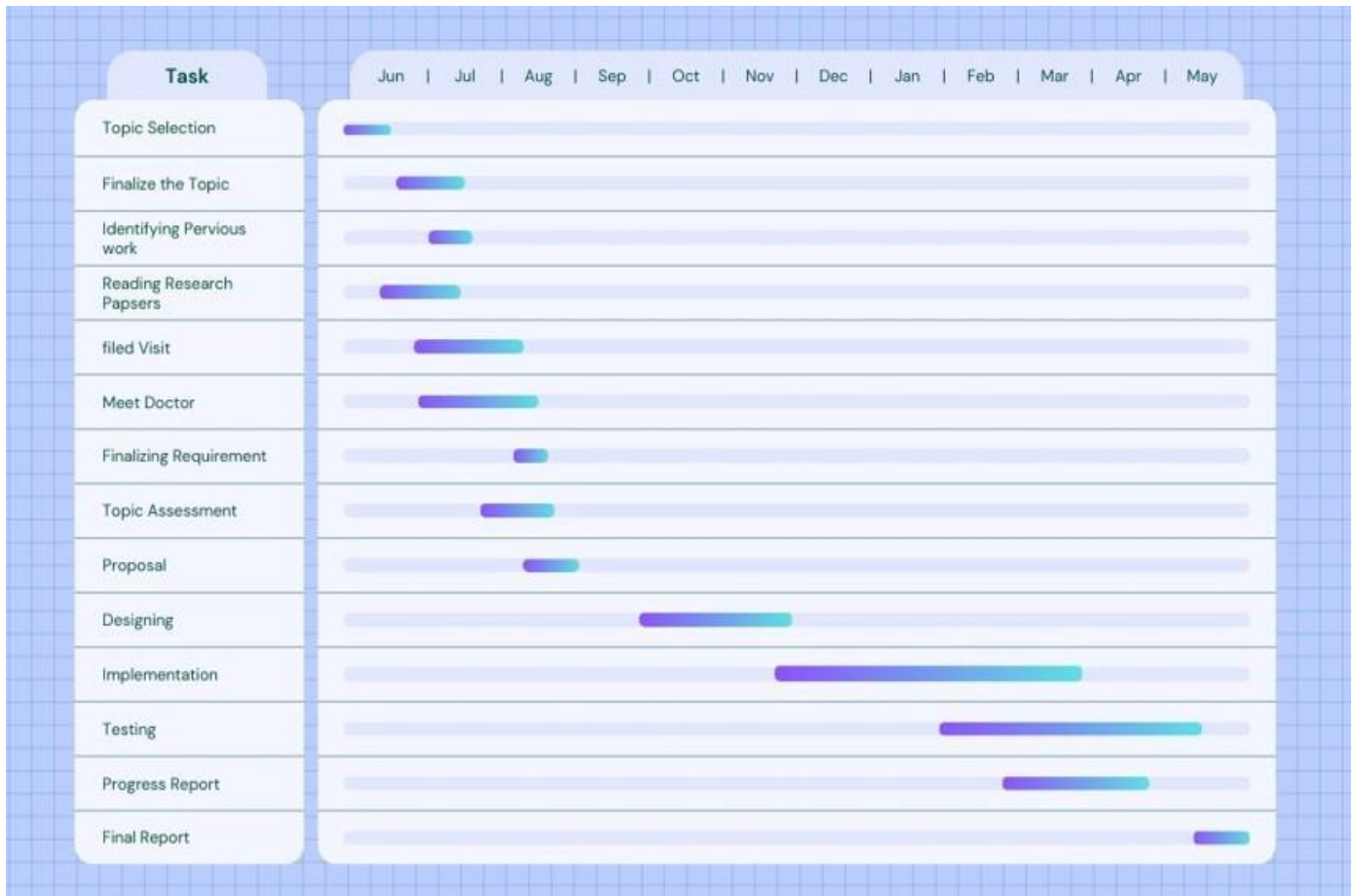
## 6.2 Non-functional requirements

- Performance

- Accuracy and Personalization

- Usability and User Experience

- Reliability and Availability

- Security

- Compatibility

- User Experience and Engagement
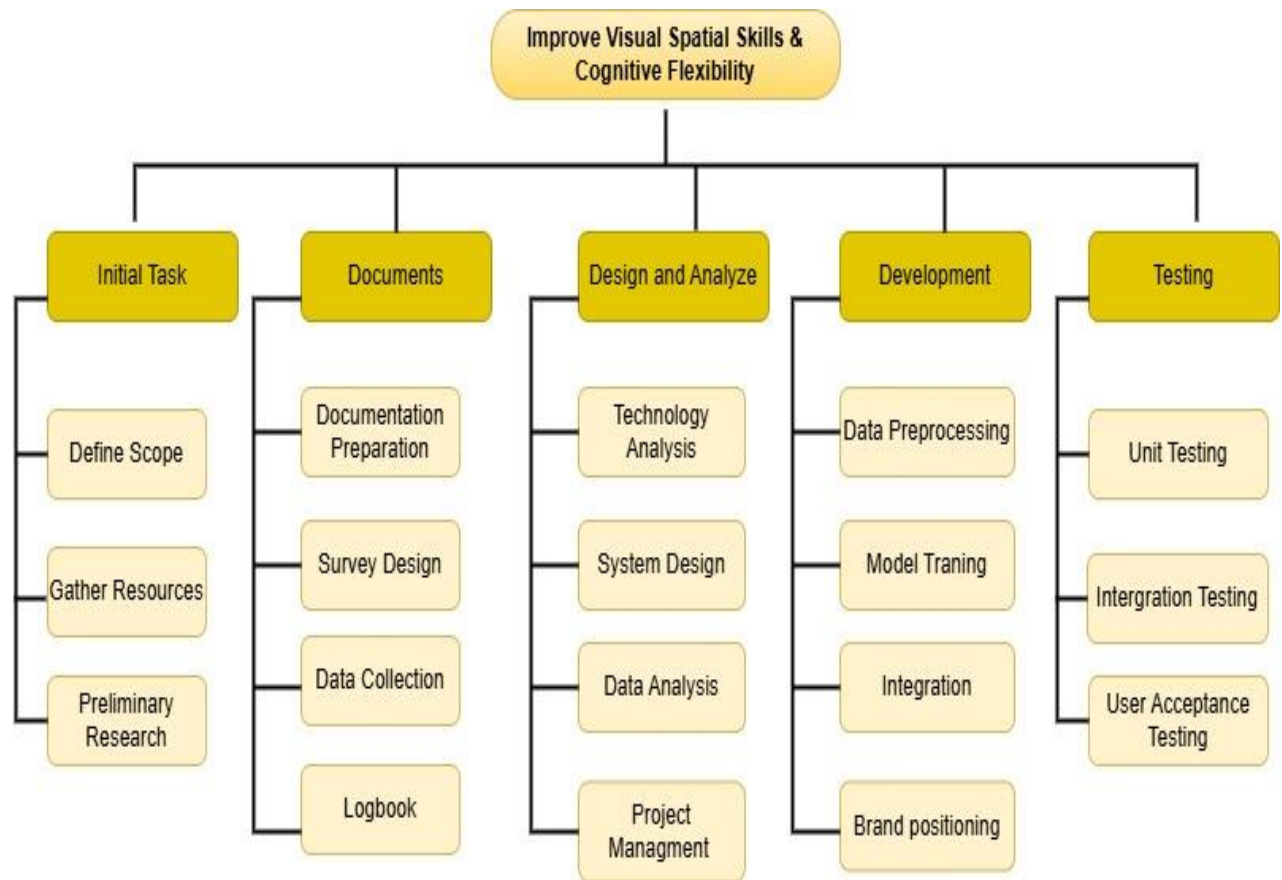
## 6.3 Expected Test Cases

| Test case ID | Test Case Description | Steps | Expected result |
|---|---|---|---|
| TC_01 | AI Image Generation. | 1.Trigger the AI to generate an image.<br><br>2.Review the generated image for completeness and accuracy. | The AI generates a high-quality image without any errors or omissions. |
| TC_02 | Image Duplication with Missing Objects | 1.Instruct the AI to duplicate the generated image.<br><br>2.Specify which objects or items should be missing in the duplicated image.<br><br>3.Review the duplicated image to ensure that the specified objects or items are correctly removed. | The duplicated image is created with the specified objects or items missing. |
| TC_03 | User Interface Display | 1.Load the complete image and the image with missing items into the user interface.<br><br>2.Check the alignment and visibility of both images on the interface. | The user interface displays both images clearly and side by side without any visual issues. |
| TC_04 | Touch Interaction for Identifying Missing Items. | 1. Have the child touch the area on the image where they believe an item is missing.<br><br>2.Monitor the system's response to the touch input. | The system accurately registers the touch and provides feedback on whether the correct area was identified. |

| TC_05 | Feedback on Correct or Incorrect Identification | 1.Have the child attempt to identify a missing item by touching the screen.<br><br>2.Observe the system's feedback after the touch. | The system provides positive feedback when the correct area is touched and constructive feedback when the wrong area is selected. |
|---|---|---|---|
| TC_06 | Enhancement of Cognitive Skills Through Repeated Interaction | 1.Record the child's initial performance (e.g., number of correct identifications).<br><br>2.Allow the child to play multiple rounds of the game.<br><br>3.Record the child's performance after several sessions. | The child's ability to identify missing items improves with repeated interactions, as indicated by an increase in the number of correct identifications. |

# 7. GANTT CHART



| Task | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Topic Selection | | | | | | | | | | | | |
| Finalize the Topic | | | | | | | | | | | | |
| Identifying Pervious work | | | | | | | | | | | | |
| Reading Research Papsers | | | | | | | | | | | | |
| filed Visit | | | | | | | | | | | | |
| Meet Doctor | | | | | | | | | | | | |
| Finalizing Requirement | | | | | | | | | | | | |
| Topic Assessment | | | | | | | | | | | | |
| Proposal | | | | | | | | | | | | |
| Designing | | | | | | | | | | | | |
| Implementation | | | | | | | | | | | | |
| Testing | | | | | | | | | | | | |
| Progress Report | | | | | | | | | | | | |
| Final Report | | | | | | | | | | | | |

# 8.WORK BREAKDOWN CHART

## 9. COMMERCIALIZATION
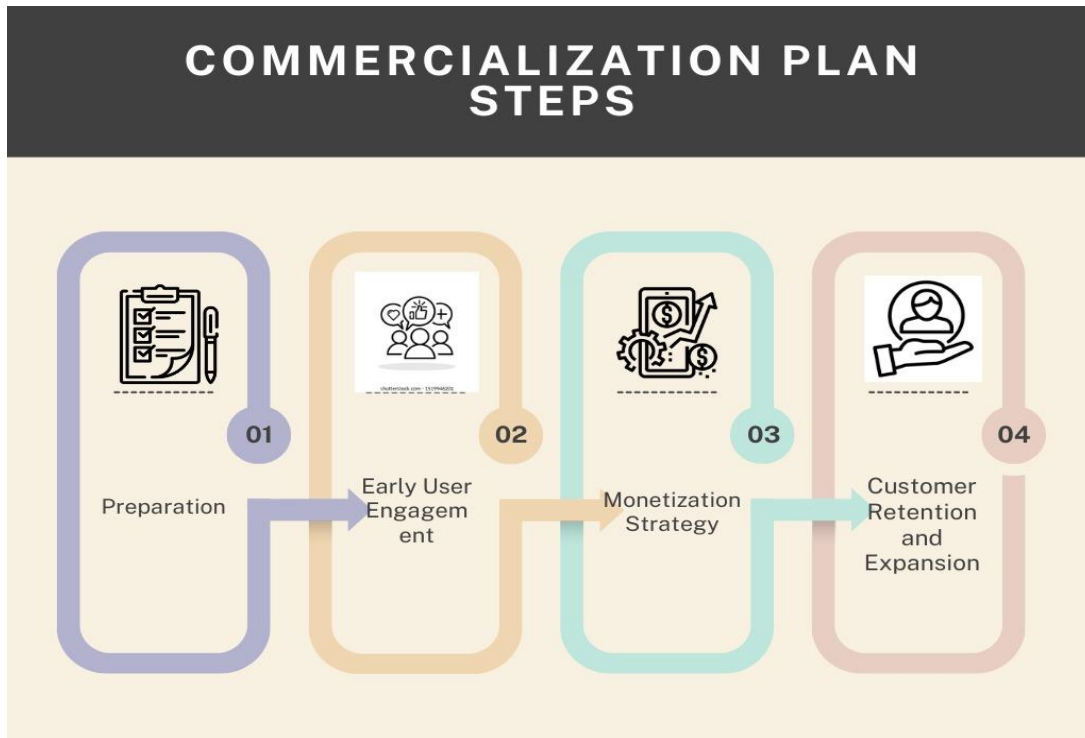


Phase 01: Preparation

- Objective: Understand target users and ensure the app works seamlessly.
- Activities: Conduct research with parents, educators, and therapists thoroughly test the app.
- Outcome: A well-defined, user-ready product.

Phase 02: Early User Engagement

- Objective: Gather feedback to refine the app.
- Activities: Offer the app for free to a select group; collect user feedback.
- Outcome: Targeted improvements, enhancing app effectiveness and usability.

Phase 03: Monetization Strategy

- Objective: Introduce paid features after refinement.
- Activities: Implement a tiered pricing model; explore partnerships with schools.
- Outcome: A sustainable revenue stream for ongoing development.

Phase 04: Customer Retention and Expansion

- Objective: Retain customers and grow the user base.
- Activities: Launch a loyalty program; phase out the free version.
- Outcome: A loyal customer base and expanding community.

# 10.DESCRIPTION OF PERSONAL AND FACILITIES

| Registration No | Name | Task Description |
|---|---|---|
| IT21181788 | Madanayake P.C.S | • Identify and analyze cognitive challenges faced by children with Nonverbal Learning Disorder (NVLD).<br>• Develop AI-driven image generation and duplication features with missing objects for cognitive skill enhancement.<br>• Implement touch-based identification games in the user interface to improve visual-spatial skills.<br>• Create a performance analysis dashboard to evaluate the child's progress and adapt difficulty levels accordingly. |

# 11. REFERENCES

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# 12. APPENDICES

## Appendix A: Plagiarism Report