MagicMind-Mobile Application to reduce **Non-Verbal Learning Disability (NVLD)**

Project Id :24-25J-150

Project Proposal Report

Mendis T.S.P.

BSc (Hons) in Information Technology Specializing in Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

June 2024

MagicMind-Mobile Application to reduce **Non-Verbal Learning Disability (NVLD)**

Project Id :24-25J-150

Project Proposal Report

Mendis T.S.P.

Submitted to:

Supervisor: Mrs. Lokesha Weerasinghe

Co-Supervisor: Ms. Malithi Nawarathne

BSc (Hons) in Information Technology Specializing in Information Technology

Department of Information Technology

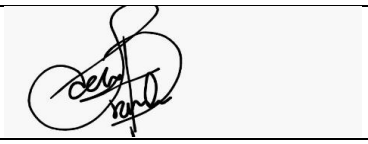
Sri Lanka Institute of Information Technology

Sri Lanka

June 2024

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
Mendis T.S.P	IT21207136	

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

.....

Signature of Supervisor

22/08/24

.....

Date

.....

Signature of Supervisor

.....

Date

ABSTRACT

A unique issue is presented by nonverbal learning disability (NVLD), which is typified by good verbal talents combined with notable deficiencies in motor coordination, social communication, and visual-spatial processing. These challenges may have a significant influence on day-to-day activities and academic performance. Conventional approaches frequently place a strong emphasis on verbal communication at the expense of the vital nonverbal and spatial skills that children with NVLD require.

To precisely address these issues, our research suggests creating a novel mobile application that makes use of artificial intelligence (AI) and machine learning. Through the uploading and analysis of real-world images, the program will help children with NVLD improve their understanding of spatial relationships and visual information processing. The software aims to enhance social interaction and spatial reasoning abilities by providing interactive learning experiences and individualized feedback.

The purpose of the study is to determine how well an AI-powered teaching tool can help children with NVLD develop their social and spatial awareness. A significant improvement in their capacity to comprehend and navigate their surroundings is the expected result, which will encourage increased independence and improve their standard of living in general. A major advancement in the application of educational technology for neurodevelopmental problems is represented by this research.

***Keyword*: Nonverbal Learning Disability (NVLD), Visual-Spatial Processing, Neurodevelopmental Disorders, Spatial Relationships, Spatial Reasoning**

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Understanding challenging visual information and navigating the physical environment are only two examples of the many daily tasks that depend on the ability to identify object relationships, a crucial cognitive ability. Children's development in areas like problem-solving, spatial thinking, and social interaction is largely dependent on their capacity to perceive and understand how objects relate to one another in space. Yet, due to deficiencies in visual-spatial processing, children with nonverbal learning disabilities (NVLD) frequently struggle with these abilities, which can have a major negative influence on their everyday functioning and scholastic achievement.

Studies have indicated that visual-spatial processing issues are a defining feature of nonverbal learning disorder (NVLD), making it difficult to perform tasks involving the interpretation of nonverbal cues and the knowledge of spatial relationships [1]. These difficulties go outside the classroom and include real-world scenarios like following instructions, deciphering maps, or engaging in activities that call for coordination and spatial awareness [2]. Despite these difficulties, there aren't many focused interventions that particularly address the requirement that kids with NVLD learn to recognize object relationships in everyday situations.

Technological developments in education, especially the application of artificial intelligence (AI), present new possibilities for designing interventions that are specifically designed to assist in the development of certain abilities. Personalized feedback and visual data analysis capabilities of AI can be used to develop interactive solutions that support children with nonverbal learning disabilities (NVLD) in developing their spatial thinking. Research has indicated that AI-powered educational tools have the capacity to improve learning outcomes, especially when they are tailored to the individual needs of the user [3]We may create a more efficient method of assisting kids with NVLD in comprehending and navigating the spatial relationships in their surroundings by utilizing these technologies, which will ultimately enhance their quality of life in general.

2. BACKGROUND & LITERATURE SURVEY

NVLD's Neurological Foundations and Visual-Spatial Difficulties,A basic description of NVLD is given by Rourke, B.P. [1], who focuses in particular on the visual-spatial impairments connected to the disorder. The study highlights how the right hemisphere of the brain, which is essential for interpreting nonverbal cues, is frequently underdeveloped in children with nonverbal learning disabilities (NVLD). Significant difficulties with fine motor control, spatial awareness, and visual information interpretation result from this neurological base. The study emphasizes the necessity of focused therapies meant to address these particular visual-spatial difficulties.

St. Pierre, Thomas, and Johnson [4] look at how kids utilize prepositions to learn and comprehend spatial relationships in their book Children's utilize of Prepositions in Word Learning and Spatial Relationships. Through supervised language use, youngsters may successfully understand spatial relationships, according to this cognitive science study. Despite the fact that the study concentrates on usual development, the insights offered may be helpful in modifying instructional approaches for kids with NVLD, who have difficulty with visual-spatial processing. Applying these findings particularly to tools made for kids with NVLD to help them comprehend object relationships in everyday situations is lacking, though.

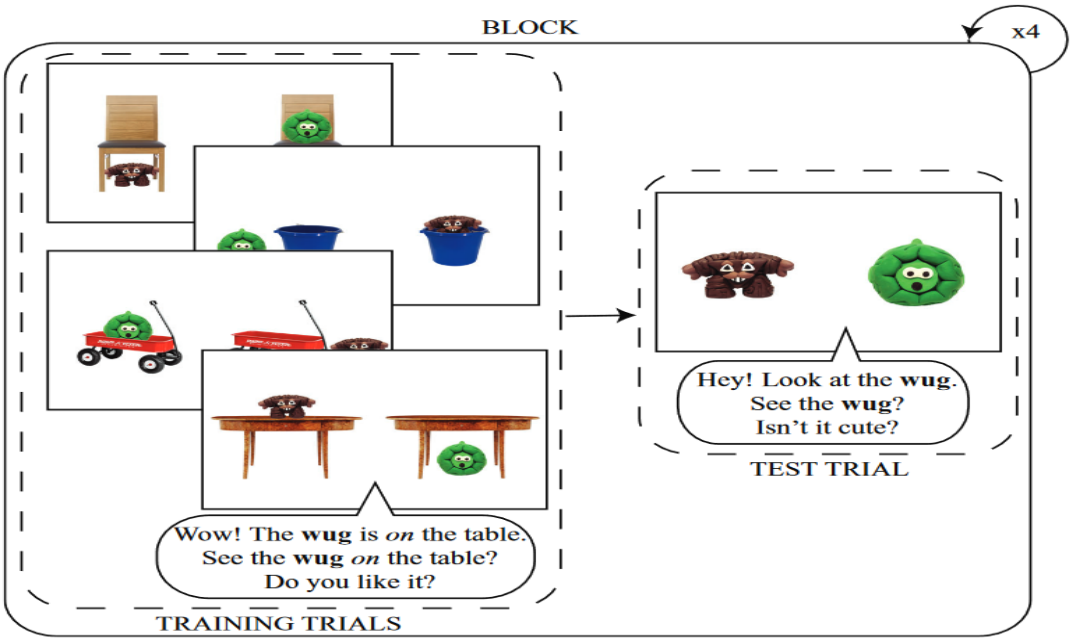


Figure 1.1:An example experimental block

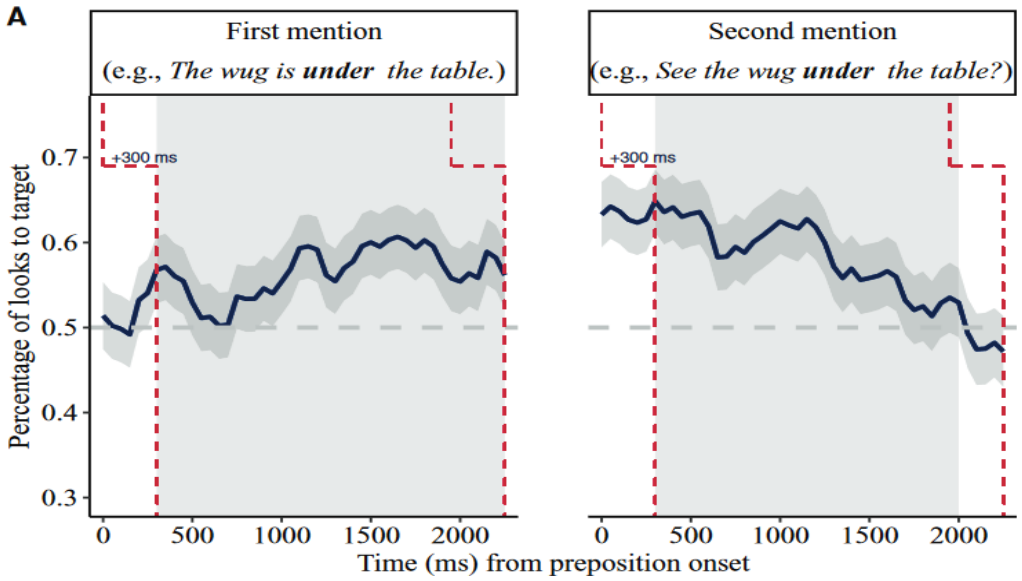


Figure 1.2:Displays the proportion of looks across all prepositions

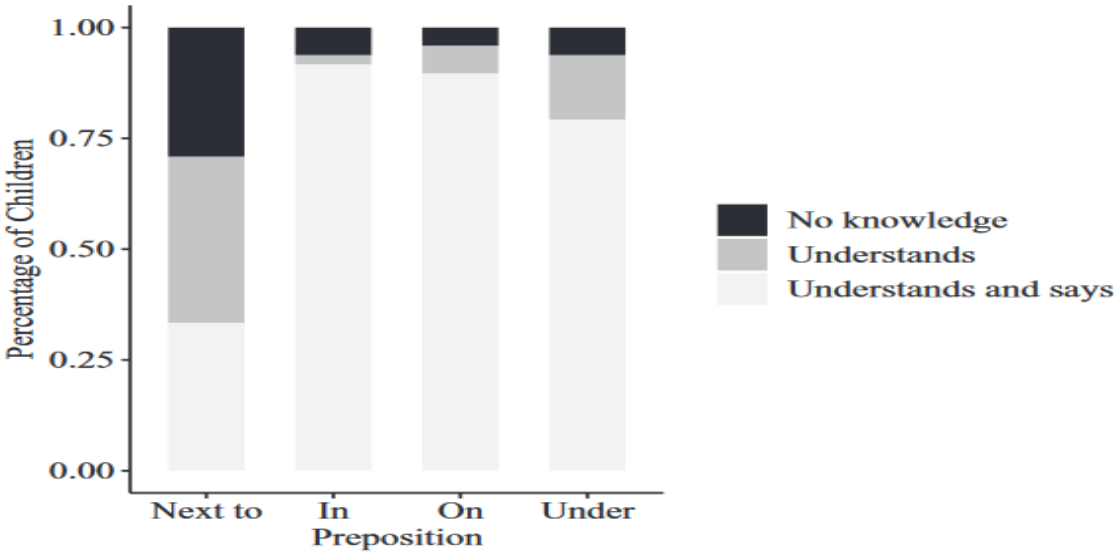


Figure 1. 3: Parental reports of their child's knowledge of prepositions.

Identifying Items for Kids with Mental Illnesses, The use of visual learning as an object recognition technique to help children with mental problems is investigated by Kristanto et al. [5]. According to the study, object recognition can be a useful strategy for improving visual learning in this particular demographic. Though this study focuses on mental illnesses in general, it does not particularly address the special requirements of kids with NVLD. It is still unknown how object identification technology could help kids with NVLD, especially when it comes to comprehending item relationships in real-world photos.

Mahdi, H.S. [6] examines the application of object identification and spatial relationship analysis in image understanding in his book picture Understanding Using Object Identification and Spatial Relationships. The study demonstrates how these methods can greatly improve the understanding of spatial relationships seen in photographs. This is especially important for instructional materials designed to help kids with nonverbal learning disabilities develop their visual-spatial processing abilities. The lack of a specific focus on children with NVLD in the study, however, indicates a gap in the implementation of these strategies for this population.

Principles of Human-Computer Interaction in Educational Instruments The significance of Human-Computer Interaction (HCI) principles in the creation of instructional tools is covered by Norman, D.A. [7]. By developing intuitive and adaptable interfaces, HCI may improve the user experience. This is especially helpful for kids with NVLD who might have trouble with conventional teaching techniques. The study highlights how important it is to provide engaging and easily available educational resources for kids with learning impairments. Research on specifically applying these ideas to aids made for kids with nonverbal learning disabilities is lacking, nevertheless.

Intelligent Tutoring Systems using AI, The use of artificial intelligence (AI) in the development of intelligent tutoring systems is examined by Woolf, B.P. [8]. These systems work especially well for kids with learning problems because they can provide them tailored feedback and adjust based on how well the student is doing. The study emphasizes how artificial intelligence (AI) has the power to transform educational resources by increasing their responsiveness to individual needs. Notwithstanding this promise, little study has been done on the use of AI-driven feedback systems designed especially for kids with NVLD, particularly when it comes to recognizing object relationships.

Real-Time Object Recognition using the YOLO Model, Redmon, J., & Farhadi, A. [9] present the YOLO (You Only Look Once) model, which combines speed and accuracy to greatly enhance real-time object identification. This technique holds great relevance in the development of instructional tools that need to analyze images in real time, such those that help kids with NVLD comprehend relationships between objects. Nevertheless, the study does not investigate the use of YOLO or related technologies in learning environments, especially for kids with NVLD.

Cognitive Techniques for NVLD Children, the focus of Carlson, C., & Phillips, R. [10] is on the cognitive techniques that kids with NVLD employ. According to the study, these kids perform well in controlled learning contexts but frequently falter when given unstructured assignments. This understanding is essential for creating teaching resources that can seamlessly switch between structured and unstructured learning environments. The gap is caused by the absence of adaptive teaching resources that can help kids with NVLD make this shift while also enhancing their comprehension of object relationships.

3. RESEARCH GAP

The majority of currently available programs either concentrate on general learning difficulties or do not offer the necessary flexibility and engagement that children with NVLD require. Furthermore, a lot of the content used in current technologies is pre-generated and might not be as interesting or applicable to users' real-world experiences.

identifying object relationships in real world technique is urgently in need of implementation, as shown by the literature review that was done above since it has received significant attention in the learning sector. We can see that the study performed so far under the area of “object relationships in real world" covers the following key points:

- Lack of Focused Intervention techniques- By offering a tool created specially to assist kids with NVLD in comprehending object interactions in everyday situations,
- HCI Application- system makes sure that the interface is user-friendly and entertaining by implementing HCI principles.
- AI-Driven Individualized Feedback - system bridges the gap in using AI for NVLD teaching tools by using AI to deliver real-time, individualized feedback.
- Real-Time Object Detection - The system uses artificial intelligence (AI) to detect objects in real-time within photographs.
- Adaptive Learning - One of your system's main features is the ability to go from organized to unstructured situations with the help of adaptive feedback.
- Focus on Object Relationship Recognition - The primary goal of system is to enhance object relationship recognition, directly addressing the insufficient research on adaptive learning technologies for children with NVLD.

Table 1:Comparison of past studies

	Lack of Intervention Strategies for NVLD	Application of HCI for NVLD	AI-Driven personalized feedback for NVLD	Real-Time Object Detection Integration	From Structured to Unstructured Environments	Technologies for Object Relationship Recognition
Research A	✓	✗	✗	✗	✗	✗
Research B	✗	✗	✗	✓	✗	✗

Research C	✗	✓	✗	✗	✗	✗
Research D	✗	✗	✓	✗	✗	✗
Research E	✗	✗	✗	✗	✗	✓
Research F	✗	✗	✗	✗	✓	✗
Proposed System	✓	✓	✓	✓	✓	✓

When comparing previous research to the proposed system, it's clear that the proposed system introduces novel functionalities that address key gaps. The proposed system uses AI to generate personalized questions and feedback based on real-world images provided by the user, offering a highly adaptive learning experience that directly targets the challenges faced by children with NVLD.

4. RESEARCH PROBLEM

What gaps exist in modern techniques and devices designed for children with NVLD, according to the text?

What role does the proposed mobile application play in improving the skills of children with NVLD?

In what ways does the mobile application plan to enhance children's spatial awareness and understanding of visual information?

Why is it important for the educational tool to be individualized and flexible in its learning experiences?

Strong verbal abilities are present, but visual-spatial, motor, and social communication skills are severely challenged in nonverbal learning disability (NVLD), a neurological disorder. Nonverbal cues, such as body language, facial expressions, and spatial relationships, are difficult for children with nonverbal learning disabilities (NVLD) to perceive. These skills are essential for social interaction and environment navigation. Conventional therapies emphasize verbal communication above all else, ignoring the nonverbal and spatial aspects that are vital to NVLD children's overall development. These kids receive insufficient support as a result of this gap, especially when it comes to their social and spatial reasoning development.

The specific and distinctive needs of children with NVLD are frequently unmet by modern techniques and devices, which results in generalized therapies that are insufficiently successful. Furthermore, the youngsters are rarely meaningfully engaged by these programs, which limits their capacity to use newly acquired skills in practical situations.

By creating an innovative educational tool - a mobile application that uses machine learning to provide individualized and flexible learning experiences-our research aims to close this gap. Children will be able to upload and examine real-world images to gain a better understanding of item relationships in their surroundings through the program, which focuses on improving spatial awareness and their understanding of visual information. This project seeks to dramatically improve the social interaction skills and spatial awareness of children with NVLD, consequently boosting their capacity to function independently in daily life. The strategy will be customized based on each child's needs and progress.

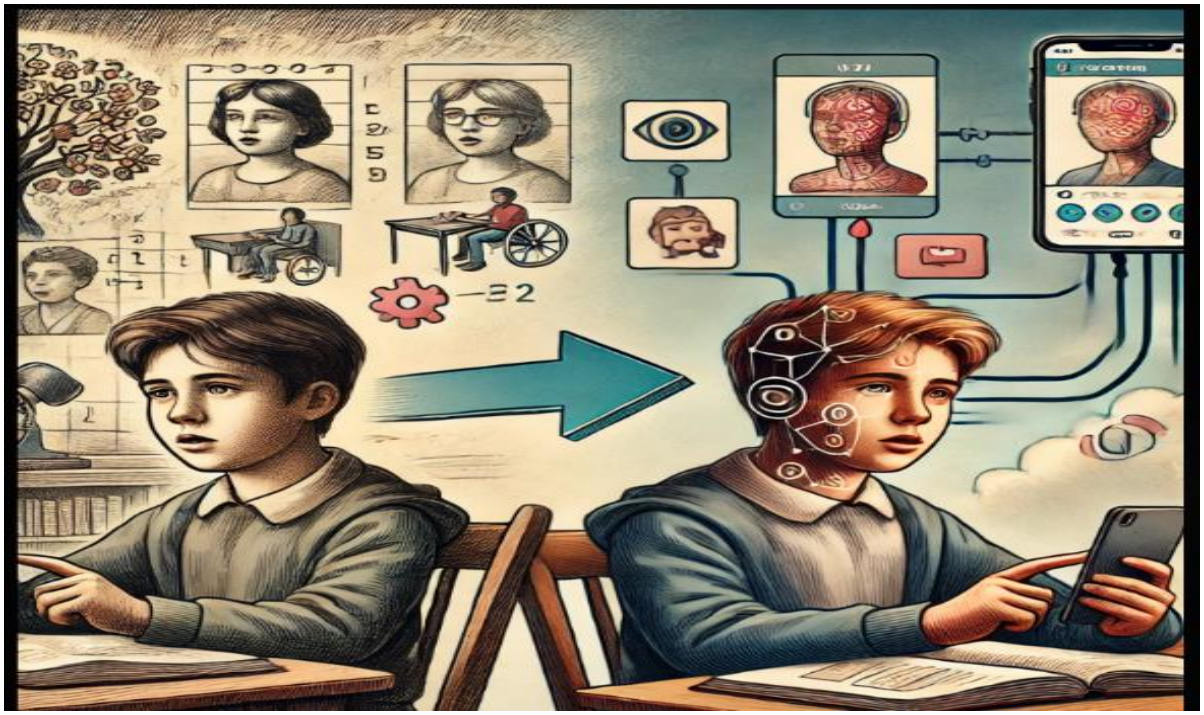


Figure 1.4:Traditional ->modern Technology

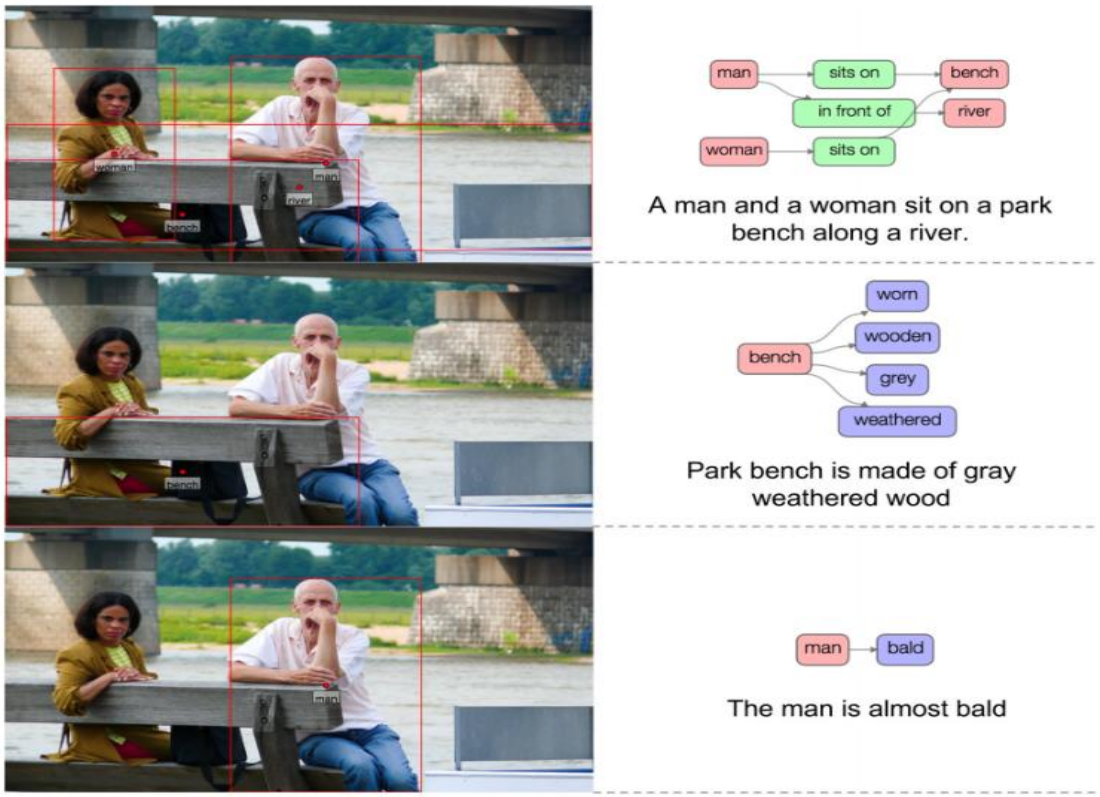


Figure 1. 5

This picture shows(figure:1.5) [11] how, for kids with NVLD, traditional teaching techniques give way to more contemporary, technologically advanced ones. It illustrates how using a mobile application that uses machine learning to deliver individualized learning experiences has replaced traditional classroom instruction. The innovation and advancement that your research aims to achieve are highlighted in this visual appearance.

5. OBJECTIVES

Children with Nonverbal Learning Disorder (NVLD) face significant challenges in critical thinking, visual-spatial processing, fine motor coordination, and social skills, which impact their daily interactions and academic performance. Enhance visual-spatial skills and pattern recognition through interactive activities that require identifying and completing images with missing elements. Develop critical thinking and spatial awareness by using AI to generate and identify object relationships within images, providing tasks that challenge children to recognize and understand positional concepts.

5.1. Main objectives

Enhanced Main Goal: Developing, implementing, and evaluating a mobile application to improve social interaction and spatial connection skills in kids with nonverbal learning disabilities is the main goal of this research (NVLD). With the use of Artificial intelligence (LLM, LVM) this application will provide tailored learning experiences that adjust to the unique learning styles and development of every child, with the goal of enhancing their comprehension of nonverbal clues and spatial relationships.

5.2. Specific objectives

- How to Create a Mobile Application That Is User-Centric:

  Intelligent User Interface: Create a user interface that is easy for kids with NVLD to browse and interact with by making it clear, simple, and kid-friendly. Children will find it easier to comprehend intricate spatial and relational ideas with the help of the interface's options to help identify relationships between objects.

  Visually Pleasing UI: Design a user interface that is both visually attractive and interesting for kids to use. Encouragement features like prizes, animations, and positive feedback will be incorporated into the design to help and inspire kids as they learn.

- To Implement AI-Driven Relationship Detection and Object Recognition Into Practice:

  Object Detection: Create and implement a system that can correctly identify and classify a number of items in a single picture. Children will be able to upload real-world photos to this system, and the app will use those images to recognize items and their relationships.

  Real-Time Feedback and Guidance: Include a feedback loop in which the app gives children immediate answers, pointers, and corrections to help them understand object relationships and develop their spatial awareness.

- To Provide Complete Help to Guardians and Teachers:
  Encourage the active participation of guardians and educators by offering doable tasks and tactics that can be used at home or in the classroom to reinforce the skills that students acquire using the app.

6. METHODOLOGY

6.1 System overview diagram

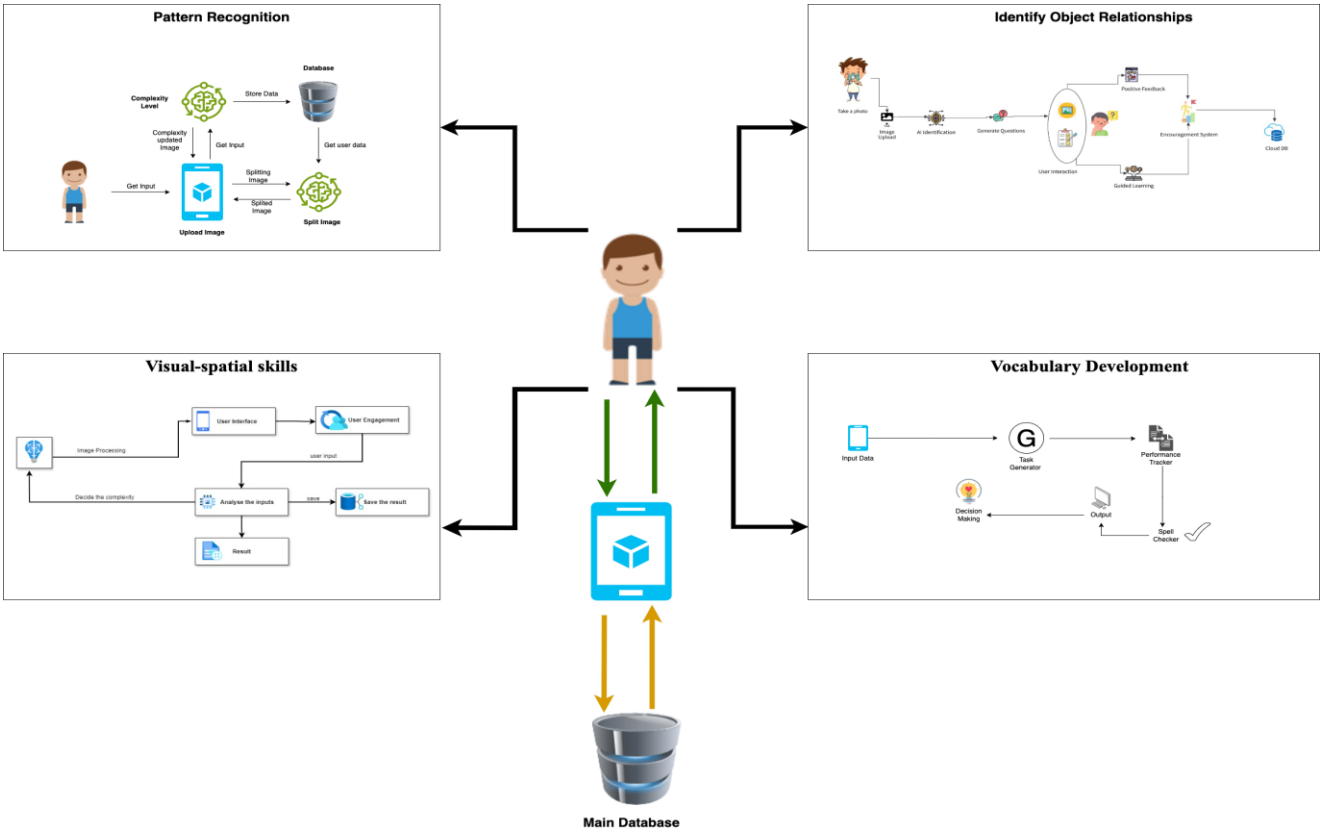


Figure 1.6:System overview diagram

The primary four subcomponents are distributed among each member in the high-level architecture diagram (Figure) that is displayed above. The following features are planned for the "MagicMind" platform.

- Enhance Your Ability to Match Interactive Patterns
- Recognizing Real-World Object Relationships
- Customized Education Routes Using Interactive Vocabulary Tests
- Boost flexibility and visual-spatial abilities

The Flutter will be used in the development of the user-accessible front end. A Firebase database will be available.

6.1.1. Software solution

The agile methodology is included in the suggested software development lifecycle plan. Project management with Scrum mythology is a straightforward method that produces better results. The development of a system is divided into sprints. The proposed system, according to the team, could be constructed in less than two weeks. A daily scrum meeting should also go no longer than 20

minutes so that it may cover the whole development process. For the daily scrum meeting, the team decided to use Microsoft Teams. A two-week evaluation of the sprint takes place. The team will do weekly sprint reviews in addition to daily scrum sessions. The team decided for managing the backlog and tasks using third-party software.

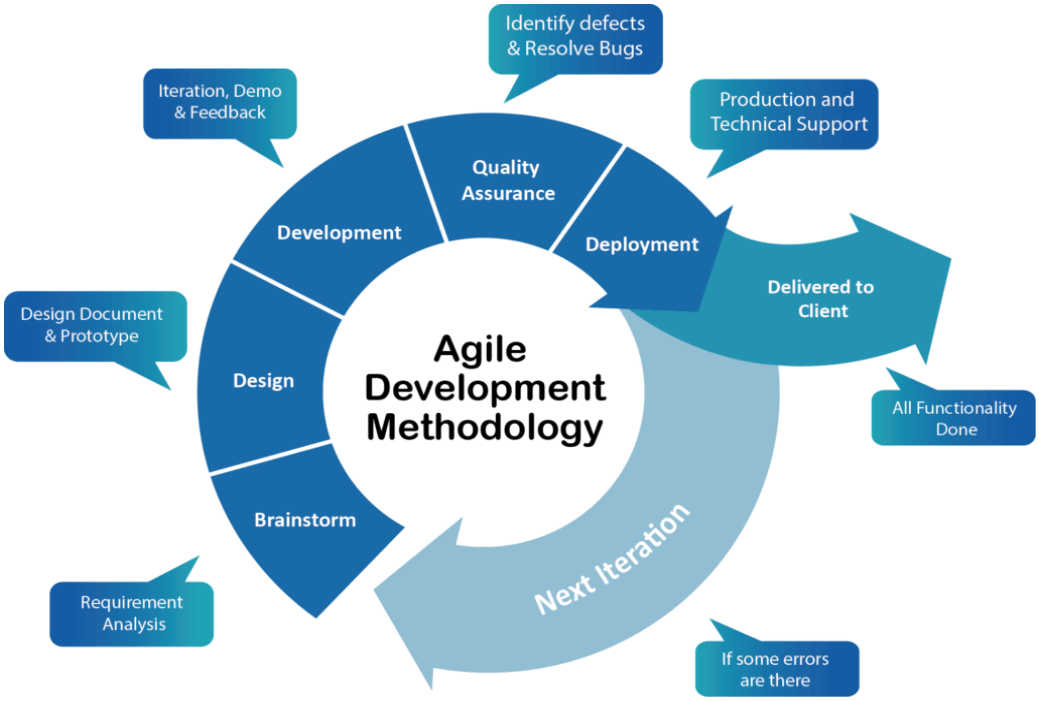


Figure 1. 7:Agile Development cycle

The fluidity of the development process is ensured by the agile methodology. The essential phases of agile software development are shown in the above diagram

6.2 Overview diagram for the identify object relationship in real world

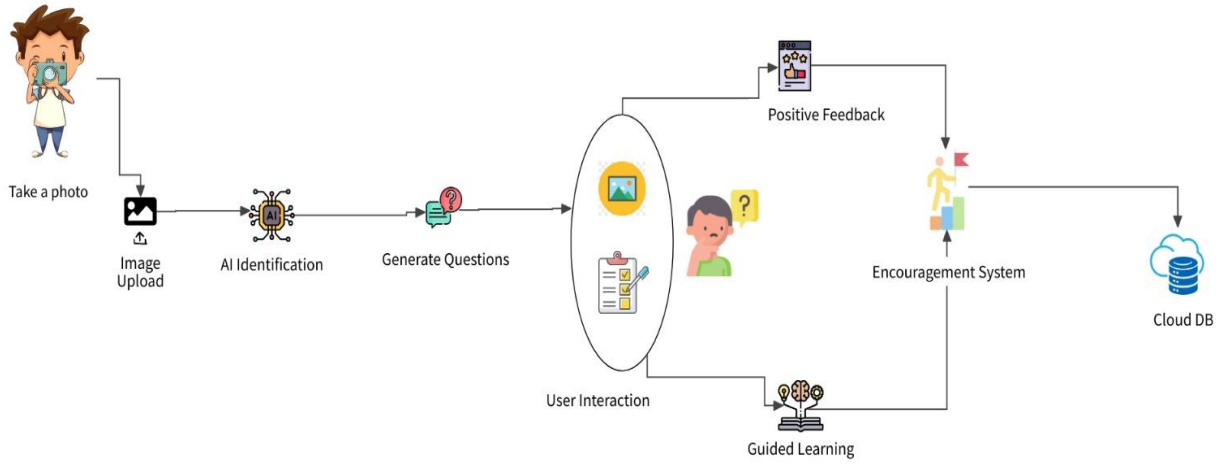


Figure 1 .8:Overview diagram for the identify object relationship in real world

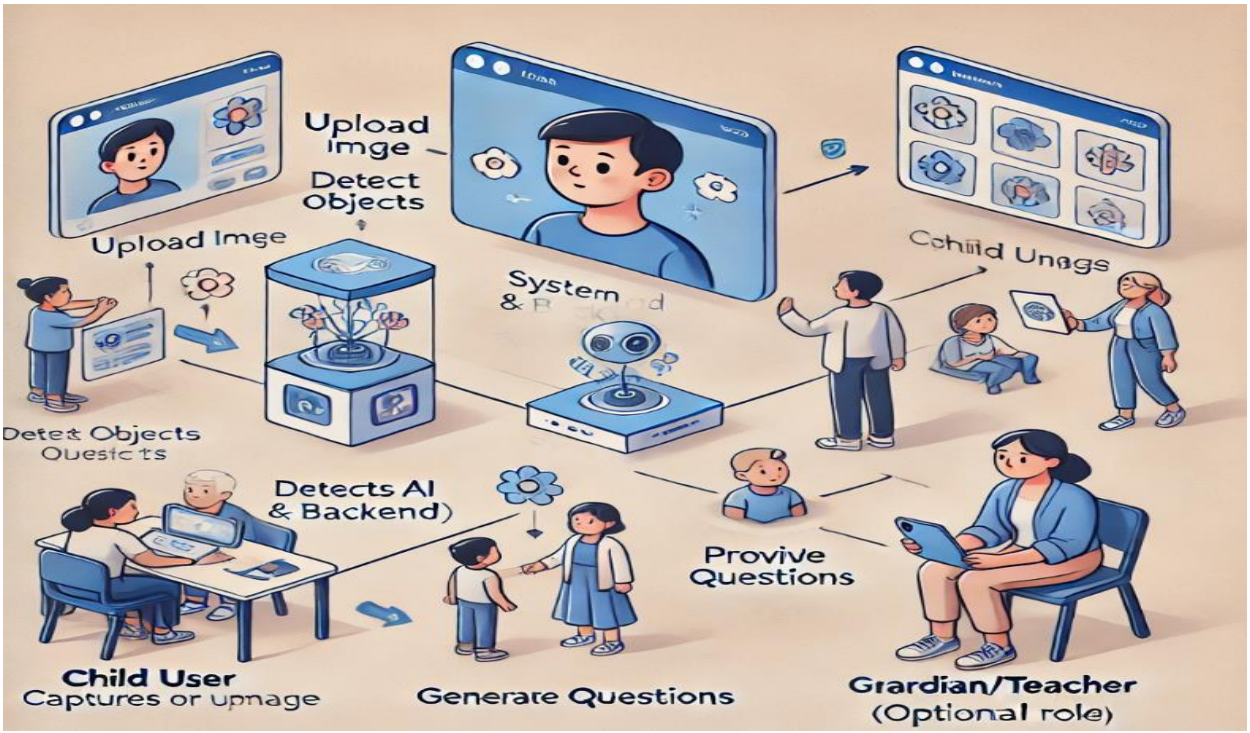


Figure 1.9:Image view Of system diagram

This system is composed mostly of three components: detect objects and their relationships, how to system provide the questions and Providing Feedback with hint.

6.2.1. Object and their relationships Detection

TensorFlow Lite Plugin**:** Use the 'tflite' plugin in Flutter, which allows you to run TensorFlow Lite models on mobile devices. Firebase ML Kit**:** Firebase offers ML Kit, which includes on-device and cloud-based APIs for image labeling and object detection.

6.2.2. Generating Questions

API Integration: You can call the OpenAI GPT API from your Flutter app to generate questions based on the detected objects. Local Language Models: If you prefer to use a local model, you could integrate a lightweight NLP model into your Flutter app using TensorFlow Lite.

6.2.3. Providing Feedback

Local Logic: Implement simple logic within Flutter to evaluate answers and provide feedback directly in the app.

6.3. Project technology stack

Table 2:technology stack

Frontend	Flutter, Language: Dart
Backend and Cloud Services	Firebase, Firebase ML Kit, Node.js
AI and Machine Learning	TensorFlow Lite, OpenAI, ONNX Runtime
APIs and Services	OpenAI API, Google Cloud Vision API
IDE	VScode
Collaboration Tools	GitHub, Trello
Testing and Debugging	Flutter Test, Firebase Test Lab,
Deployment	Google Play Store/Apple App Store

6.4. Use Case Diagram

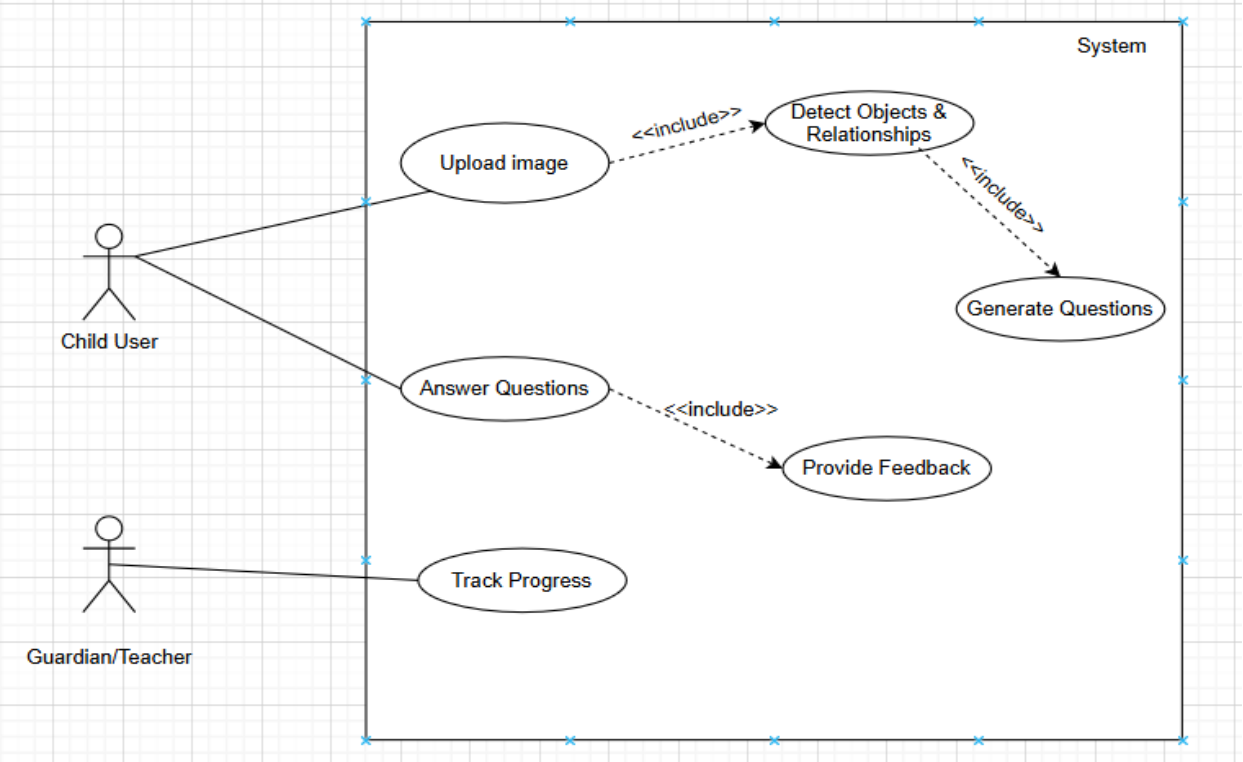


Figure 1.10:Use Case Diagram

7. PROJECT REQUIREMENTS

7.1. Functional Requirements

Children and guardians must be able to securely register and log in, upload photographs, and have their images preprocessed for analysis. Multiple items and their spatial relationships should be recognized by an AI system, which should also be able to create interactive questions to aid in children's understanding of these relationships and offer prompt feedback. The system needs to manage user profiles, measure progress, change the complexity of the questions, and provide an encouraging mechanism.

7.2. Non-Functional Requirements

Performance

- To ensure a seamless user experience, the system needs to process and analyze photos in just a few of seconds.

Usability

- The user interface should be intuitive and easy to navigate, especially for children aged 10-13.

Accessibility

- The system should be accessible to users with disabilities, incorporating features such as voice feedback and adjustable text sizes.

Scalability

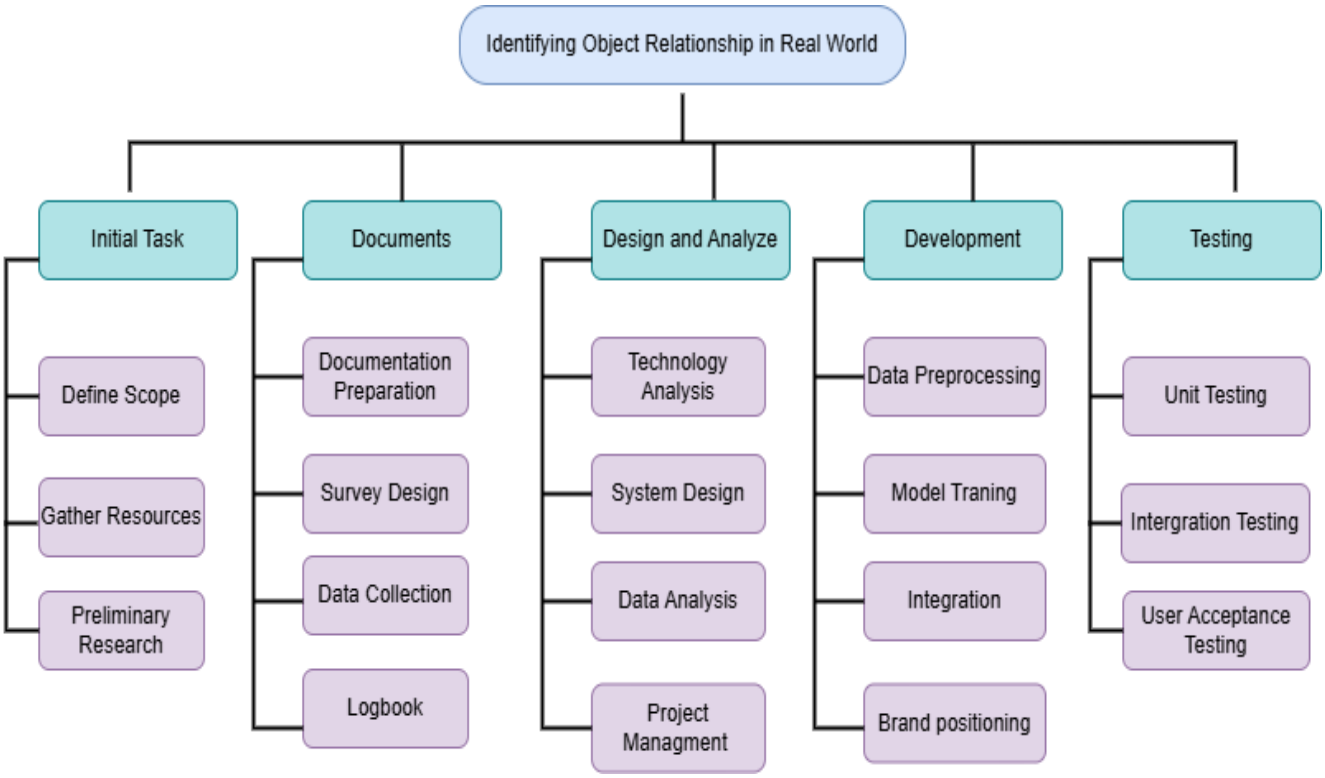
- The system should be able to handle an increasing number of users and images without performance degradation.

7.3. Test Cases for the Identifying object relationships in real world

Table 3:Test Cases

Test case ID	Test Case Description	Steps	Expected result
TC_01	Verify that the user can successfully upload an image.	1.Launch the app. 2.Navigate to the image upload section. 3.Capture an image using the camera or select one from the gallery. 4.Upload the image.	The image is successfully uploaded, and a confirmation message is displayed
TC_02	Verify that the AI correctly detects objects in the uploaded image.	1.Upload an image containing multiple distinct objects. 2.Wait for the AI to process the image.	The system accurately identifies the objects and displays them on the screen
TC_03	Verify that the system generates relevant questions based on detected objects.	1.After detecting objects, the system generates a question. 2.The question should relate to the objects and their spatial relationships.	The question is relevant to the image content and is displayed correctly.
TC_04	Verify that the user can submit answers to the generated questions.	1.Display the question. 2.Submit an answer.	The answer is submitted successfully, and the system proceeds to evaluate it
TC_05	Verify that the system provides accurate feedback based on the user's answer.	1.Submit a correct answer. 2.Submit an incorrect answer	The system provides positive feedback for correct answers and corrective guidance for incorrect answers.
TC_06	Verify that the system tracks the user's progress and displays it to the guardian/teacher/Doctor.	1.Complete multiple interactions within the app. 2.Navigate to the progress tracking section.	The progress is accurately tracked and displayed

8. WORK BREAKDOWN CHART



9. COMMERCIALIZATION

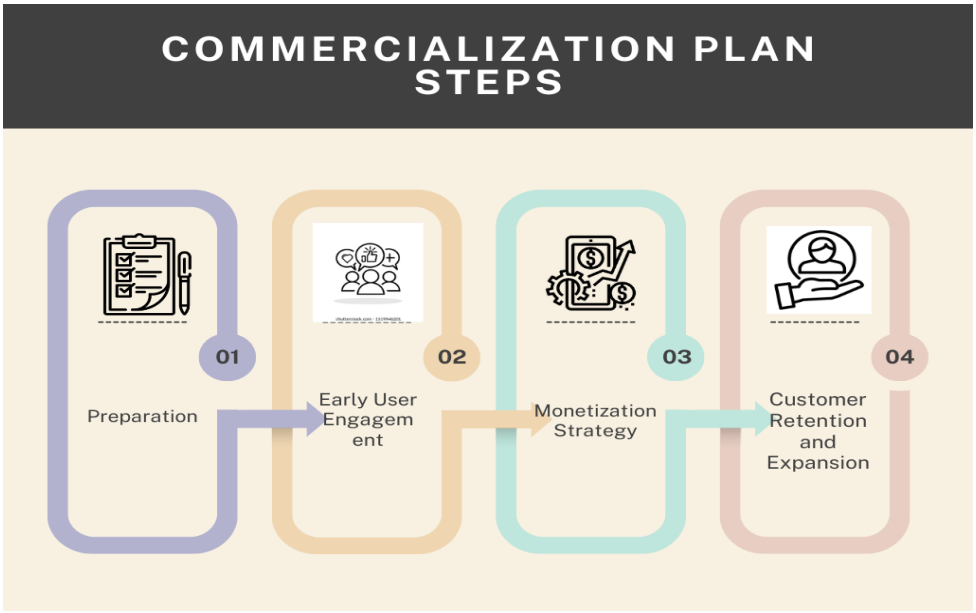


Figure 1. 11: Commercialization Plan

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
IT21207136	Mendis T.S.P	• Children Upload Image in real world. • Display image (AI for relationship identification). • Add question to identify relationship • Provide a selectable option to identifying relationship • If children select correct answer, Positive reinforcement • if select wrong answer, provide the Guided learning • Implement a encourage system to motivate children

11.REFERENCES

[1] B. P. Rourke, *Nonverbal Learning Disabilities: The Syndrome and the Model*. New York, NY, USA: Guilford Press, 1989.

[2] I. C. Mammarella and C. Cornoldi, "An analysis of the criteria used to diagnose children with Nonverbal Learning Disability (NLD)," Child Neuropsychology, vol. 20, no. 3, pp. 255-280, 2014.

[3] R. Luckin and W. Holmes, Intelligence Unleashed: An Argument for AI in Education, 2016.

[4] T. St. Pierre and E. K. Johnson, "Looking for Wugs in all the Right Places: Children's Use of Prepositions in Word Learning," Cognitive Science, vol. 45, no. 8, 2021, Art. no. e13028.

[5] A. Kristanto et al., "Visual Learning as Object Recognition to Recognize Image for Mental Disorder Children," in Proc. 2019 IEEE Int. Conf. Eng., Technol. Educ. (TALE), 2019, pp. 1-6.

[6] H. S. Mahdi, "Image Understanding Using Object Identification and Spatial Relationship," Int. J. IT Eng., vol. 3, no. 12, pp. 35-47, 2015

[7] D. Norman, The Design of Everyday Things: Revised and Expanded Edition. New York, NY, USA: Basic Books, 2013.

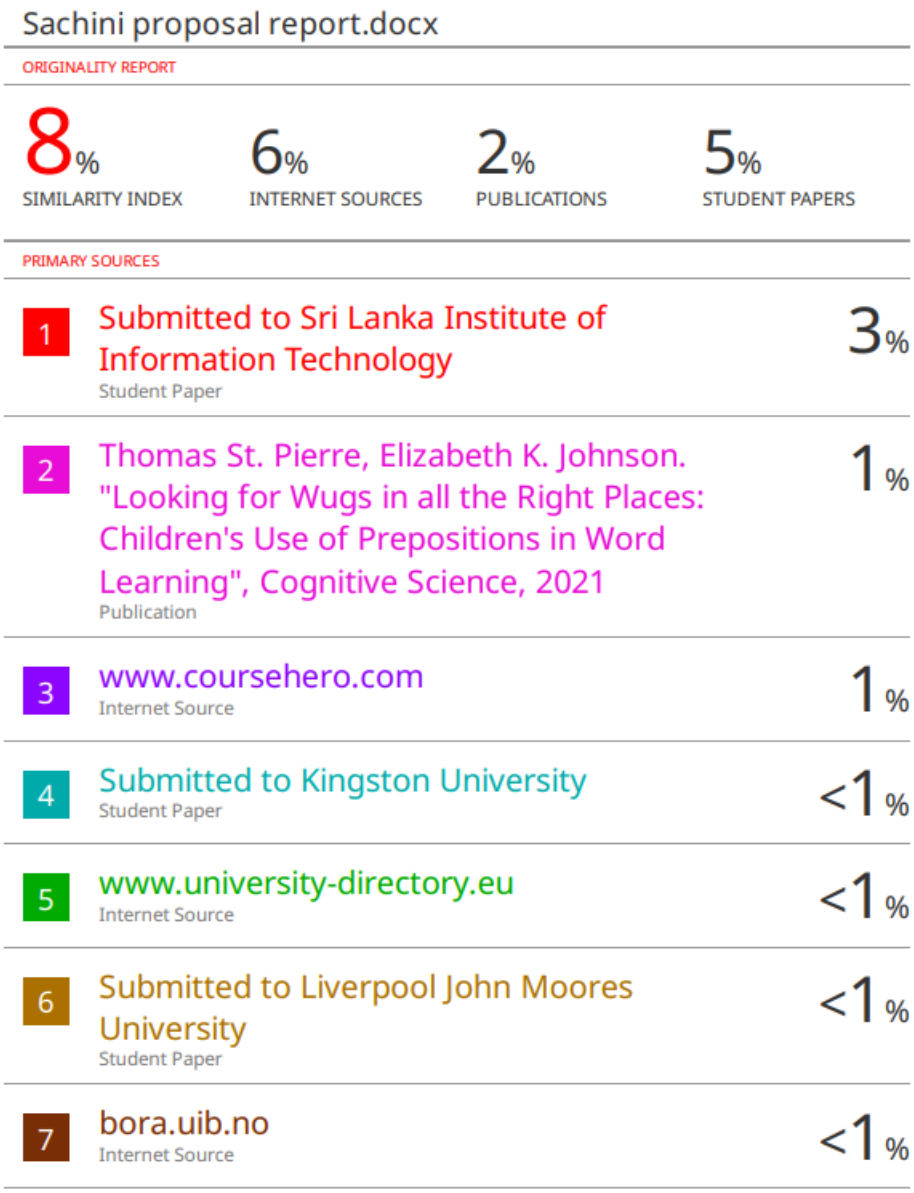
[8] B. P. Woolf, Building Intelligent Interactive Tutors: Student-centered Strategies for Revolutionizing e-Learning. Morgan Kaufmann, 2010.

[9] J. Redmon, "YOLOv3: An Incremental Improvement," arXiv preprint, arXiv:1804.02767, 2018.

[10] C. Carlson and P. R. Carlson, "Cognitive strategies in children with NVLD," J. Learn. Disabil., 2004.

[11] R. Krishna et al., "Visual Genome: Connecting Language and Vision Using Crowdsourced Dense Image Annotations," Int. J. Comput. Vis., vol. 123, pp. 32-73, 2017.

12.APPENDICES



Sachini proposal report.docx

ORIGINALITY REPORT

8%	6%	2%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Sri Lanka Institute of Information Technology Student Paper	3%
2	Thomas St. Pierre, Elizabeth K. Johnson. "Looking for Wugs in all the Right Places: Children's Use of Prepositions in Word Learning", Cognitive Science, 2021 Publication	1%
3	www.coursehero.com Internet Source	1%
4	Submitted to Kingston University Student Paper	<1%
5	www.university-directory.eu Internet Source	<1%
6	Submitted to Liverpool John Moores University Student Paper	<1%
7	bora.uib.no Internet Source	<1%

Figure 12.1:appendix 1

8	Jaspreet Kaur, Divya Gupta. "Chapter 4 Unleashing the Potential: Study on Artificial Intelligence Effect in Education Sector", Springer Science and Business Media LLC, 2024 Publication	<1 %
9	Parikshit N. Mahalle, Namrata N. Wasatkar, Gitanjali R. Shinde. "Data-Centric Artificial Intelligence for Multidisciplinary Applications", CRC Press, 2024 Publication	<1 %
10	as-proceeding.com Internet Source	<1 %
11	www.hostedredmine.com Internet Source	<1 %
12	www.mdpi.com Internet Source	<1 %
13	www.slideshare.net Internet Source	<1 %
14	Prudence W. Fisher, Jazmin A. Reyes-Portillo, Mark A. Riddle, Hillary D. Litwin. "Systematic Review: Nonverbal Learning Disability", Journal of the American Academy of Child & Adolescent Psychiatry, 2022 Publication	<1 %

Figure 12.2:appendix 2