LEARN MATE : ENHANCING META-COGNITIVE SKILLS OF AUTISTIC CHILDREN USING MACHINE LEARNING

24-25J-209

Project Proposal Report

Tharaki D.H.D

B.Sc. (Hons) Degree in Information Technology Specialized in Data Science

Department of Computer Science

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Declaration of The Candidate & Supervisor

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

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Tharaki D.H.D	IT21254970	

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

…… 22/08/2024

Signature of the supervisor Date

…… 22/08/2024

Signature of the Co-Supervisor Date

Acknowledgment

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Finally, I would like to express my gratitude to all the people who help me by providing their valuable assistance and time during this research.

Abstract

Metacognitive skills in children with Autism Spectrum Disorder are to be improved. Critical skills that this research aims to specifically address include self-monitoring, planning, and self-regulation. Metacognition involves being conscious and in control of one's cognitive processes, and it forms a very integral part of personal development and success. Research in autism has increased many-fold in recent times, but most study efforts have traditionally been directed toward diagnosis and identification rather than toward developing and nurturing the potential of such children. The current study closes this gap through the development of a well-rounded framework that helps autistic children discover their personality, preference, and specific skills. The research contributes to the development of child-centric programs in that interventions will be tailored on the needs of each child to help them surmount challenges of autism and live an independent successful life. Clustering techniques like K-Means, Hierarchical Clustering, DBSCAN, Gaussian Mixture Models (GMM), and others will be used to achieve personalised interventions. These techniques arrange kids in groups according to shared traits, learning styles, and other characteristics. This will make recommendations that are extremely precise to the needs of each individual kid. These clustering strategies ensure customised support by assisting in the understanding and resolution of the distinct metacognitive issues that each child confronts. The study finds inspiration in well-known individuals who, despite obstacles associated with autism, have made significant contributions to society, such as Bill Gates, Elon Musk, and Albert Einstein. These illustrations show that autism is not only a manageable condition that can be made to work to one's advantage with the right assistance and care, but it is also a condition that can be managed. In this study, using a combination of individualized learning strategies with metacognitive training and collaboration with educators and health professionals who will discuss ways of promoting the development of children with autism. This thus, at the tail end of things, should be able to present that even children with this disorder can create full, enriching lives for themselves if they have access to the right help and support. The research will help not only in increasing the understanding of autism within the academic world but also in practical solution finding to improve each child with ASD to full potential.

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Abbreviations	Description
ASD	Autism Spectrum Disorder
VR	Virtual Reality
AR	Augmented Reality
UI	User Interface
NLP	Natural Language Processing

1. Introduction

1.1 Background

Autism Spectrum Disorder (ASD) is a complex developmental condition that impacts on how an individual experiences and interacts with the environment. This condition is characterized by difficulties in social communication, narrow interests, and repetitive behaviours. The word "spectrum" is used because it has various symptoms as well as severity levels; hence every person with ASD possesses unique strengths and challenges. ASD usually appears during early childhood, and symptoms can vary natively over time in severity but persist throughout an individual's lifetime. ASD's causes are still not well understood although they are thought to be a mixture on genetics and the environment. Therefore, early diagnosis and intervention are especially important since they help improve outcomes significantly enabling those with autism to learn vital skills and live fulfilling lives. ASD individuals often struggle in social interactions, understanding nonverbal cues or forming relationships. Some individuals have routines or rituals that make them get upset when there are changes around them.

With the right support and understanding, children with ASD can break through their struggles and succeed their lives

The cognitive, affective, psycho-motor, and metacognitive domains are the four primary domains of learning. To improve learning and life outcomes in terms of strengths and challenges, I am focussing my study on the meta-cognitive domain, which includes assisting children with ASD in developing abilities like self-awareness, planning, and self-regulation.

Research

There is research that has done by Neuro Development Centre in Northern Sri Lanka using 123 sample of children to identify the ASD population and their differences with each other. Some of the statistics according to the research are given below.

- 1 in 93 from aged 18 to 24 months has ASD
- Among them,
    - The average age of diagnosis was 3.4 years
    - Most children (69.9%) had mild to moderate symptoms of autism
    - All children (100%) presented with speech-related difficulties
    - 91.9% have Behavioural Issues
    - 96.7% have Poor Social Interaction
    - 78 % have Sensory Issues [9]

Characteristics	Children (N=123)	
	no.	%
Gender		
Male	88	71.5
Female	35	28.5
Child's position in the family		
First-born	95	77.2
Second-born	23	18.7
Third-born	5	4.1
Place of birth		
Sri Lanka	91	74.0
Other country	32	26.0
Mode of delivery		
Normal vaginal delivery	49	39.8
Assisted vaginal delivery	5	4.1

Figure 1:Statistics of the Research By Neuro Development Centre, Sri Lanka

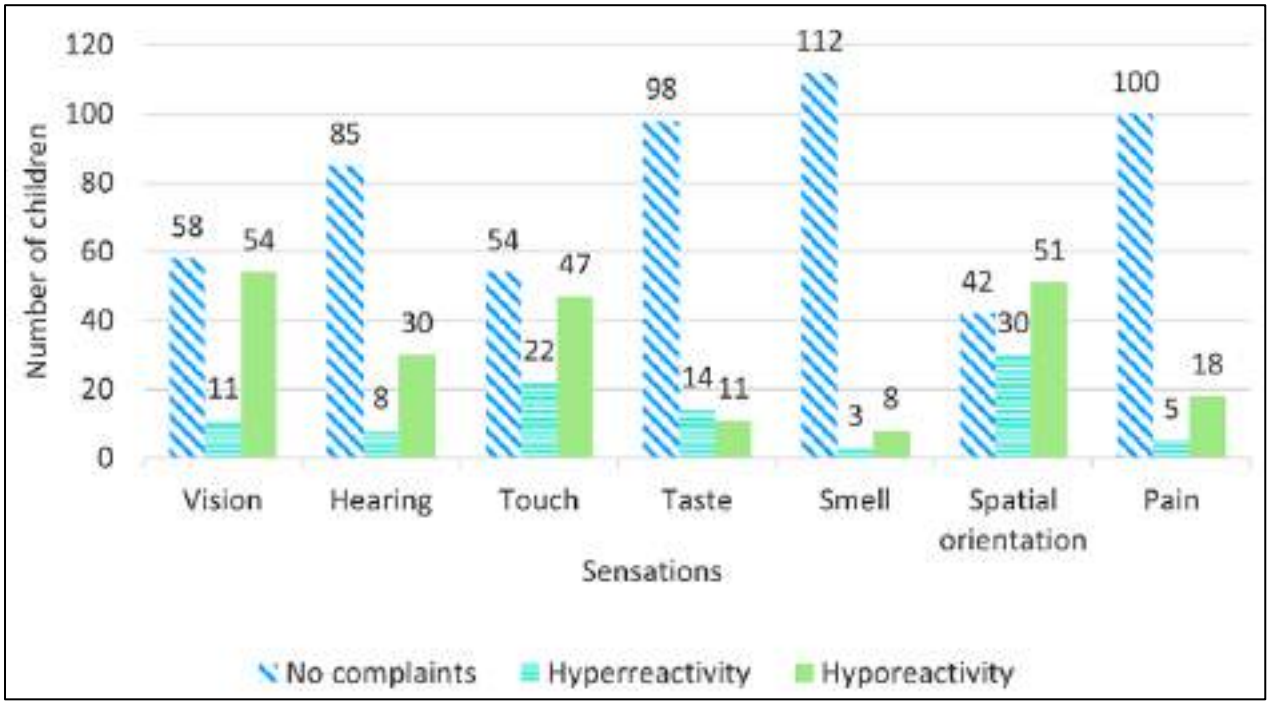

Figure 2:Statistics of the Research By Neuro Development Centre, Sri Lanka

Characteristics	Children (N=123)	
	no.	%
Speech related		
No speech	58	47.2
Few words only	59	48.0
Speech regression	6	4.9
Social interaction		
Poor eye contact	108	87.8
Not responding to call	117	95.1
Not interacting with others	119	96.7

Figure 3:Statistics of the Research By Neuro Development Centre, Sri Lanka

Metacognitive Domain

The awareness of one's own thought and learning processes and understand the patterns behind them is known as the metacognitive domain. It includes a variety of talents and skills that enable kids to control their mental processes in situations involving learning and solving problems. Essential elements of children's metacognitive realm consist of:

Metacognitive Knowledge

- Declarative knowledge: Understanding potential useful solutions.
- Procedural knowledge: Understanding how to apply tactics.
- Conditional Knowledge: Understanding which methods to use and why.

Metacognitive Regulation

- Planning: Deciding on strategies and establishing goals before a learning an assignment.
- Monitoring: Examine and rating one's comprehension and performance during the work.
- Evaluating: Rethink and evaluating the results, after finishing a task.

To help kids with autism understand better and manage their own learning, they need to learn how to think about their thinking. Being aware of themselves and managing their actions helps them solve problems and do well in school. By learning these skills, kids with autism can feel more confident and independent, making their everyday tasks easier. This growth also helps them overall, both in school and in dealing with challenges, supporting their social and personal development.

1.2 Literature Survey

1.2.1 Overview of Metacognition in Autistic Children

Thinking about how we think, which is called metacognition, is especially important for learning and solving problems. Kids with autism sometimes think differently than other kids. Studies show that these kids often have trouble judging how well they are doing and controlling their thinking. They might find it hard to look at their own thoughts, which can slow down their progress in school and in life. The research also shows that when kids with autism have trouble with metacognition, they can struggle with adjusting to new learning situations and using what they learn in various places. [6].

1.2.2 Challenges in Metacognition Monitoring and Controlling

Keeping track of and managing thinking skills is especially hard for people with autism because they often have trouble with self-awareness and making decisions. A study shows that kids with autism have weaker thinking skills, especially when they need to assess how well they did and make choices. This often shows up as not being sure about their choices, which can make learning and solving problems difficult. Also, the study points out that these challenges are made worse by the fact that each child with autism has different thinking skills, making it hard to create a single method to improve these skills. [7].

1.2.3 Intervention Strategies and Technological Innovations

Research shows that using digital tools and smart learning technologies can improve these thinking skills in autistic children. These technologies usually involve giving individual feedback, using interactive learning methods, and tools that encourage children to think about their thoughts and set goals. Such methods are designed to fit the special needs of autistic children, giving them organized and fun ways to build their thinking skills. Additionally, adding computer learning techniques to these technologies helps adjust and personalize the learning methods, making the solutions more helpful as time goes on. [8].

1.2.4 Implications and Practice and Future Research

Improving the ability to think about thinking in children with autism can help them in more ways than just doing well in school. It can make them more independent, better at solving problems, and better at managing their feelings. Studies suggest that more work is needed to make technology tools easier to use, fun, and helpful for all kids with autism. We also need to study the long-term effects of these tools on these children's thinking skills. Researchers should investigate using these technologies in regular schools and therapy sessions, making sure they work well with what is already being done and support the overall growth of kids with autism. [6] [7].

1.3 Research Gap

Research Paper	[1]	[2]	[3]	[4]	[5]
Focus	Supporting Children's Metacognition using facial expressions	Digital technologies and metacognitive skills training	Visual strategies for teaching metacognitive skills	Innovations in metacognitive learning using Robots	Improved metacognitive monitoring and learning outcomes
Methodology	Facial Emotion Recognition based Intelligent Tutor System	Using VR	Using images and videos	Using Robotic and AR technology	Analyse the meta cognitive abilities and features of ASD children
Sample Population	Autistic children (ages 6-12).	Autistic children and adolescents (ages 8-16)	Autistic children in middle childhood (ages 7-10)	Autistic children (ages 7-15) from various educational settings	Various age groups across multiple studies focusing on autism and metacognitive skills.
Key Findings	Identified significant variability in metacognitive development among autistic children, influenced by cognitive and environmental factors.	Digital tools can enhance metacognitive awareness and self-regulation in children with ASD, especially in controlled environments.	Challenges in developing metacognitive skills are related to deficits in executive functioning and self-regulation.	Technological interventions can lead to significant improvements in metacognitive skills, especially in monitoring and controlling thought processes.	Autistic individuals tend to have lower metacognitive accuracy compared to neurotypical peers, with variability across different cognitive tasks.
Research Gap	Need for more comprehensive studies on long-term impacts.	Lack of integration with traditional educational practices.	Limited focus on the integration of technology in traditional classrooms.	Need for more personalized learning tools.	Variability in outcomes across different studies.

Table 1:Research Gap

1.4 Research Problem

How can machine learning techniques be used to enhance the metacognitive domain of autistic children through customized and adaptive learning strategies?

This study investigates how customised and adaptive learning strategies based on machine learning (clustering) can improve the metacognitive skills of children with autism. Children are grouped according to attributes like age, gender, and proficiency level to deliver customised recommendations.

Real-time tracking can be performed according to the dashboard that instructors and parents may access, which displays the progress of the kids. Every day, tasks change depending on how well each child does, making sure they are suitably challenged. By enhancing metacognitive abilities like self-control and problem-solving, this method seeks to make learning more successful.

2. Objectives

2.1 Main Objective

- To create an application that offers autistic kids **Customized** exercises according to their learning levels to enhance their metacognitive skills.

2.2 Sub Objectives

- **To assess how well the application helps children with autism with self-regulation, planning, and reflection.**
  The objective is to assess the extent to which the application improves autistic children's planning, contemplation, and self-regulation abilities. This will involve monitoring their development over time and examining the ways in which the app affects their capacity to make plans, keep track of assignments, and evaluate their educational experiences.

- **To build a scalable and easily accessible tool to assist caregivers, educators, and parents in supporting the metacognitive development of children with autism.**
  Provide a tool that can be readily scaled and used on multiple platforms. Regardless of location or resources, the app should help user support the metacognitive development of autistic children by offering personalised, adaptive tasks and insights into each child's progress.

- **To guarantee data privacy and security for every user.**
  Put user data security and privacy first by putting sophisticated encryption and security measures in place. Assure compliance with data protection regulations and the responsible handling of all sensitive information to safeguard children and their families.

- **To seamlessly connect with current therapeutic and educational programs.**
  Create the application with seamless integration into current educational and therapeutic frameworks in mind. The intention is to improve on present therapies without altering them, making it simple for therapists, schools, and other support systems that are already engaged in the child's development to adopt.

3. Methodology

3.1 Project Overview

Learn Mate is a web application created to help kids with autism to acquire their skills and knowledge. Learn Mate aims to bridge the gap by providing focused procedures to assist these kids in overcoming their obstacles and developing their personalities, in contrast to traditional methods that mostly concentrate on diagnosing autism.

Learn Mate is designed to meet the specific requirements of autistic children, which differ from those of typical children. The program makes use of machine learning techniques to identify the unique challenges that each child faces and offer customised solutions. The four main domains which make up the learning process are cognitive, emotional, psychomotor, and metacognitive.

Learn Mate evaluates each of these areas, predicts the child's competence in each, and provides exercises that are specifically tailored to the children. These are not usual activities; instead, they have been carefully chosen and offered with the advice of subject-matter specialists to guarantee that they meet the specific requirements of every child.

Learn Mate helps autistic children to overcome their limitations, acquire essential abilities, and create a strong, independent identity by focussing development rather than just identification.

3.2 System Diagram

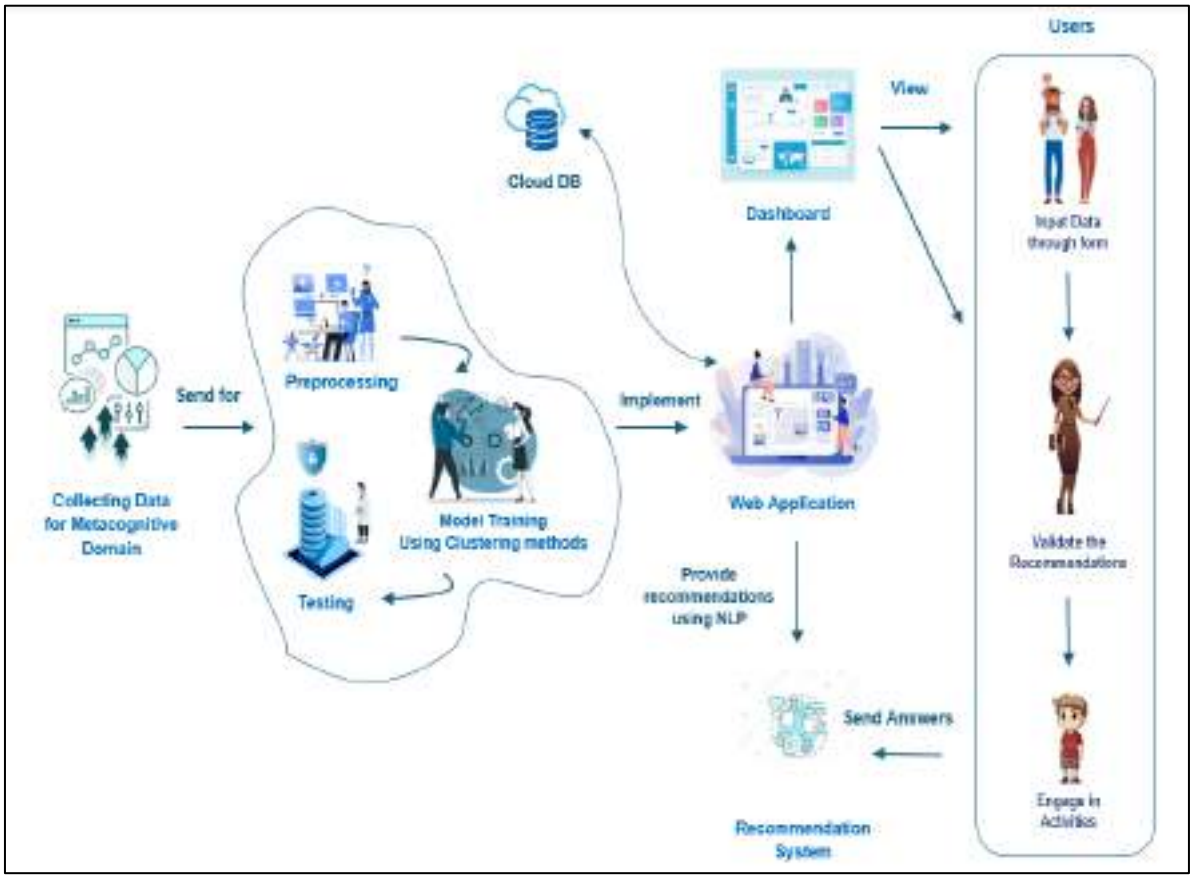

Figure 4:System Diagram for Meta Cognitive Domain

3.3 System Overview

3.3.1 Requirements and Data gathering

To improve the development and efficiency of our application for metacognitive skill-building, data is being gathered from hospitals and learning centres specializing in serving children with autism. Three institutions, Chithra Lane Learning Centre, Ayathi Hospital, and Lady Ridgeway Hospital will be reached out to. In addition, datasets accessible on well-known platforms like Kegalle are being utilized.

Moreover, meetings will be held with professionals such as psychiatrists, teachers, and doctors specializing in autism to gather the necessary requirements and details. Information will be collected about the areas where these children face the most challenges, the meditations and practices being used to support their development, and additional use cases.

Below is the list of skills and some metrices that will be taken to build the model and to categorize the children into groups:

Self-Regulation Skills

- **Goal Setting:** Number of goals set independently in a day.
- **Planning:** Time taken to plan tasks or activities.
- **Monitoring:** Frequency of self-check-ins during a task.
- **Self-Assessment:** Number of self-assessments after tasks.
- **Task Persistence:** Time spent on a task without giving up.
- **Adaptability:** Number of successful adjustments made to task changes.

Reflection Skills

- **Self-Reflection:** Frequency of reflection on performance or emotions.
- **Critical Thinking:** Time taken to analyse and solve problems.
- **Learning from Mistakes:** Number of successful retries after mistakes.
- **Perspective-Taking:** Number of times the child recognizes others' viewpoints.
- **Self-Evaluation:** Number of self-assessments made daily.

Planning Skills

- **Goal Setting and Prioritization:** Number of tasks successfully prioritized.
- **Strategic Thinking:** Time spent strategizing for tasks.
- **Time Management:** Time taken to complete tasks within a timeframe.
- **Resource Allocation:** Number of resources used effectively during tasks.
- **Contingency Planning:** Number of alternative plans considered.

Decision Making Skills

- **Evaluating Options:** Number of alternatives considered before decisions.
- **Risk Assessment:** Number of risks identified before tasks.
- **Making Informed Choices:** Frequency of well-thought-out decisions.
- **Evaluating Consequences:** Number of times potential outcomes are evaluated.
- **Reflecting on Decisions:** Number of reflections on decisions after a task.

Communication Skills

- **Expressing Thoughts and Feelings:** Number of words used to communicate feelings.
- **Active Listening:** Number of active listening cues demonstrated.
- **Clarifying and Confirming Understanding:** Number of clarification questions asked.
- **Negotiating and Resolving Conflicts:** Number of successful conflict resolutions.
- **Providing and Receiving Feedback:** Number of times feedback is given or received.
- **Most Used Words:** Frequency of specific words used in communication.
- **Word Count Per Day:** Total number of words spoken daily.

3.3.2 Designing

The designing phase will refer to developing the UI for the web-based application. This will be done using Figma. Since the application is going to be web based, the first page that needs to be designed will be the sign in-signup page. After this, comprehensive personnel progress chart to be provided in detail and made accessible to the responsible personnel such as parents and teachers.

The aspect of the dashboard is important as it must contain all necessary data which are to be easily viewed. After that, there is going to be a change in the UI where the child will then be presented with specific recommendations that will be made to him or her. This interface must be professionally designed to facilitate the completion of these tasks, as well as to be simple, clear, and appropriate for a child.

Knowing the fact that autistic children are sensitive to different things, the application will be designed in soft colours with a touch of warm tones. The complete set of UI elements including the buttons, forms, and activities will be quite simple so most of the times user involved would be either kid or adult.

3.3.3 Implementation

As for the implementation phase the actual product in terms of the strategic plan will be produced. The first one is the necessity to structure the received dataset into the table, because most of the data would be based on prescriptions. Once the dataset is structured the data will then be pre-processed to remove unwanted data and only that data containing information that will be used in building the model will be used.

Based on the pre-processed dataset, one will use K-means clustering model, Gaussian Mixture Model and DBSCAN clustering model. These models will assist to discover heterogeneous clusters in the given data set.

Subsequently, with the help of NLP techniques such as content based and collaborative filtering, customized suggestions regarding these groups will be given. These recommendations will involve small tasks to improve the child's planning, regulation, monitoring and self-evaluation abilities.

After the child is finished and has submitted the answers to the questions, the answers will be graded automatically, and the resulted score will be included in the dashboard. The child's progress shall be served in the form of graphs and tables to ensure that the information can be easily comprehensible by the general population.

3.3.4 Testing

To begin with, accuracy, precision, and Mean Squared Error (MSE) statistics will be calculated to measure the efficiencies of the models which will lead to the generation of recommendations. But the system may not give the correct predictions because the recommendations are given based on the inputs that parents give about a child. However, to minimize the chances of giving the wrong recommendations, the activity list which is developed at the end of the process will be checked by a teacher, a specialist in the field of autism. The activities, however, will only be presented to the child for his or her interaction only after the teacher has gone through the processes and ensured the correctness of the results. The inclusion of this condition guarantees that what is recommended is in the best interest of the child.

3.3.5 Commercialization

A pilot version will be made available to organisations that provide data, such as educational and therapeutic facilities, before it is commercialised. We will collect feedback from these centres to make the system better. The application will be improved with new features based on the feedback, with an emphasis on improved activity adaptation and progress monitoring. The last version will be released to the public after it has been refined, with an emphasis on educational institutions and parents looking for customised learning solutions for their special needs children.

3.4 Tools & Technologies to be Used

3.4.1 Tools

- VS Code - Building and implementing the application
- Firebase - Cloud Database to store data
- Figma - UI Designing
- GitHub – Version Controlling and Collaborations

3.4.2 Technologies and Libraries

- React - For frontend
- Python - For backend
- Flask - To integrate frontend and backend
- NLTK, Scikit Learn - For NLP and clustering machine learning technique

4. Requirement Analysis

4.1 Functional Requirements

- **User registration and profile management**
  Parents, teachers, and other carers must be able to build user profiles for children in the system, which will record personal data such as age, gender, language preferences, and level of autism.

- **Evaluation of Metacognitive Skills**
  Using metrics like task persistence, word count, and completion time, the system should evaluate students' abilities in self-control, planning, reflection, decision-making, and communication.

- **Clustering and Child Grouping**
  To deliver customised recommendations, the system must use unsupervised learning (clustering) to group children according to their attributes (e.g., age, gender, ability level).

- **Customised Task Recommendations**
  To support the child's learning in the cognitive, metacognitive, affective, and psychomotor domains, the system should generate adaptive tasks at varying degrees of difficulty based on the child's group and daily development.

- **Progress tracking and visualization**
  Teachers, parents, and other carers should be able to view each child's daily progress, which should be tracked.

- **Daily Task Adaptation**
  To ensure ongoing adaptation to the child's developing skill levels, tasks must be modified every day based on the child's development and performance in prior activities.

- **Data Collection and Analytics**
  To guide future recommendations and analysis, data on task performance, including time spent, frequency of self-assessment, and communication indicators, must be gathered.

- **Integration with Educational Programs**
  Must be able to easily incorporate into already-existing therapeutic and educational initiatives, guaranteeing that they are in line with the child's present treatment or educational strategies.

- **Alerts & Notifications for Teachers and Parents**
  Must provide frequent updates and warnings regarding the child's development, any problems found, and adjustments to the work difficulty

4.2 Non-Functional Requirements

- **Scalability**
  The platform must be scalable to accommodate an increasing number of users, students, and tasks without experiencing a decline in performance, particularly when it is utilised by different carers and schools.

- **Performance**
  To guarantee seamless engagement throughout learning sessions, it should react to user input and update task recommendations in real-time with the least amount of latency.

- **Data Security and Privacy**
  To guarantee the security and confidentiality of sensitive information, including children's personal data and progress records, strong data encryption and access controls must be implemented.

- **Reliability**
  Prominent levels of dependability are required to provide error-free daily updates, suggestions, and progress tracking with no loss of data.

- **Usability**
  The interface should be simple to use and support a wide range of users with different technical skills, including children. It should be easy to use for both carers and children.

- **Compatibility**
  To reach as many users as possible, compatibility should be ensured across a variety of platforms, including desktop computers, tablets, and mobile phones, and across many operating systems.

- **Maintainability**
  The system should be simple to maintain, with well-organised code and modular components that allow for upgrades, bug repairs, and the incorporation of new features without interfering with current functioning.

- **Compliance with Data Protection Laws**
  To guarantee the legal protection and moral treatment of users' personal and medical data, compliance with pertinent data protection rules (such as GDPR and HIPAA) is required.

- **Availability**
  The platform should have high availability, or uptime, to ensure that users can access it without interruption anytime they need to.

- **Integration Capabilities**
  Must offer APIs or alternative ways to interface with currently in use learning management systems, therapists' tools, or other applications.

4.3 User Requirements

4.3.1 For guardians and parents

- **Make and Maintain Profiles for Children**
  The option to build profiles for their kids and fill them out with details about their likes, gender, age, and degree of autism.

- **View Child's Progress**
  The dashboard makes it simple to view and keep track of the child's progress, which includes daily task completion and the development of self-control, planning, and reflection abilities.

- **Get Notifications and Alerts**
  Be informed in a timely manner regarding the child's development, the completion of tasks, and any areas that could require extra assistance.

- **Establish Learning Goals**
  The capacity to establish or alter learning objectives in conjunction with educators or considering the child's developing abilities.

- **Protect Data Privacy**
  Manage privacy preferences to limit who has access to their child's information while maintaining the privacy of performance and personal data

4.3.2 For Teachers

- **Assign and Customise Learning assignments**
  Capacity to designate or alter assignments in accordance with the needs of the kid, making sure that they are in line with current educational or therapeutic initiatives.

- **Access to Progress Reports**
  Follow the child's long-term development and view comprehensive reports on how they performed in metacognitive areas like planning, self-regulation, and decision-making.

- **Track Daily and Weekly Task Completion and Engagement**
  Track the child's level of engagement and task completion to determine where he or she may be struggling or succeeding.

- **Collaborate with Parents**
  Share suggestions for improvement or modifications to the child's lesson plans, as well as updates on the child's progress.

- **Adjust Task Difficulty**
  To ensure ongoing adaptive learning, adjust task difficulty levels in accordance with the child's performance and developmental stage.

4.3.3 For Autistic Children

- **Personalised Learning Experience**
  Assign assignments and engage in activities based on the student's age, ability level, and metacognitive needs (e.g., goal setting or reflection exercises).

- **Engaging and Adaptive Tasks**
  Set daily goals depending on their growth, provide diversity, and challenge them to the right extent.

- **Fun and Interactive Interface**
  Learn with an engaging, kid-friendly interface that is simple to use and navigate.

4.4 System Requirements

- **Frontend & Backend**: Use of modern technologies and frameworks like React JS, Flask, Python and AI/ML frameworks such as Scikit-learn, TensorFlow
- **Database**: A cloud storage such as Firebase.
- **APIs**: RESTful APIs for interaction between frontend, backend, and other services.

4.5 Use Cases

4.5.1 Use Case 01 – Initial Recommendations for New users

Actor - Parent

Description - When a child is a new user, the parent provides essential details like age, gender, country, metacognitive skill ratings (e.g., self-monitoring, planning, self-regulation), which the system uses to create first set of recommendations for the child.

Steps -

- Parent logs into the system and created a new account for the child.
- System asked the parent to enter the child’s information
- System processes the inputs and uses clustering techniques to group the child with others with similar profiles.
- Based on the group system generated initial list of activities tailored to the child’s learning level and meta-cognitive skills set.

4.5.2 Use Case 02 - Validation of Recommendations

Actor - Teacher

Description - The system generated learning activities are going to be validated by the teacher to ensure the sustainability of these activities before they are assigned to the child.

Steps -

- Once the system generated the activity list, it will be notified to the teacher before the activities are presented to the child.
- The teacher reviews the recommendations and assesses whether the activities are suitable for the child's current level and needs.
- If the teacher finds them appropriate, they approve the activities, which are then assigned to the child.
- If changes are needed, the teacher will adjust the activities and provide feedback for the system for more tailored recommendations.
- System tracks the teacher’s validation input to improve future recommendations.

4.5.3 Use Case 03 - Engage in Recommended Activities

Actor - Child

Description -The student engages with the personalized activities recommended by the system based on their profile and learning needs

Steps -

- After the validation of the activity list, the child can go to the recommendation tab and start working on them
- The system monitors the performance of the child and engagement throughout the activity
- Continue working with the list and once all the tasks are finished, child can submit the answer to the system to be checked

4.5.4 Use Case 04 - Monitor Progress Visualization

Actor - Parent, Teacher

Description - The system generates visual reports that allow teacher and parents to track the progress of the child’s learning and monitor meta-cognitive skill development

Steps -

- Teacher and parent log into the system
- System displays the dashboard showing the child’s progress in different learning domains
- The responsible parties can compare current performance with past reports and identify the areas for improvement.

4.5.5 Use Case 05 - Real Time Guidance

Actor - Child

Description - The system adapts learning tasks in real-time based on the student's performance and behaviour during ongoing activities.

Steps -

- The child starts an assigned task
- The system monitors the performance by tracking time
- If the system detects difficulty (if child takes more time), it offers hints or additional guidance.
- If the student performs well, the system adjusts the difficulty of subsequent tasks to provide more challenging content.
- The system adapts the future learning path based on the student's ongoing performance, ensuring the tasks are neither too easy nor too difficult.

4.5 Test Cases

4.5.1 Test Case 01 - User Registration and Profile Creation

Objective - Ensure that new users can successfully register and create a profile for the child

Steps -

- Navigate to the registration page
- Enter necessary details in the form
- Create a username and password
- Login to the system

Expected result - User registration is successful, and child’s profile is created and saved

4.5.2 Test Case 02 - Initial Skill Assessment for new child

Objective - Verify that parents can input initial ratings for the child’s metacognitive skills

Steps -

- Go to Recommendations tab
- Enter the necessary details and fill the form
- Submit Information

Expected Result - System successfully stores the data and predict a level for the child. Then it generates the first set of tasks for the child.

4.5.3 Test Case 03 - Teacher validation of Recommendations

Objective - Ensure teacher can approve or modify the recommended tasks before assigned to children.

Steps -

- System generates a set of tasks for the child
- Notify the teacher for validation
- Teacher reviews the recommendations and either approve or modify the tasks

Expected Result - Teacher can successfully validate and adjust the recommendations.

4.5.4 Test Case 04 - Real Time Progress Tracking

Objective - Check if the system tracks the student's performance and provides real-time feedback.

Steps -

- Student completes a learning task.
- System analyses performance metrics.
- Real-time feedback is provided.

Expected Result - Tracks the progress, and provides appropriate feedback based on the performance.

4.5.5 Test Case 05 - Progress visualization for Parents and Teachers

Objective - Ensure that parents and teachers can view the student’s progress through a dashboard.

Steps -

- Navigate to the progress report section.
- View student progress visualization and feedback.

Expected Result - Display the progress with graphs or charts that clearly show the student’s improvements and areas for development.

4.5.6 Test Case 06 - Error Handling in Activity Engagement

Objective - Ensure that the system manages errors during the engagement of activities.

Steps -

- Start an activity.
- Create a system error (e.g., disconnect internet or crash the browser).
- Attempt to resume the task.

Expected Result - The system should correctly manage the error and allow the student to resume from the point they left off.

4.6 Wireframes

Figure 5:Login Page

Figure 6:Dashboard Page

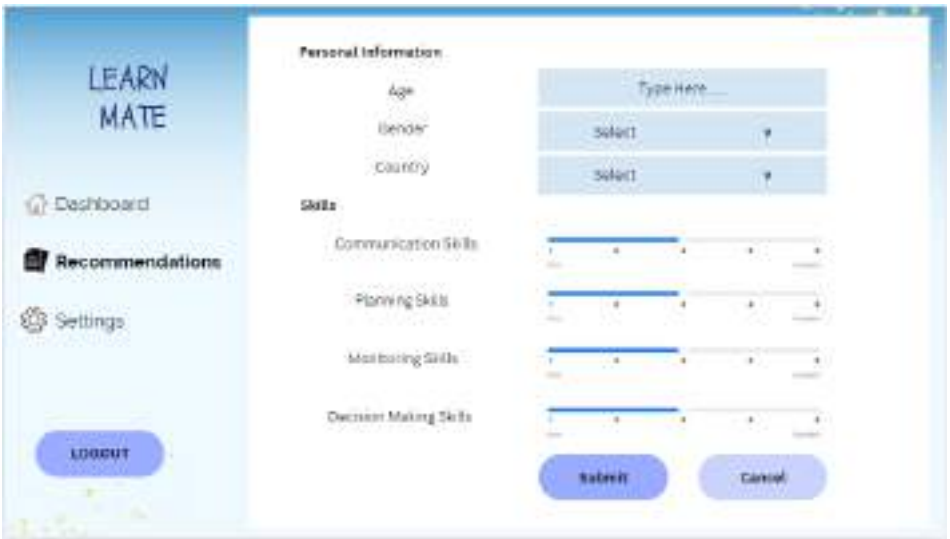

Figure 7:Recommendations Page1

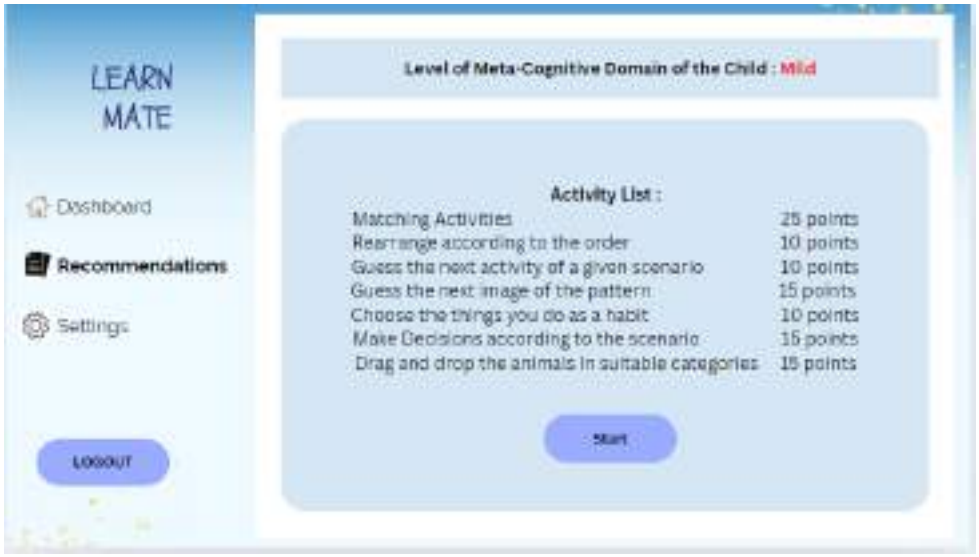

Figure 8:Recommendations Page2

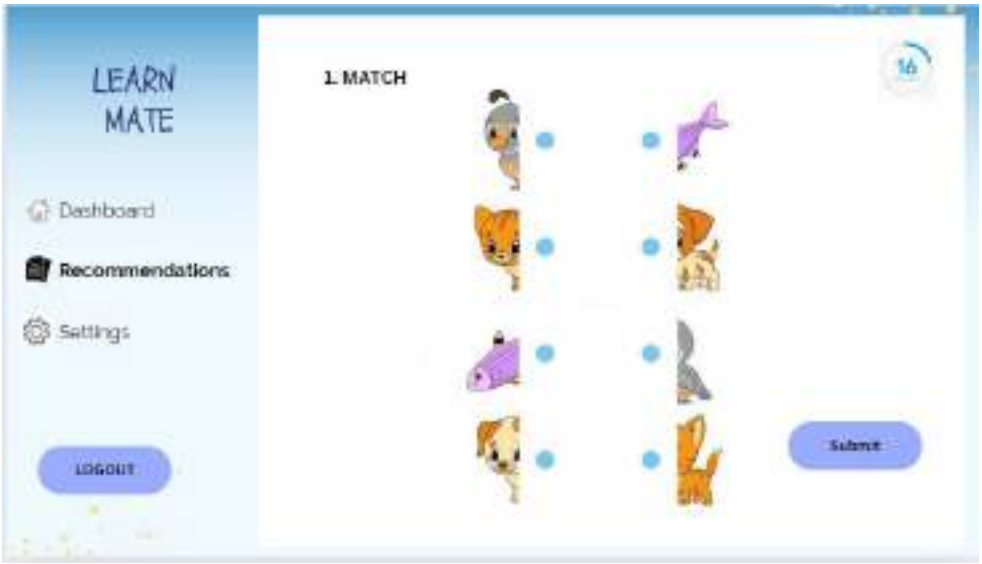

Figure 9:Recommendations Page3

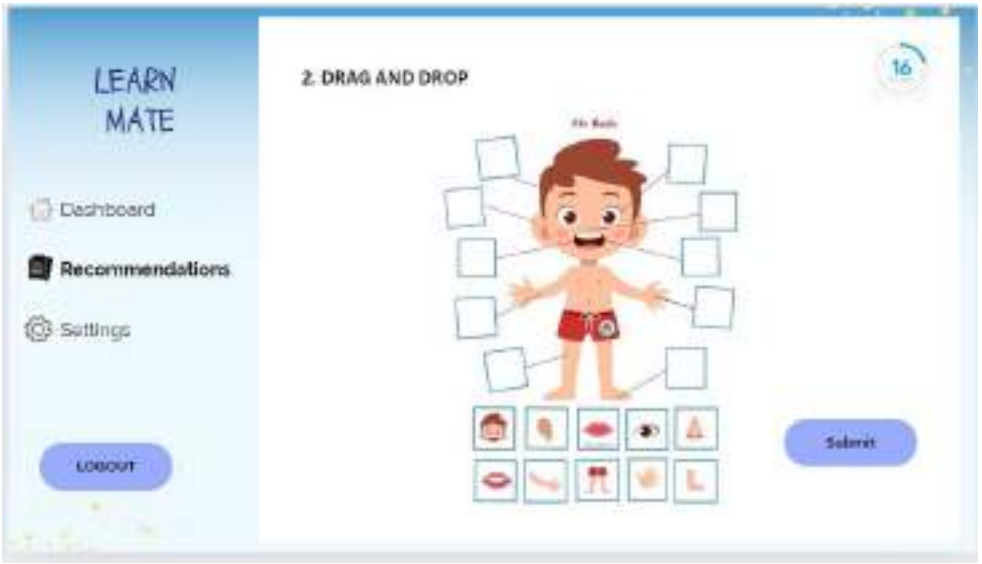

Figure 10:Recommendations Page4

Figure 11:Settings Page

5. Work Breakdown Chart

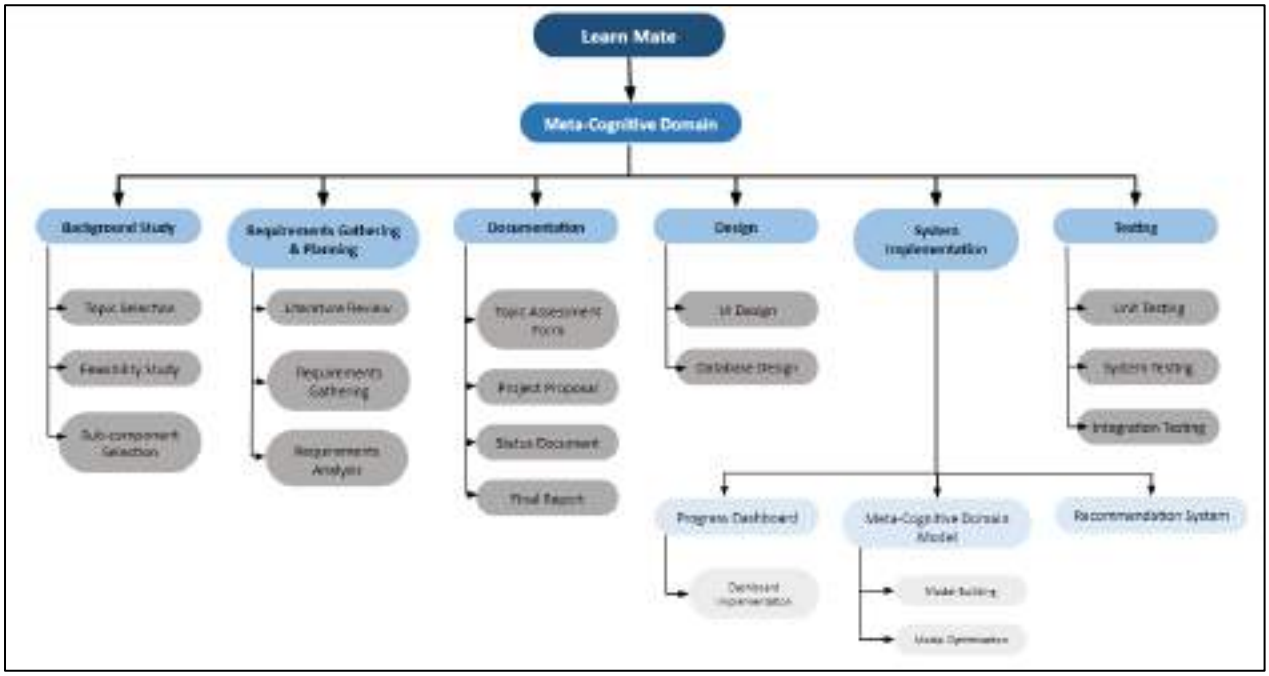

Figure 12:Work Breakdown Chart

6. Gantt Chart

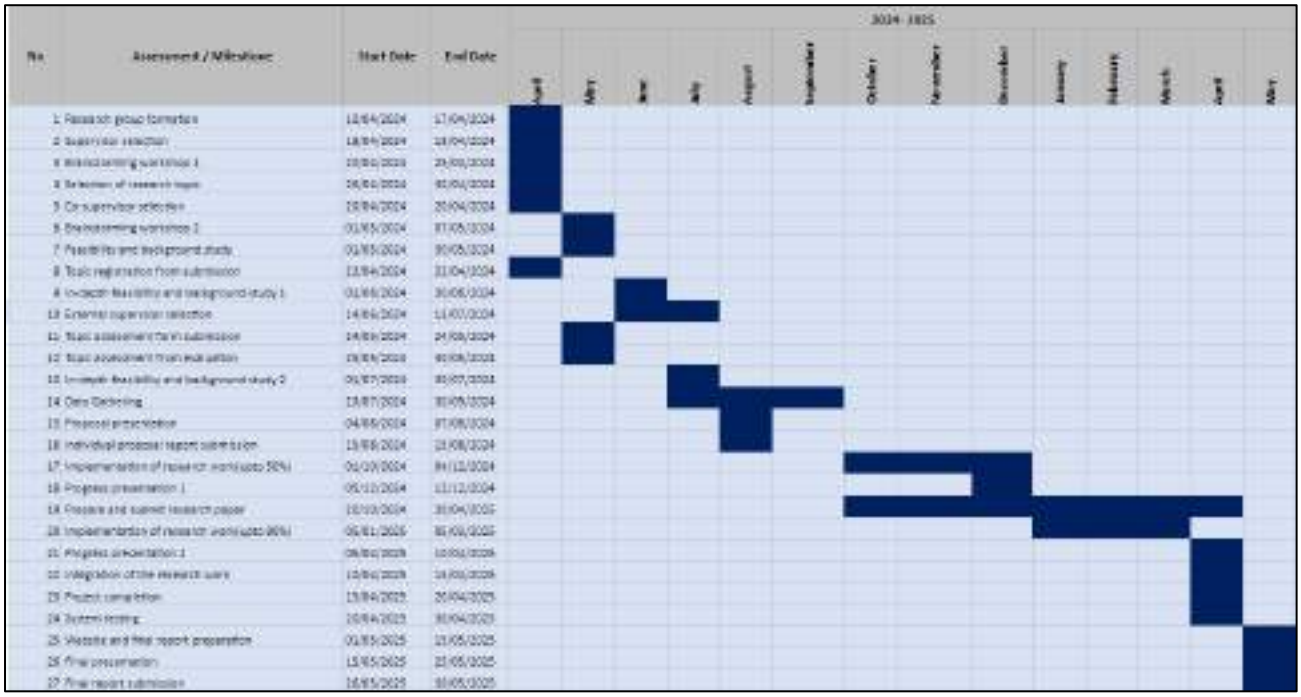

Figure 13:Gantt Chart

7. Budget and Justification

Component	Amount (LKR)
Stationary Items	2000
Internet Connection	5000
Electricity	3000
Transportation	3000
Consultations	3000
Telephone Credits	500
Google Colab Pro	5000
Open AI Plus	10000
Total	**17000**

Table 2:Budget Justification

8. References

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