AI-Driven Behavioral Assessment and Intervention for ADHD

Project Proposal Report

Project ID: 24-25J-261

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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.

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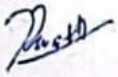
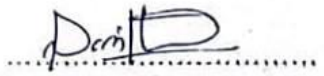
Manamperi R.S	IT21290992	

The supervisor/s should certify the proposal report with the following declaration. The above candidate is carrying out research for the undergraduate dissertation under my supervision.



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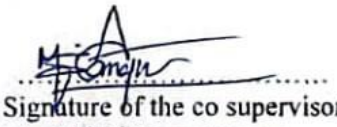

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ABSTRACT

This research proposes an AI-driven intervention system designed to assist children with ADHD, particularly those with the Predominantly Inattentive type, by combining emotion recognition and behavioral assessment to provide real-time, personalized interventions. The system integrates focus enhancement games, emotion-based game adjustments, and task organization tools that adapt based on the child's emotional state and performance. Using a pre-trained ResNet50 model for facial emotion detection and reinforcement learning for task management, the system continuously evolves based on real-time behavioral data, promoting sustained focus and emotional regulation. The model leverages techniques such as data augmentation, dropout regularization, and fine-tuning to address overfitting and enhance generalization. This user-centered system aims to improve cognitive and emotional development, offering a scalable, holistic alternative to traditional ADHD treatment methods. The outcome is a personalized learning environment that helps children with ADHD manage attention and emotions, with potential applications in educational and home settings, ultimately improving academic performance and well-being

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ADHD	Attention-Deficit/Hyperactivity Disorder
AI	Artificial Intelligence
PI	Predominantly Inattentive (Subtype of ADHD)
RCT	Randomized Controlled Trial
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition
CNN	Convolutional Neural Network

1. INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that impairs a child's capacity to regulate attention based on the context of the situation; organize tasks; and sustain attention, as is seen in Predominantly Inattentive ADHD [1]. This subtype, however, usually presents lesser tangible signs and symptoms and many go undiagnosed, and patients experience problems in learning, social relationships and general functioning. Although there is a broad array of traditional intervention tools in practice, a lot of them do not the flexibility and interest in the children's appropriateness and the specificity of their individual needs in emotional and cognitive profiles to address the ADHD issue in children [2].

The intervention of this study includes an Artificial Intelligence based behavioral intervention system for children with Predominantly Inattentive ADHD, to potentially increase attention, organization and emotional Self-Regulation through use of smart tools. Focus enhancement games form the basis of the system, where their level of difficulty is dependent on real time performance and facial expression analysis of the emotional state of the patient [3]. This way, the child does not get bored with the approach used and the intervention corresponds to the child's present mood and personal development level [4]. The system also proposes the use of emotion-based game adaptation, allowing for real-time changes of the tasks or introduction of motivators based on recognized affective states like frustration or sadness [5]. Together with that, there are task organization tools, which are based on time management theories and practices like the Pomodoro Technique, that help children to organize and prioritize tasks [6]. A progress tracking and rewards system encourages children not only to stay on task and finish work, but gradually improve in attention and organization. I believe that the key innovation is that the system makes it possible to apply real-time emotional adaptation and reinforcement learning models as well as include a comprehensive reward system, making the learning process individualized and interesting for the learner [7]. This is unlike the more conventional static model which is mostly unchanging and thus not well equipped to handle individual child differences with outcomes that can be massively enhanced in the long run by the type of dynamic system in place here [8].

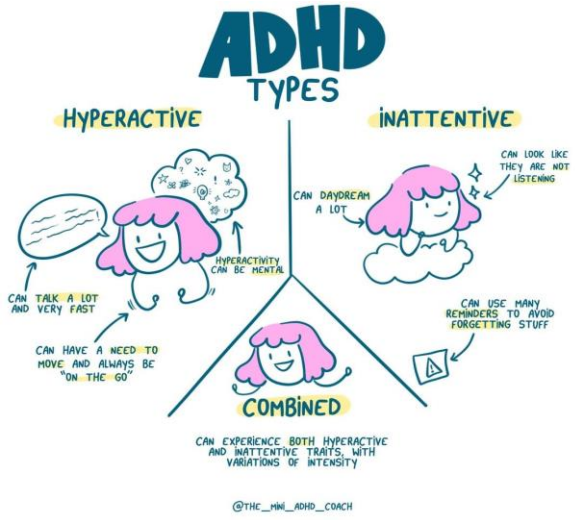

Figure 1.1 ADHD Types

Source - https://www.theminiadhdcoach.com/adhd-awareness/adhd-types

1.1. Background Literature

ADHD is a neurological disorder impacting children and adults that are diagnosed with the following symptoms: inattention, hyperactivity, and impulsiveness [9]. ADHD is broadly categorized into three main types: It is comprised of Predominantly Inattentive ADHD, Predominantly Hyperactive-Impulsive ADHD and the Combined Type which has symptoms of both [1].

In this type children with ADHD-PI have traits like leg swinging, making noise during class or at home, and being too much involved in movement than in listening or sitting still. Such symptoms are observable and hence they were identified earlier as compared to other symptoms whose diagnosis involves internal examination. On the other hand, Predominantly Inattentive ADHD also referred to in this study is characterized by different symptoms such as forgetfulness, weakness in sustaining attention and organization difficulties [10]. These behaviors are frequently unobserved and therefore such children are not diagnosed and recommended for early interventions. Possible symptoms for this subtype are like those seen in the inattentive subtype, but children may be restless or "space out", which may cause marked low performance in school and difficulty in developing interpersonal relationships [9] [1].

Addressing Inattention Through Gamification

Use of gamification is beneficial especially when it comes to dealing with inattention caused by ADHD. Strategies can be conveniently built into items that are part of an individual's daily life; these can include formative incentives, hierarchy and quests, which have been proven to enhance focus [11] [12]. The games intended to help ADHD management contain such tasks as focusing, memorizing, and completing tasks; as for the level of difficulty, it increases if a child performs well [13]. The approaches make learning fun, and this addresses some of the fundamental symptoms of inattention [14] [15].

Emotional Regulation in ADHD

Emotional impulsiveness or insecurity is another important component of ADHD that worsens the problem with attention and task fulfillment. For Children with Predominantly Inattentive ADHD the child may get frustrated or bored when it is time to do tasks that are particularly demanding [16]. Real time emotion detection systems can then be designed as part of an overall system for detecting deception through facial recognition as another solution to this problem. Knowing the emotional condition of a child, including such state as bore or frustration, these systems can adjust the level of difficulty of accomplishing tasks or introduce elements that can motivate the child to perform a task [17] [18].

Personalization Through Reinforcement Learning

Marking and feedback, customization based on performance analysis, make it possible to create challenging systematic sequences of tasks and their content. This prevents something from being too hard for a child to comprehend, it also challenges the child to progress slowly to the next level of difficulty. Core to teaching and learning, personalized reinforcement learning enables children to be productively engaged at recommended levels without getting bored because tasks that are set for them are not overly simple or get frustrated because tasks are set such that they are not achievable because they are complex [19] [20].

Task Management and Executive Functioning

Self-organization and planning issues which stem from the executive dysfunction Ing is seen often in children with Predominantly Inattentive ADHD. Children require reviewing tools that enable task organizing including planners, reminders and how-to-do lists for the activities [21]. These tools can be complemented by such elements as time management with the help of such ideas as the Pomodoro technique which implies the work in intervals with a break in between [22].

Tracking Progress and Reinforcing Positive Behaviors

Students complete many activities, and progress tracking systems along with rewards like badges or creating a new level in the game give constant positive encouragement to work and focus. All these mechanisms encourage formation of long-term behavior which enhances achievements of good results as students to focus and complete tasks.

Culturally Relevant Interventions

Many current ADHD management is initiated and developed in the western world's so the applicability on societies like the Sri Lankan society is questionable at the most [23]. To understand the targeted culture and population, the interventional programs must be culturally appropriate and language as well as resources tested. Culture-sensitive strategy enhances utilization and implementation in areas lacking or having limited access to resources [24].

Holistic Approaches to ADHD Management

By combining gamification, responsiveness to subjects' emotions, and task organizing tools, the proposed concept offers a balanced strategy for addressing Predominantly Inattentive ADHD. These interventions address cognitive, emotional, and executive functions of children and young adults in their attempts to treat ADHD [25].

This research extends from these principles, with the goal of developing a culturally appropriate and isolatable intervention system for children diagnosed with Predominantly Inattentive ADHD. Strengthening the deficiencies of existing applications, the designed solution aims to improve attention, planning, and manage stress in children, parents, and teachers to obtain the results.

1.2. Research Gap

Research A - This research specifically shows how gamification strategies can be applied to agile mobile learning applications for enhancing mathematical performance of high school learners. The authors present various concepts that can be incorporated in game-based learning including the use of challenges, achievement badges, and rewards. Recall that the application is indeed to increase the student engagement towards mathematical learning that traditional systems indicate as less engaged and the mechanics incorporated into the application encourage the learner to progress through levels solving problems. This way, the study validates the chosen mechanics usefulness, noting positive shifts in learners' motivation, their perseverance, and performance, in general, to illustrate the power of gamification in learning [26].

However, the study proposes some limitations in the analysis of the results: It is good for general student populations but lacks provisions for neurodiversity, including children with ADHD for instance, they have different needs including challenges of attention, difficulty in managing emotions, and failure to concentrate. Finally, the system does not have components which adapt to behavioral styles or emotions of the user. It is designed in a structural fashion that doesn't allow for the changing of game challenges or rewards depending on the outcome provided by the user, which is essential for long term use in learners with ADHD. The effective elements of an individualized approach to needs associated with ADHD are not included: for instance, emotional sensitivity and adaptations [26].

However, the presented work takes gamification concept further by introducing it to a specific setting and targeting inattentive ADHD in children. It also incorporates real time behavioral and emotional monitoring utilities like face detection system that defines the child status at any given time. Thus, an of the game flow is modified as follows to keep the audience or the players engaged all the time. For instance, if a child seems to get distracted or pressured, the system can present easier problems or provide extra positive stimulus. This makes the learning not only fun but also aligned to the specific child's needs in a way that eliminates the gap as found in the study.

Research B - In this research, the AI-assisted digital therapy aims to help children with ADHD establish lower impulsive behavior. The therapy uses AI algorithms to provide individualized of the therapy meanwhile its major approach is to make normalization of the spontaneous oscillatory activity assessed by magnetoencephalography (MEG). The work offers a wealth of evidence in support of the effectiveness of AI-based therapeutic approaches, which show a reducing degree of impulsivity and enhanced cognition among the subjects. This shows great power of AI in ADHD where data accuracy can drastically change the approach to the treatment and management of the disease [27].

However, the strength of the study is that it only addresses the impulsiveness which is one of the defining ADH D symptoms. As a result, it fails to pay attention to others important areas of development like emotional control, maintaining constant attention, and building self-control skills. The therapy targeting neoplasms is neuropsychological and fun is not applied as gamification is fashionable now-a-days for creating interest and motivation. Also, it does not have features for dynamic task organization and individual assignments, a foundation to provide specific methods for inattentive ADHD. Their absence causes certain limitations on the range and relevance

of the therapy, especially for children who have trouble concentration and managing their own moods [27].

The proposed system extends from these findings in a way that closes all these gaps. They use real-time measures of facial recognition and activity to determine the emotional state of a child for modification of their therapy. This encompasses items that can be used to improve target attention, motivation and other related aspects, for example games with unique enhancement features normally incorporated in a game. Moreover, the system incorporates features of dynamic task activities, which change the nature and degree of child activities depending on the result and child's mood. With the help of all such components, the system offers a comprehensive solution for ADHD treatment, addressing the problems concerning impulsiveness, emotional, and self-controls besides appealing and individual.

Research C - This study aims to fill this research gap by providing an understanding of how ICT can help educationally motivated children with ADHD. Our research underlines the necessity for such tools and helps in structuring a learning process that, in its turn, would contribute to increasing the results of achievements at institutions. This talking point focuses on the design of static applications, concerns and techniques to assist children in planning the sequence and timing of tasks to decrease mental load that comes with multitasking and disorganization. These tools are intended to give a systematic learning approach that is an advantage to children that have difficulties in concentration as well as accomplishing tasks on time [28].

Nevertheless, the tools for the management of tasks described in the study are limited to their static character and their inability to consider changes in performance or mood. This static nature hampers their applicability, because children with ADHD have variable patterns of attentiveness and motivation that must be countered as soon as possible and in an individual manner. Further, this study does not consider the utilizations of applicable techniques such as applying gamification or reinforcement learning to increase the level of interest and self-motivated learning. These gaps emphasize the importance of developing and implementing the ambulatory and engaging approaches allowing for the treatment of various and diverse difficulties a child with ADHD might experience [28].

The proposed system directly overcomes these limitations by providing AI-adaptive tools for measuring the child's successes and failures and their corresponding interactive self-regulatory systems. For example, if a child is having some difficulty, for example in a corresponding activity, the system will make that task easier or offer more assistance. On the other hand, the system can add to the difficulty and continue providing the child with new tasks even if the child is doing well. There is also gamification utilized to enhance the learning experience and engagement by using elements such as rewards, progress bar, and game profiles. Thus, the integration of indicated elements makes the system rather flexible and adaptable to learning child needs and preferences, while providing effective support to children with inattentive ADHD, something the more rigid tools mentioned in the study cannot achieve.

Research D - The current research aims at offering an extensive description of digital health interventions utilized for ADHD care and emphasis on their effectiveness in primary care settings. The study also underscores the fact that the issue of accessibility and cultural appropriateness

should be accorded with due priority in the development of such interventions. Cognitive interviewing is presented as a promising methodological advancement because it fills gaps in existing tools such as lack of individualization or cultural sensitivity. For example, it is standard to overlook language particularly the language that students understand fully, methods of teaching as well as other related factors that relate to the cultural practice. The study also focuses on the scarcity of dynamic characteristics of contemporary tools that hinder them from fulfilling the functional requirements of ADHD consumers [29].

However, these studies don't offer specific suggestions as to how these gaps should be overcome or filled. It also fails to consider gamification or the design of learning environments that are important in fashioning effective modality taken to be a form of intervention. Described tools have fewer dynamic characteristics and cultural adaptations and are less effective for inattentive ADHD children who need structured and culturally appropriate interventions [29].

The proposed system aims at enhancing these findings by focusing on cultural adaptation suitable for the user. This can range from language choice options to locally relevant content to allow it to cater for the discontinuous nature of the intended public. The system also adapts to learning environments where game flows and task management necessarily occur according to children's needs and differences. All these features not only increase activity and attractiveness to users but also solve the problem of child attention deficit of the inattentive type. Therefore, by integrating cultural adaptation along with AI-assisted tools in the system, there are best coverage measures in ADHD management as the gaps examined in the present study shows.

Table 1.1 Research Gap

	A	**B**	**C**	**D**	**Proposed System**
Gamified Learning Approaches	✓	✗	✗	✗	✓
Emotional and Behavioural Analysis Tools	✗	✗	✗	✗	✓
Adaptive Task Management Tools	✓	✗	✓	✗	✓
Tailored Activities for Focus Enhancement	✓	✓	✓	✓	✓
Support for Self-Regulation Skills	✗	✗	✓	✗	✓

Personalized Game Flow	✗	✗	✗	✗	✓

Accordingly, the proposed system is designed to combine the advantages of previous studies but, at the same time, avoid their shortcomings and become a specific and comprehensive solution to inattentive ADHD. Thus, integrating gamification, tools for emotional regulation, adaptive task management, and cultural relevance in the approach guarantees the individualized effective intervention for ADHD children. This not only increases interest and enrolment but also offers help for work against attention and emotional regulation difficulties, which in turn makes this a revolutionary addition to ADHD treatment.

1.3. Research Problem

Children with Predominantly Inattentive ADHD often face academic, social, and emotional difficulties that are unique compared to those with the more visibly disruptive Hyperactive-Impulsive ADHD. Symptoms such as inattention, distractibility, disorganization, and forgetfulness are commonly under-recognized, particularly since children with inattentive ADHD may not exhibit outward behaviors like fidgeting or interrupting others [9]. This leads to delayed diagnosis and intervention, which can severely impact their academic success and emotional well-being. Children with this subtype of ADHD often underperform academically, as they struggle to focus on tasks, maintain attention during lessons, and keep track of assignments [1].

Inattention-related challenges are often compounded by poor emotional regulation. Children with inattentive ADHD may experience emotional reactions such as frustration, anxiety, or boredom, which further inhibit their ability to stay focused and engaged [18]. These emotional difficulties, often overlooked by existing interventions, can create significant barriers to learning and task completion. Traditional ADHD interventions frequently fail to adapt to the emotional and attention fluctuations that children with inattentive symptoms experience. For example, a child who becomes frustrated during a task may require support such as reduced difficulty or added motivation, but most existing systems do not integrate emotional awareness or real-time adjustments based on the child's mood or engagement level [18].

Furthermore, executive functioning challenges particularly in task organization, time management, and prioritization are at the heart of the difficulties children with inattentive ADHD face. These children may struggle to initiate tasks, break them into manageable steps, and stay organized, making it difficult to meet deadlines or finish assignments. Without effective tools for task management, children can quickly become overwhelmed, which can lead to academic underachievement and emotional distress. While some task organization tools exist, they are often not dynamic enough to cater to the specific needs of children with ADHD, particularly when attention spans or motivation fluctuate throughout the day [30].

In addition to these challenges, existing interventions for ADHD often lack the personalization needed to be effective for children with inattentive ADHD. Most tools provide generic solutions that fail to account for the individual differences in performance, attention span, and emotional state. Personalized interventions that adapt in real-time to a child's progress, difficulties, and emotional responses are essential for engaging children and helping them overcome barriers to attention and task completion. Traditional systems fail to integrate modern technologies, such as reinforcement learning, which could provide dynamic, personalized learning pathways tailored to the child's current need [20].

Moreover, cultural relevance plays a critical role in the success of ADHD interventions. Many current ADHD tools have been developed in Western contexts and are not easily applicable to children in regions like Sri Lanka, where local cultural norms, educational systems, and available resources differ. Culturally adapted interventions that consider language, educational practices, and socio-economic conditions are vital to ensure that children in these regions have access to effective ADHD management tools [31].

The critical gap in ADHD management lies in the lack of adaptive, emotionally aware, and culturally relevant interventions tailored to the needs of children with Predominantly Inattentive ADHD. Current tools do not address the dynamic nature of attention and emotional regulation, nor do they provide personalized feedback or task management solutions that adjust to a child's changing needs. This research proposes to fill these gaps by developing an AI-driven intervention system that combines gamification, emotion-sensitive algorithms, reinforcement learning models, and task organization tools to provide a holistic, personalized, and culturally appropriate solution for children with inattentive ADHD. The proposed system will ensure sustained engagement, improve task completion, enhance emotional regulation, and foster better academic and social outcomes [32].

Traditional ADHD management systems primarily focus on behavioral or pharmacological interventions, which often lack personalization. Behavioral strategies are typically generic and fail to adapt to a child's fluctuating attention and emotional states. Moreover, emotional dysregulation a common challenge in children with inattentive ADHD is frequently overlooked in existing tools. Emotional states like frustration, boredom, or anxiety can disrupt engagement and task completion, but traditional systems rarely incorporate mechanisms to detect or respond to these states in real-time. Children with inattentive ADHD frequently exhibit deficits in executive functioning, including poor task organization, difficulty managing time, and challenges in prioritizing tasks. These deficits can severely hinder their ability to perform academically and complete daily responsibilities. While some task management tools exist, they are often static and fail to accommodate the specific needs of children with ADHD. Effective tools must break tasks into manageable steps, integrate reminders, and offer feedback dynamically to address these challenges [18] [33].

Existing interventions are often developed in Western contexts, with little regard for the cultural, educational, and socio-economic differences in regions like Sri Lanka. These tools may not align with local teaching methods, language preferences, or available resources, creating a gap in their accessibility and effectiveness. The lack of culturally relevant interventions further limits their adoption and success in diverse settings. Most interventions do not leverage modern technologies,

such as reinforcement learning or emotion-sensitive algorithms, which could enable dynamic adjustments based on a child's performance and emotional state. This one-size-fits-all approach fails to account for the variability in attention levels and emotional needs that define inattentive ADHD. Adaptive tools that provide real-time feedback and personalization are crucial to maintaining engagement and ensuring positive outcomes [31] [34].

The major problem of ADHD treatment is that there are no approaches connected with adaptiveness, awareness of own and others' emotions, and cultural sensitivity. To fill these gaps, this research aims at implementing an AI based intervention system which includes gamification, real time emotion detection, reinforcement learning and task management tools. This is an ideal strategy that will effectively help children with inattentive ADHD to achieve better academic, emotional and social results by implementing cultural appropriate solutions and an engaging solution [14].

2. OBJECTIVES

2.1. Main Objective

The main goal of this research is to undertake a research study on tools and activities to help children suffering from Predominantly Inattentive ADHD pointing at adaptive learning and other technologies to help enhance focus, organization, and attention span. This is intending towards primary deficits in children with inattentive ADHD such as the ability to sustain attention, to organize tasks and to complete activities. They usually impact academic achievement, emotional health, as well as social growth. Static behavioral therapies or educational web application fails to provide for the dynamic need of such children as are observed in their peculiar behaviors.

2.2. Sub Objectives

- **Develop Adaptive Focus Enhancement Games**

  It means designing an engaging game, like the falling star reaction time game and gather statistics on attention span, reaction time, and impulsivity. From this module, children should be able to behave naturally; the brighter side being that this will also be entertaining for the children while collecting valuable information on children's behavioral responses. The use of this game should be helpful to children in their respective learning level of the primary school, culturally adapted and well appropriate for use in Sri Lanka.

- **Develop Adaptive ADHD Symptom Prioritization and Questionnaire System**

Design a parent-completed rating scale for the child that is contingent on the child's performance on the game, and which targets the child's specific ADHD symptoms (inattentive, hyperactive-impulsive, or combined). The questions will be selected based on DSM-5 to offset the standard general format of the questionnaire but also to meet the individual needs to increase the percentage of correct diagnosis. This adaptive system assists in organizing the appropriate means of data collection for completing the questionnaire in a shortened, most likely representatives of children's probable symptomatology.

- **Integrate Multimodal Data Analysis for ADHD Type Identification**

  Create a data fusion system that will combine the child's game data with feedback from parents and come up with the overall rating of the new features for the identification of the ADHD indicators. By employing the machine learning technique, the system will be able to compare different patterns from both such data sets with a view of giving the necessary direction whether the child has ADHD or not and if so, which type. The advantage of this approach is that it accounts for real-time behavioral interaction and offers observational feedback in addition to interaction and effective interval assessment.

- **Create user-Friendly Interfaces**

  Adaptive interfaces are recommended for the ADHD assessment tool so that children and their parents can effectively use the tool. This will include use of simple icon on the home page, no use of many buttons on the home page, and use of proper pictures which a child will understand for effective learning will be observed without congesting the child's brain thus making the game enjoyable. It will also include other options such as size, voice, and color for the convenience of the user with special needs especially children with ADHD by avoiding many distractions.

3. METHODOLOGY

3.1. System Architecture Diagram

3.1.1. Overall System Architecture Diagram

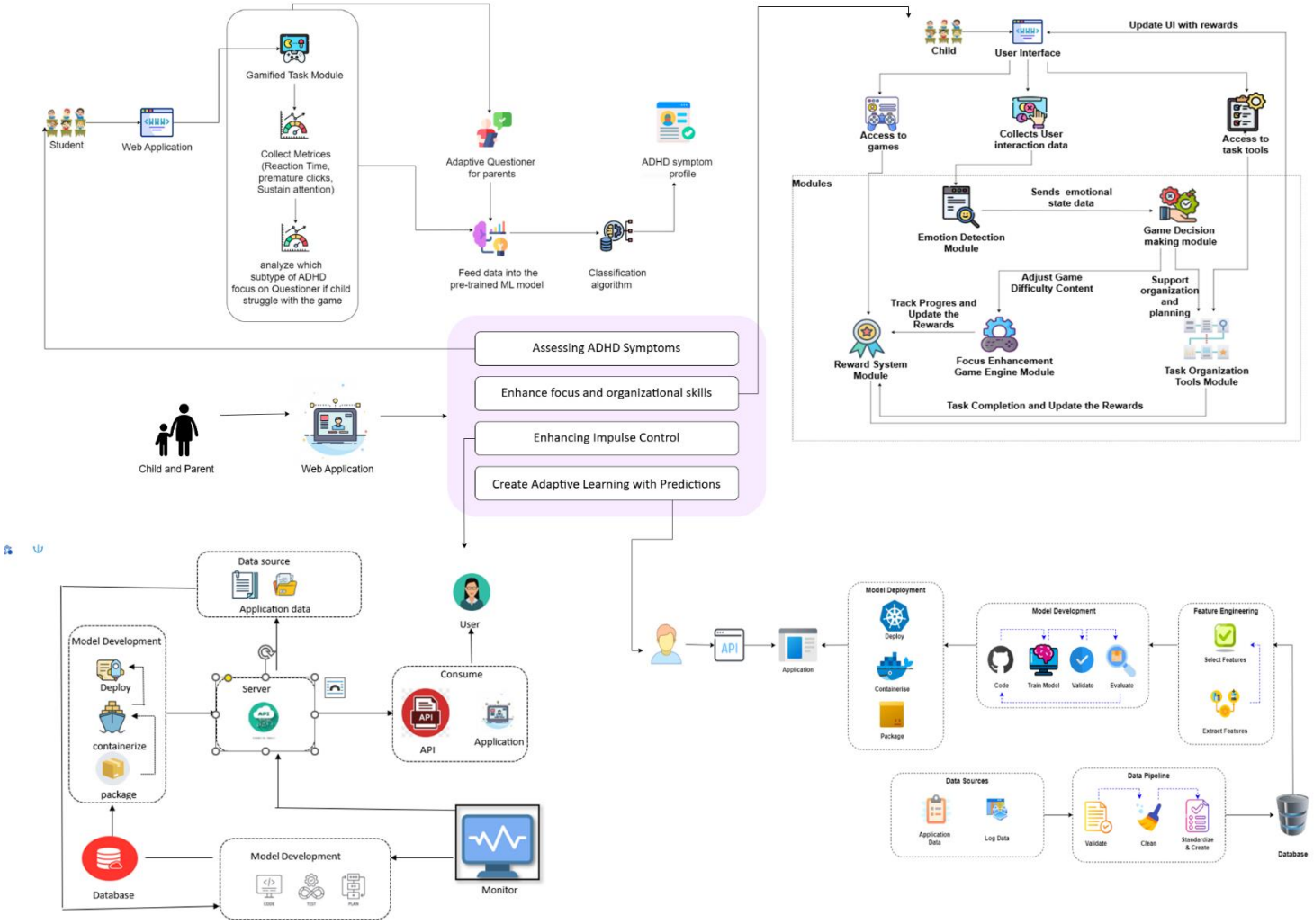

Figure 3.1 Overall System Architecture Diagram

The decision to proceed with the compilation of an ADHD assessment and intervention application for the Sri Lankan primary school students, is possible because of a structured system architecture, which will effectively; diagnose, assess and manage all the aspects of attention deficit hyperactivity disorder within schools. This culturally appropriate and engaging, gaming, model of application is evidence based and will help children, parents and teachers. It includes game-based modules, learning that adjusts to a student's performance, behavior management strategies, and, use of big data in coming up with algorithms to tackle ADHD in its entirety.

1. Gamified ADHD Assessment Module

With this module, the conventional ADHD screening methodology is enhanced with online gameplay criteria that are tested clinically. The "falling star" reaction-time game is played by kids with the ADHD rating-scales of response times, focus duration, and impulsiveness in

mind. The desire to label this format as a game is not only justified by the fact that it provides data on performance but also because it achieved the goal of child participation willingly and enthusiastically. In addition, parents fill in an adaptive DSM-5 questionnaire, e.g., the Vanderbilt ADHD Diagnostic Parent Rating Scale, which changes depending on the answers provided. This module uses gameplay data and caregiver reports and input data which is learned from pre-trained machine learning model and offers a preliminary diagnosis of different subtypes of ADHD such as Inattentive, Hyperactive-Impulsive or both. This dual-input methodology increases the reliability of the assessment as well as creates a strong foundation for developing individualized intervention plans.

2. Attention and Organizational Skills Enhancement Module

This curriculum is suitable for ODD children who mainly have the inattentive form for ADHD; this program's goal is to bolster children's concentration and organizing skills after a fun school period. The module proposes an innovative approach in arranging educational tasks of the module based on the child's learning-teaching style, mood, and attitude. For example, if a child is frowning or looks bored, the module can make tasks easier or add incentives so as to grab the child's attention. One more critical component addresses the need for providing incentives by using something as simple as a game. Through being awarded stars, trophies, badges or level gradients, then children make connections with positive gains encouraging them to continue paying attention and finish tasks. These are cultured to familiar and immediate responses among the Sri Lankan students without the medium of English. Also, real time constant surveillance on such data ensures that the system is able to fine tune activities as they occur. For instance, if a child's behavior suggests that he/she is not concentrating, the system is likely to provide him/her with smaller working exercises that are likely to capture his/her interest. Due to its self-adjusting nature, the module enables the development of sustainable long- and short-term attention patterns for a child together with good organization and learning etiquette.

3. Structured Routines for Impulse Control Module

This module is specific to hyperactive-impulsive ADHD children; the program deals with the issues of impulsivity and hyperactivity by using schedules throughout a day. The structure of the services also extends to convenience where parents and educators get several options, specifically to create a preferable child schedule. These routines are created to keep the child productive and to instill discipline as well as self-control in him/ her. It uses activities including mindfulness exercises, workouts and task by task practices. Such activities are play activities that are both fun and constructive in nature that help channel energies positively while at the same time training children not to push at things and people randomly. For instance, a child may take breaths after getting involved in an event that probably makes him or her excited,

this can help calm the kid down. Another advantage is its flexibility though the routines may be modified depending on the child's learning achievement or some conditions. For instance, in the case of improved regulation of impulses, a specific child can be made to do tasks that are more demanding by increasing the level of difficulty within the schedule that is made. It also makes sure that the child's learning process is not interrupted but goes on till the system is good enough. Further, it contains recommendations for parents or teachers to use these routines effectively at home and school setup.

4. AI-Driven Adaptive Learning and Intervention System

This one is the most technologically intensive component of the system, which is also potentially the most useful since it would keep a constant eye on a child's development and adjust to the pace and needs of the child immediately. The system achieves this by capturing essential performance indicators including response times, frequency of task accomplishment, focus duration and behavioral characteristics generating a comprehensive child progress profile. This data is analyzed using detailed artificial intelligence algorithms that make it easier to determine trends, possible issues and suggest the type of intervention that is necessary. In particular, the predictive potential of the module is remarkable. For example, if data shows that a child's attention decreases in some tasks, the system may recommend changes like changes in the duration of the tasks, or how a break should be inserted. Likewise, if the system notes regions of the child's competence, the system may assign further complicated tasks so as to achieve the kid's elevated cognitive level. These insights are made easily understandable by a convenient user interface for both parents and teachers. The detailed feedback consists of the following: the visual representation of the progress, potential problems or areas for development and recommendations for the further child's development. For example, a teacher may get advice on the possible approaches to use when in class, while a parent may get advice on ways to engage the child in developing his/her skills at home.

This arrangement makes these components work concurrently to help in management of ADHD comprehensively. From gamification, adaptive learning, structured routines and AI analytics, the system not only helps in the development of the child but also helps caregivers and teachers to effect meaningful developmental changes in the way ADHD is managed.

3.1.2. Component Specific System Architecture Diagram

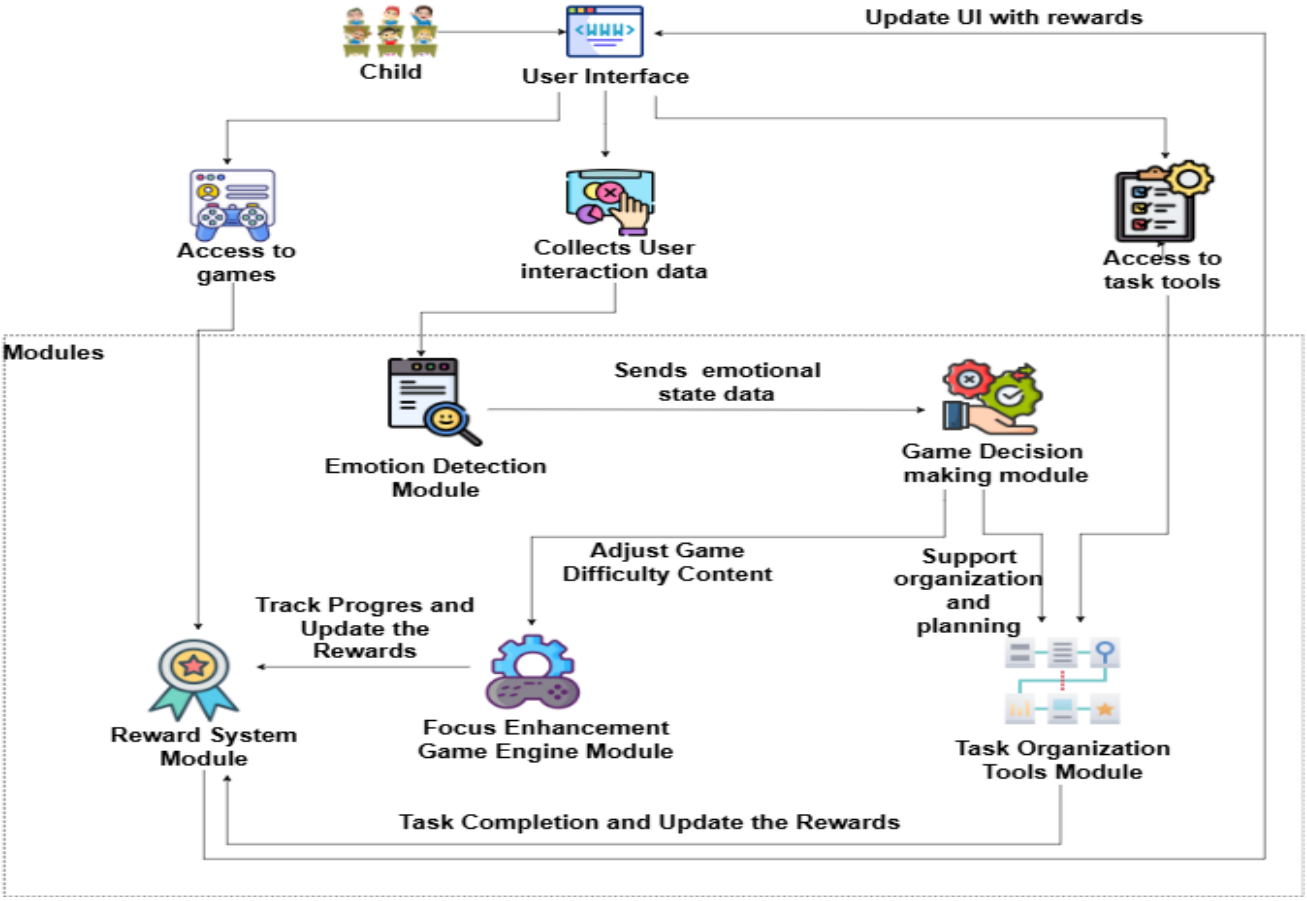

Figure 3.2 Component Specific Architecture Diagram

This system intends to meet the requirements of children with Predominantly Inattentive ADHD using artificial intelligence with both gamification and adaptive learning. More specifically, it is designed to address concerns like inattention, disorganization, and behavioral regulation with a distinct designed intervention approach based on modules and individual differences. In addition, it is significant that using advanced technologies, the working of the system contributes to the progress in cognitive advancement and adaptation to even further advancements.

- **User Interface (UI)**

The User Interface (UI) is a simple and easy-to-navigate interface that works as the infrastructure of interaction of the user with the system. This way it offers the user a set of features like focus-enhancement games, tasks organization tools as well as trackers. Largely due to the use of bright images and a bright, uncluttered layout, children are made to remain interested and comfortable while using the system.

- **Emotion Detection Module**

The Emotion Detection Module is the core of adaptivity of the system. For example, it exploits facial emotion recognition and interaction data to identify in real time the child's emotion level, whether it is happy, bored or frustrated. These ideas are used to modify activities together with the degree of difficulty of tasks or games so that the child stays interested without getting bored or frustrated.

- **Game Decision-Making Module**

In a similar way, the Game Decision-Making Module changes those aspects that concern the game's flow according to data from the Emotion Detection Module and the performance of the individual. It makes sure these activities are appropriate for the child's current level of concentration and his/her abilities to learn. For instance, if the child looks like he/she is frustrated, the Anti-Frustration Pro Feature reduces difficult tasks and if the child is performing well high-level games are introduced to keep the child mentally challenged.

- **Focus Enhancement Game Engine Module**

The FEGEM environment includes several games aimed at increasing the children's attention and practicing executive functions. These games incorporate reward systems levels and leader boards to maintain the child's engagement. The mechanics of this module allow the child to improve focus and problem-solving skills gradually by adapting and changing accordingly to child's real-time feedback and morale.

- **Task Organization Tools Module**

The Task Organization Tools Module helps in the development of necessary life skills through learners being provided with structures of undertaking some of the activities. Something like reminder, setting priority, and the calendar helps in teaching children how to accomplish tasks in a structured manner. This sort of simulation works alongside the actual gaming, in that children can practice what they have learnt in real situations.

- **Reward System Module**

The Reward System Module also involves a process of encouraging the children through the process of rewarding them. To monitor performance over games as well as tasks, the system provides points, badges or virtual tokens for accomplish tasks. This way not only motivates children and raises morale, but also maintains active engagement and makes the children link effort with achievements.

- **Data Workflow and Integration**

The system employs a fully integrated data flow where users' interactions go through real-time analysis in the Emotion Detection Module. These insights are used by the Game Decision-Making Module to facilitate dynamic changes of activities. Coordinated data from all modules means a

progressive learning experience that remains constant and progressive, with feedback processes to maximize learning.

- **Innovative Features**

Some unique aspects of the system include the ability to adapt to the emotional context in real-time and reinforcement, learning to improve classifier's performance, and game elements to get better cognitive performance. Also, linkages to the task management tools show interconnection of learning with practical applicability as making the system comprehensive in addressing ADHD cases.

- **Key Benefits**

It again provides the capability to deliver learning that is tailored to the person and optimized for each learner's needs. When gamification is integrated with adaptive learning, it also becomes an appealing educational platform for cognitive and behavioral advancement. Moreover, their design enables the extension of new components as needed and the expansion of other extra parts of the hardware and software designs, making it a long-term, viable solution to ADHD interventions.

3.2. Software Solution

3.2.1. Development Process

The process of creating new solution encompasses an idea of creating the AI-based system for children with predominantly inattentive ADHD and with considering the challenges listed above. It includes components such as gamification, emotion detection algorithms, and a task assignment system as well to deliver an effective learning environment. The development of the system uses a unique, cyclic process, which enables the increase in its usability, versatility, and compliance with the objectives of a user-focused approach for children with ADHD.

Key Principles of Agile Methodology

- **Collaborating with Customers**: Agile emphasizes close communication with customers and stakeholders. The team gathers feedback regularly to ensure the product aligns with customer requirements and expectations [35].

- **Incremental Progress (Iterations)**: Work is divided into short, manageable cycles, typically lasting 2-4 weeks. Each cycle, called a "sprint," delivers a functional portion of the product that is reviewed and evaluated for feedback [35].
- **Adaptability**: Agile is structured to respond efficiently to change. Whether it's a new client request or a market trend, the team can pivot quickly to accommodate updated priorities [35].

- **Team Collaboration**: Agile relies on cohesive teamwork among developers, testers, designers, and other technical experts. Collaboration simplifies processes, increases efficiency, and ensures smooth workflow [35].

- **Continuous Improvement**: After every sprint, the team evaluates its performance to identify strengths and areas for improvement. This iterative approach fosters better productivity and execution in future sprints [35].

- **Focus on Functional Deliverables**: Agile prioritizes delivering usable parts of the product in each sprint. This ensures the team consistently provides functional outputs for review, keeping development aligned with goals [35].

Advantages of Agile Methodology

- **Accelerated Delivery**: Agile enables the rapid delivery of product components, allowing quicker releases to the market and faster overall project completion [35].

- **High Flexibility**: Agile teams can easily shift focus or priorities when new challenges or changes arise, ensuring adaptability throughout the development process [35].

- **Improved Quality**: With frequent reviews and iterations Agile helps identify and address issues early, resulting in a superior final product [35].

Source - 360logica.com/blog/the-importance-of-different-agile-methodologies-included-in-agile-manifesto/

Figure 3.4 Agile Methodology

1. **Requirements Analysis**

   The initial process involved in the developmental process of the intervention system was a factor considering process. This included a critical evaluation of the current issue areas affecting children with ADHD, with much emphasis being put on their cognitive as well as

emotive development issues, hence a stale on attention regulation plus executive functions. The features like real time emotion identification, fun elements and personal TO DO list were also crucial findings. Also, tangible results which are focus, the rates of accomplishment of tasks and users' engagement were mentioned. These were the guidelines used to ensure that the designing and development of the system called Attend system was constructed to meet the basic needs of children with ADHD [36].

2. System Design

After the requirements were collected, the design process started. An architectural approach that was modular is used since the development of the system was anticipated to follow modularity. Some of the features developed in the design were a user interface that did not require much complexity and that would easily capture the interest of the child. The Emotion Detection Module was uniquely intended to detect real time facial expressions to monitor the emotional state of the user. This emotional data was incorporated with the Game Decision-Making Module, which determines the difficulty level of the games in relation to the feelings of the child as well as the accomplished tasks. The Focus Enhancement Game Engine was created to give the user a computer game that fits the way the user learns with the game's material progressively getting harder or easier depending on their results, and the Task Organization Tools Module was made to encourage the user to develop good study habits in terms of time management. Last of all, the Reward System Module was added to encourage the users and at the same time, monitor the performance of users [37].

3. Data Collection and Preparation

Particularly important were the methods of data collection and preparation to guarantee the system could properly identify the user's emotion and respond to it. The Emotion Detection Module was trained on three datasets that are easily accessible to the public. Moreover, replaying some of the key user interactions was also used in the tuning of the decision-making algorithms of the GDM and FEGE game modules. Consent was gained from the children for their pictures and names not to be captured during the data gathering activity due to the privacy of the users. This phase also included action preparation of interaction data set that will be useful in the refinement of the system's machine learning algorithms [38].

4. Module Development

The design and staging of each module were performed simultaneously to allow for great flexibility. The Emotion Detection Module could implement real time facial recognition using computer vision models. The Game Engine was designed with the means of reinforcement learning to adapt the level of difficulty of the game according to the reactions of the child. The Task Organization Tools were designed as calendars for and with children where they can set tasks, reminders, and goals for themselves and track their progress. The Reward System Module was created to make users more active with the system by

monitoring completion of jobs and providing positive reinforcement in the form of rewards [39].

5. Integration

After these individual modules were compiled, the next process was to link them in a system mode. They requested that the designers make the different modules to be interoperable so that they could pass data between them smoothly. For instance, information gathered from the Emotion Detection Module impacted the action taken in the Game Decision-Making Module and changed game difficulty according to the child's developing feelings. In the same regard, the progress towards completion of tasks within the Focus Enhancement Game Engine and Task Organization Tools was timed and actual progress reported before it is further carried forward with rewards. Validation confirmed that the system was integrated into a single body, meaning that the user environment was coherent.

6. Testing and Validation

The efficiency, the effectiveness and the ease of use of the system have also been tested to facilitate increased functionality. After developing each module, the unit testing was done to ensure that each of the sub parts was in the right order. Finally, the integration test was performed to verify whether the required intra-and inter- modularity within the system was correctly implemented. Real users conducted usability testing, and the developer's got insight about the system interface and its performance. Performance testing was used for verifying that the system was capable of processing real-time data for the purposes of emotion recognition and game adjustability without severe delay or failures.

7. Deployment

Since then, the system underwent a rigorous testing phase before being rolled out in a controlled environment for additional user feedback. The first stage was to introduce the system for use by children with ADHD within naturalistic contexts like home or school environment. The users were trained in how to use the system for proper implementation, and the way of receiving constant feedbacks were provided. The system was also provided with the features of receiving software upgrades and sophisticated enhancements based on experimental learning and emancipated information.

8. Maintenance and Scalability

The system is also set up for post-deployment care and modification in the form of regular upkeep. This way, there is no let-up to see whether the system works properly and it's useful for constant improvement where the game is updated more often and the latest advanced method of reading emotions from human beings is provided to determine how better the system can be with a view to enhancing the gaming experience. Another aspect is that the system is quite scalable and there are Objectives of expanding the system for a greater user population. Furthermore, as the studies of ADHD and the abilities to recognize

emotions advance, new adjustments will be incorporated to meet the new research and development that will always be relevant to children with ADHD.

The logistic steps of this process of software development also confirm the current and efficient method of research which in this proposed system meets the ADDHA standards. The constant cycle of feedback between developers, users and researchers ensures that the system continues to be a useful tool to improve concentration and organization of children with mainly inattentive ADHD.

3.2.2. Requirement Gathering

- **Interviews**

Interviews consist of face-to-face communication with the clients with a view of gaining more comprehensive information from them. It can be open-ended (the results of which will be based on a set number of questions) and closed-ended (more question-and-answer format). For instance, interviewing parents of children with ADHD allows a client to identify the pain areas, for example, tools to improve the focus or facilitate tasks. Likewise, the ADHD professionals may focus on such aspects as intervention emotional involvement in the system.

- **Surveys and Questionnaires**

Surveys and questionnaires result in the possibility of gathering information from many people. It could be an open-end as well as close-end questionnaire that reveals user preference, system demand, and absence. For instance, a poll designed for educators will concern what tools they employ today and what they would like to see in a new instrument.

- **Observations**

Stakeholders may also not state certain activities and aspects that can be revealed when the use of artifacts is spared in a natural setting. For example, watching ADHD children play or while studying will help us understand their attending ability, emotional behavior, and social functioning. The experiences described here can be applied to make better design choices such as changing focus enhancement game difficulty levels.

- **Focus Groups**

Discussion involves the stakeholders, who share their requirements and issues collectively in the focus group. To gather requirements for this research, one focus group with parents, educators and healthcare professionals can be brainstorming about to create a list of possible features and functionalities that the created system should possess. Such an approach might also allow for the identification of conflicting requirements and come to a solution.

- **Document Analysis**

Useful secondary data can be obtained from current documentation, for example from educational plans for students with ADHD, from research papers on the topic or from other reports that have investigated available intervention tools. It makes it easy to notice holes in existing solutions, and the given method is a start in designing a system that tries to meet the user's need.

- **Prototyping**

Prototyping is a process where initial mock-ups or basic, simple implementation of the system is developed to receive responses from user. For instance, an actual focus-enhancement game interface can be produced and users' preferences in focus-enhancement game design can then be obtained. This iterative process increases the likelihood of the final system being illustrative of the user's requirements.

4. PROJECT REQUIREMENTS

4.1. Functional Requirements

- **Emotion Detection Module**

The system must therefore contain an emotion detection module which involves the assessment of the facial expression of the child in order to get the sentiment of the child. For instance, the component should detect feelings like happiness, sadness, or frustration so that the latter generates this information to the decision-maker component that in turn alters the level of difficulty of games or intervention activities.

- **Focus-Enhancement Games**

The system should include activities in the form of games whose aim is to increase attention, duration and concentration. Such games should incorporate a feature through which the level of difficulty should change depending on the status of the child, that is, whether they are too bored or too challenged.

- **Adaptive Learning Environment**

The platform ought to incorporate reinforcement learning for development of an optimal workflow. Based on the gathered data regarding a user's activity it is necessary to define a proper sequence and the complexity of games or tasks and to bring them directly toward a child and his learning pace.

- **Task Organization Tools**

  The system must also define the tools for controlling performing tasks and their arrangement. Such elements as lists of things to do and reminders should enable children to reflect on the tasks to be accomplished and to do it with better skills at the executive functions.

- **Progress Tracking and Reports**

  It should also show how the child is performing over time and include specific reports on the progress of the child. These reports should show enhanced aspects of attendance, concentration, and rate of completion of tasks. Hopefully, parents and those individuals teaching children can track the results and make modifications as needed.

- **Reward System**

  To maintain motivation, the system should include a reward system. Children earn points or rewards for completing tasks and achieving milestones. The reward system must integrate with the user interface, showing visible progress and encouraging continued participation.

- **Decision-Making Module**

  The decision-making module should analyze the inputs from the emotion detection and interaction data to advise on or change interventions. This module is essential because it makes it easy to change the interventions being offered to fit each child's short-term goals to make sure that the goals and hence the interventions, are still useful.

4.2. Non- Functional Requirements

- **Performance**

  The user interaction information, such as emotions and game modifications, must be handled in real time with small delays. The response time of adaptive activities should not be over 2 seconds so as not to interrupt the fluent interaction of a user with the application.

- **Scalability**

  It should have the ability to accommodate many users at the same time in order to suit the organization on a regional or even global scale. It should be scalable to handle additional traffic and big user data without affecting the performance.

- **Usability**

  The intended users of the system include children, parents and educators and as such, the chosen graphics and colors are visible, attractive and easy on the eyes for the children and clearly labeled and laid out for easy use for the parents and teachers. Reports and other business objects must be clear, and points or badges must be a child-like portion of the interfaces.

- **Security**

  It needs to guarantee the data protection approach from keeping the user data, the individual's profile, and their emotional status safe through encryption and use of secure login details. Certainly, adherence to such legislation as GDPR or COPPA is essential for protecting children's data.

- **Maintainability**

  This is why the system architecture must be such that it admits easy upgrade and modifications changes. Lack of coupling lets replace, for example, emotions detection or game units without affecting the whole system.

- **Accessibility**

  The platform should follow accessibility types which include web content accessibility guidelines (WCAG) 2.1 to capture the disabled children. Such things as screen readers, voice commands, and even icons and pictures that can be changed to fit people who have problems seeing.

- **Compatibility**

  The system should be mobile and tablet devices and for windows, mac and laptop devices. Any interface that is delivered through the web and consequently through applications must behave accordingly in different browsers and operating systems.

- **Data Storage and Privacy**

  The system needs to safely save and manage the population data in a common or cloud database. It should offer use right control, which means only the appropriate users who should access certain data such as the outcomes of the emotional analysis.

4.3. Software Requirements

1. **Development Environment**

- **Programming Languages**:
  Python: For machine learning algorithms and data analysis.
  JavaScript: For creating an interactive and dynamic user interface.
  SQL: For managing data storage and retrieval in databases.
- **Integrated Development Environment (IDE)**:
  Visual Studio Code facilitate coding and debugging.

2. **Machine Learning Frameworks**

- TensorFlow: For implementing deep learning models, particularly for emotion detection through facial expression analysis.
- Scikit-learn: For reinforcement learning algorithms and data preprocessing.
- OpenCV: For image processing in the emotion detection module.

3. **Database Requirements**

- **Database Management Systems (DBMS)**:
  MySQL or PostgreSQL for storing user data, interaction records, and progress tracking information.
  MongoDB for managing unstructured or semi-structured data related to emotional states and user interaction logs.
- **Cloud Storage**:
  AWS S3 or Google Cloud Storage for secure data backups and scalability.

4. **Frontend Tools**

- **Frameworks**:
  React.js or Angular.js for creating responsive and user-friendly interfaces.

5. **Backend Tools**

- **Frameworks**:
  Node.js for event-driven backend processes.
- **API Integration**:
  RESTful APIs to enable communication between modules like the emotion detection engine, decision-making engine, and the UI.

6. **Gamification Libraries**

- Phaser.js: For lightweight 2D game development compatible with web platforms.

7. **Hosting and Deployment**

- **Cloud Platforms**:
  AWS Cloud for hosting and deploying the application.

8. **Emotion Detection Integration**

- **Facial Recognition Libraries**:
  Dlib for facial expression analysis.
  Face API.js for web-based emotion detection.
- **Emotion Datasets**:
  FER-2013 dataset for training emotion detection algorithms.

10. **Security Tools**

- **Authentication**:
  JWT for secure user authentication.

4.4. User Requirements

- **Child-Friendly and Engaging Interface**

The interface of the system should be colorful, child-friendly and as close to 'user-friendly' interactive as possible. Appropriate learning should consist of incentives like rewards, badges, and leaderboards to retain the children's interest.

- **Personalization**

The system must be able to create a profile for students to help the system recommend games or tasks appropriate to each child's learning difficulties and strengths. Dynamicity is important in activities and based on the performance and feeling of the child.

- **Adaptive Learning Features**

It is required that games and tasks change automatically depending on the interaction data regarding performance history and current and future moods. It is appropriate for the learning environment to offer well defined steps that match the child's current developmental stage.

- **Security and Privacy**

In simple terms, parents and guardians need to be confident that their child's data (including name/address and learning progress) is safe and protected. The system must be GDPR or COPPA compliant, meaning that all data provided by or about each user must be protected.

4.5. Test Cases

Table 4.1 Test Case 01

Test case ID: TC01				
Test title: Validate emotion detection and dynamic task adaptation				
Test priority (High/Medium/Low): High				
Module name: Emotion Detection Module				
Description: Verify if the system detects the user's emotional state and adjusts task difficulty dynamically to maintain engagement.				
Pre-conditions: Facial expression analysis is enabled, and the user is interacting with the system.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
TC01	• Display a frustrating expression during a task.	• System reduces task difficulty.	• System reduced task difficulty	**Pass**
	• Display a happy expression during a task. Display a boring expression during a task.	• System maintains or increases task difficulty to match engagement level.	• The system increased task difficulty based on performance and engagement.	**Pass**
	• Display a boring expression during a task.	• The system suggests a break or switches to a less demanding activity.	• The System suggested a break with a relaxation task.	**Pass**

Table 4.2 Test Case 02

Test case ID: TC02				
Test title: Validate adaptive gameplay based on performance.				
Test priority (High/Medium/Low): High				
Module name: Focus Enhancement Game Engine				
Description: Ensure game difficulty adjusts dynamically based on user performance trends.				
Pre-conditions: User is actively engaging in the game, and the system is tracking performance.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
TC02	• Successfully complete multiple game levels.	• System increases game difficulty progressively.	• The system progressively increased difficulty after each level.	**Pass**
	• Fail multiple game levels consecutively.	• The system reduces game difficulty or offers in-game assistance.	• System reduced difficulty and displayed a help tutorial.	**Pass**

Table 4.3 Test Case 03

Test case ID: TC03				
Test title: Validate task creation and reminders functionality.				
Test priority (High/Medium/Low): Medium				
Module name: Task Organization Tools				
Description: Test the creation, scheduling, and notification features for task management.				
Pre-conditions: User is logged in and accesses the task management interface.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**

TC03	• Create a new task with a specific deadline.	• Task is saved and visible in the task list with the set deadline.	• The task was saved and displayed in the task list.	**Pass**
	• Wait for the scheduled notification time.	• System sends a notification reminder for the task.	• System sent a notification at the set time.	**Pass**

Table 4.4 Test Case 04

Test case ID: TC04				
Test title: Validate reward allocation for completed tasks.				
Test priority (High/Medium/Low): Medium				
Module name: Reward System Module				
Description: Ensure users receive rewards for successfully completing tasks or games.				
Pre-conditions: User has completed a task or game level.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
TC04	• Complete a game level.	• Users receive points or badges displayed in the rewards section.	• Points were allocated, and a badge was displayed.	**Pass**
	• Complete a scheduled task.	• The user receives the associated reward.	• The user received the reward immediately.	**Pass**

Table 4.5 Test Case 05

Test case ID: TC05				
Test title: Validate progress tracking and report generation.				
Test priority (High/Medium/Low): High				
Module name: Progress Tracking Module				
Description: Ensure the system accurately tracks user performance and generates detailed progress reports.				
Pre-conditions: User has completed multiple activities.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
TC05	Complete several game levels and tasks.	Progress data is updated on the dashboard in real-time.	Progress data updated accurately and displayed instantly.	**Pass**
	Request a progress report.	The system generates a detailed report with activity performance metrics.	Generated a comprehensive report with detailed metrics.	**Pass**

Table 4.6 Test Case 06

Test case ID: TC06				
Test title: Validate emotional state recognition accuracy under varied conditions.				
Test priority (High/Medium/Low): High				
Module name: Game Decision-Making Module				
Description: Ensure the system switches tasks dynamically based on emotional feedback.				
Pre-conditions: Emotion Detection Module is active during task interaction.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**

TC06	• Display frustration during a task.	• The system switches to a less challenging or more engaging task.	• System switched to an easier task with a motivational note.	**Pass**

Table 4.7 Test Case 07

Test case ID: TC07				
Test title: Last Determination of the Kind of ADHD Based on Multiple Analysis				
Test priority (High/Medium/Low): High				
Module name: Emotion Detection Module				
Description: Ensure the system accurately recognizes user emotions in different lighting and camera angles.				
Pre-conditions: Emotion Detection Module and camera are functional.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
TC07	• Display different emotions (happy, sad, neutral).	• The system correctly identifies and labels the displayed emotion.	• System labeled all emotions accurately.	**Pass**
	• Adjust lighting conditions during expression.	• The system maintains recognition accuracy despite lighting changes.	• System recognized emotions under varied lighting.	**Pass**

4.6. Design

4.6.1. Use Case Diagram

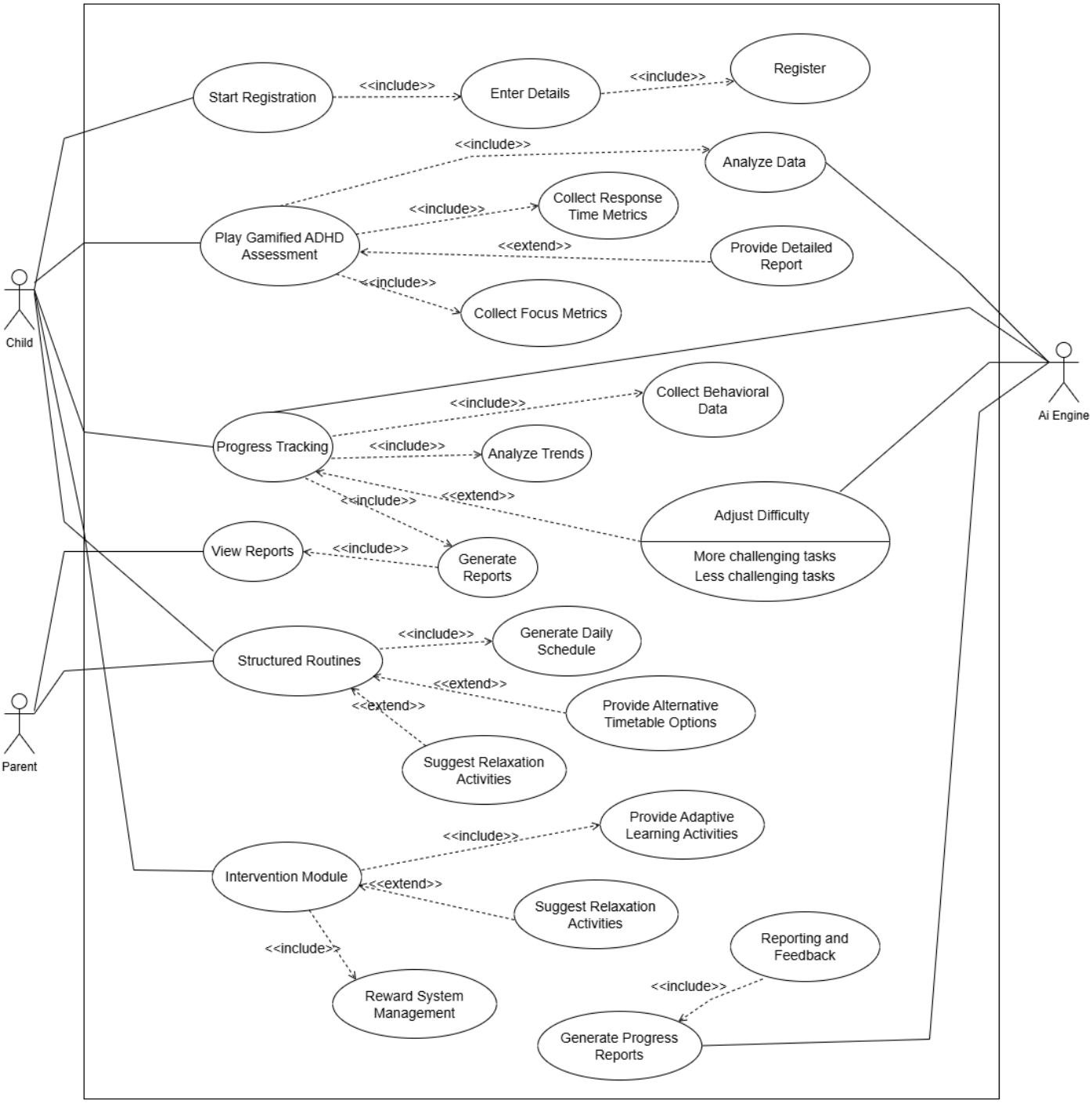

Figure 4.1 Use Case Diagram

4.6.2. Sequence Diagram

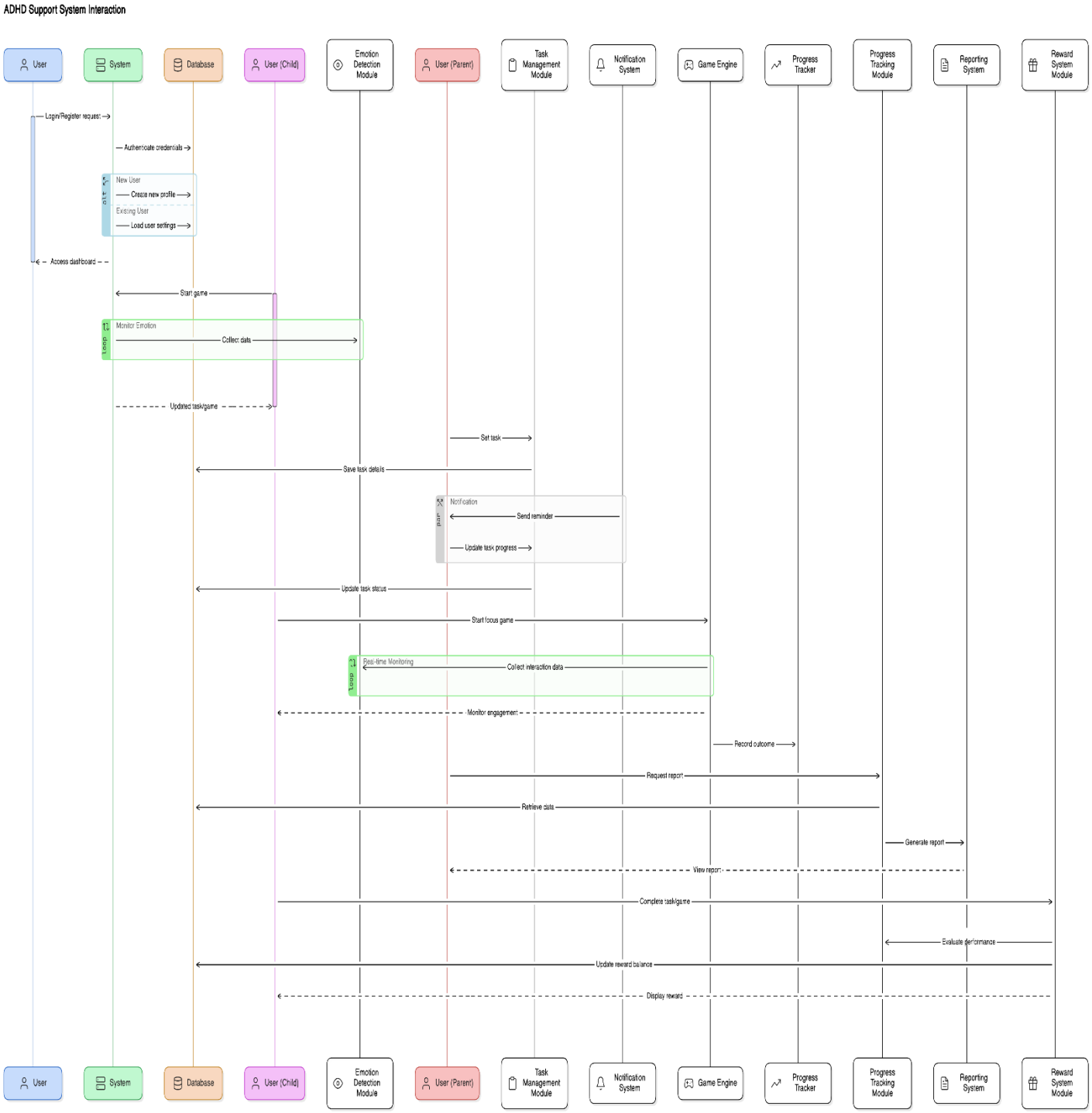

Figure 4.2 Sequence Diagram

4.6.3. Emotion detection model training

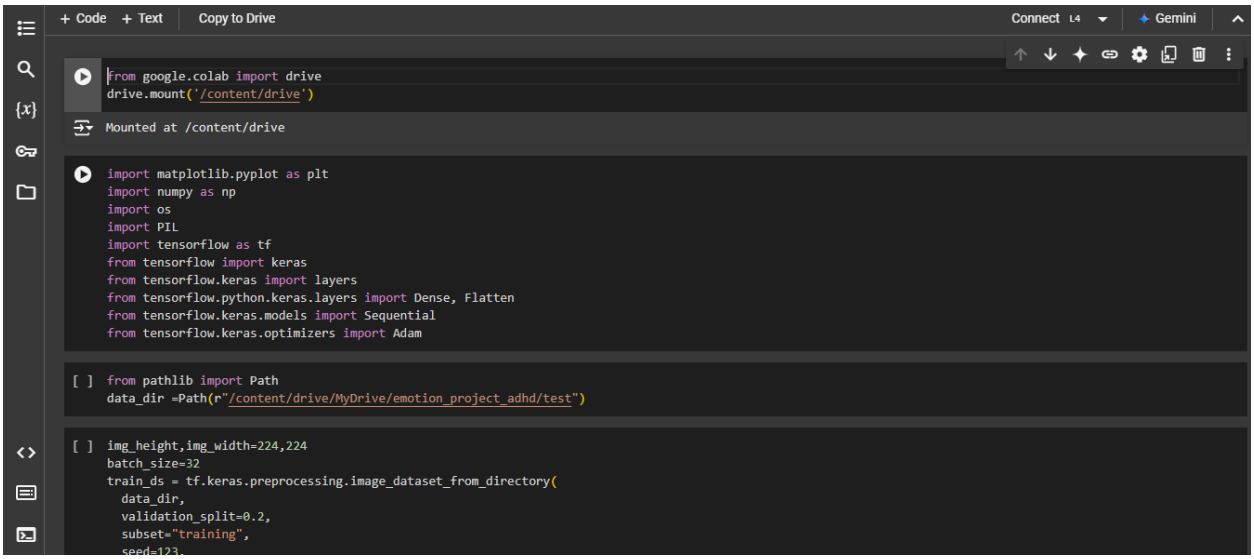

Figure 4.3 Model Training 01

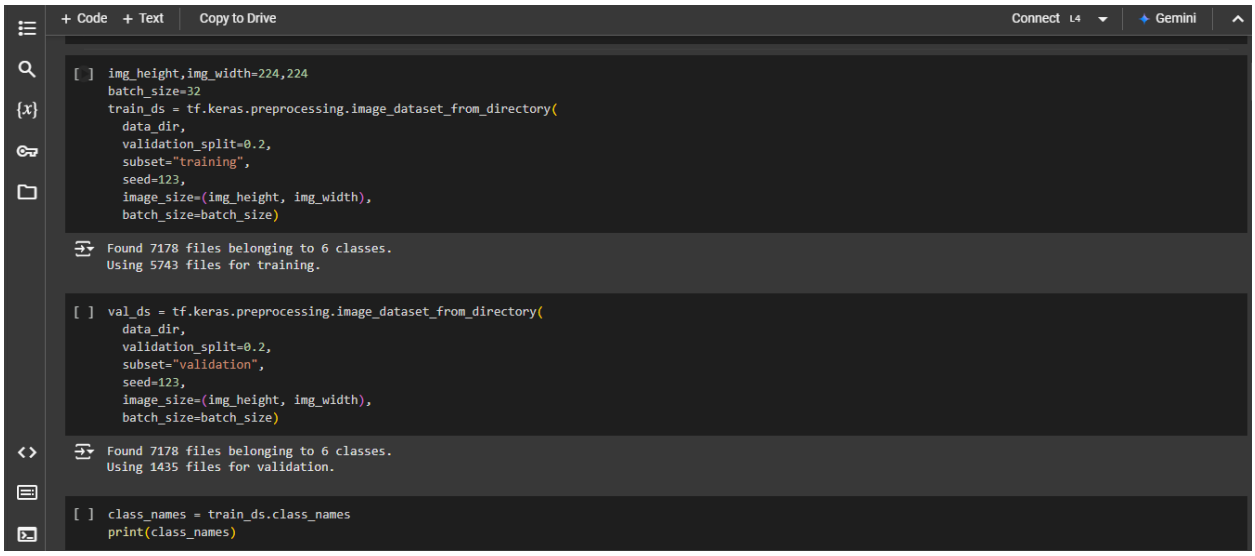

Figure 4.4 Model Training 02

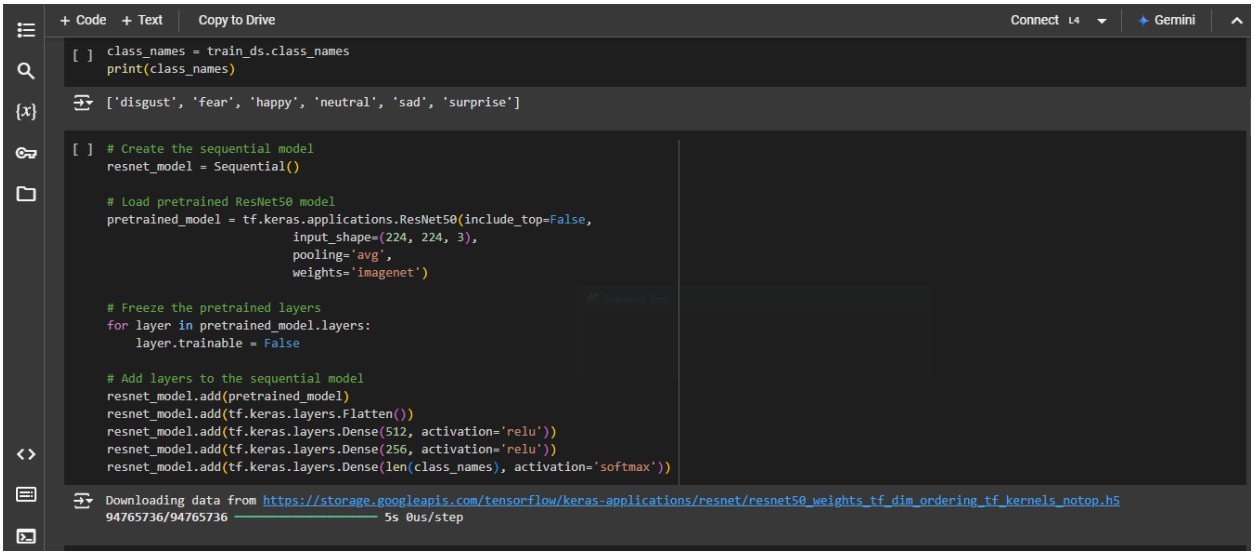

Figure 4.5 Model Training 03

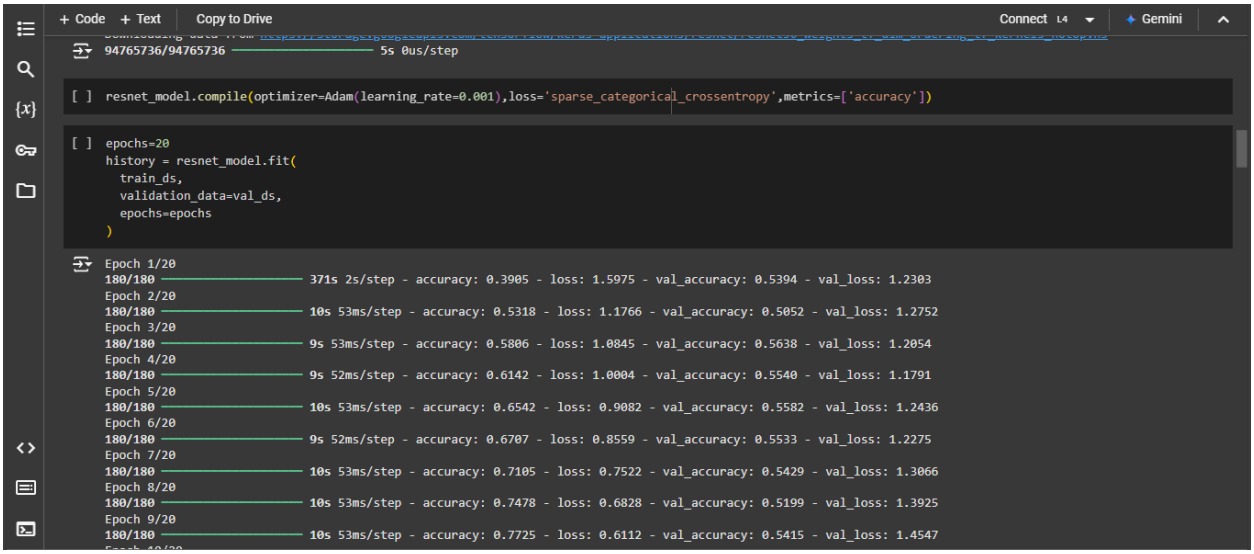

Figure 4.6 Model Training 04

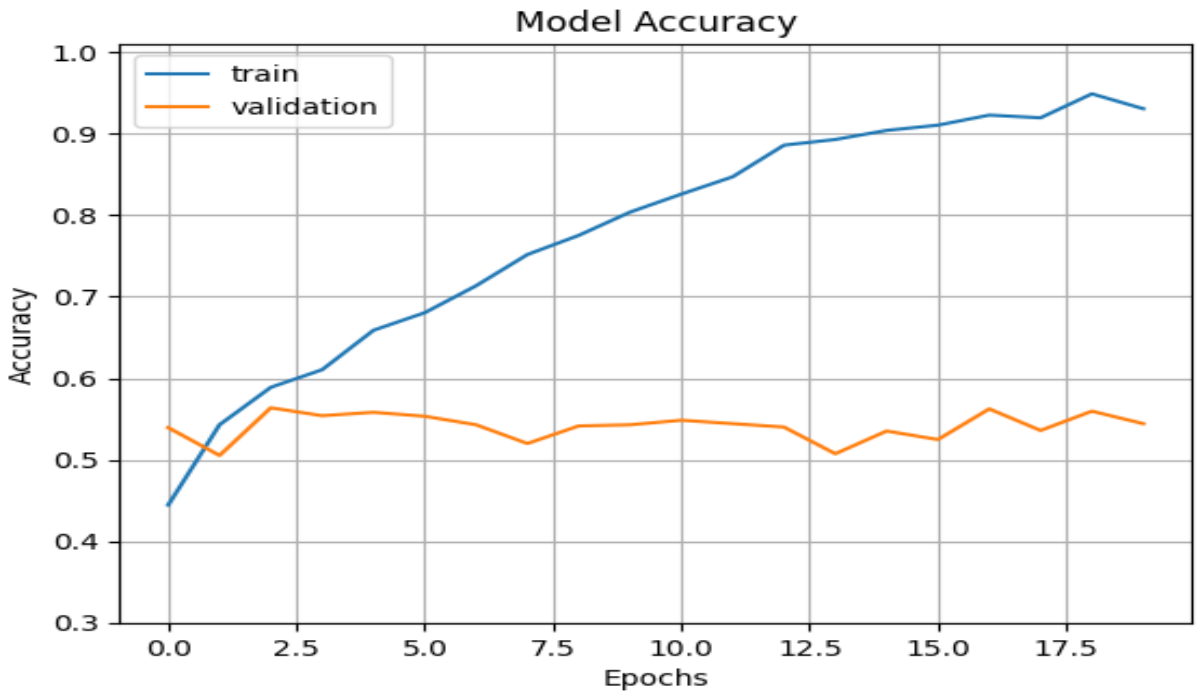

Figure 4.7 Model Accuracy

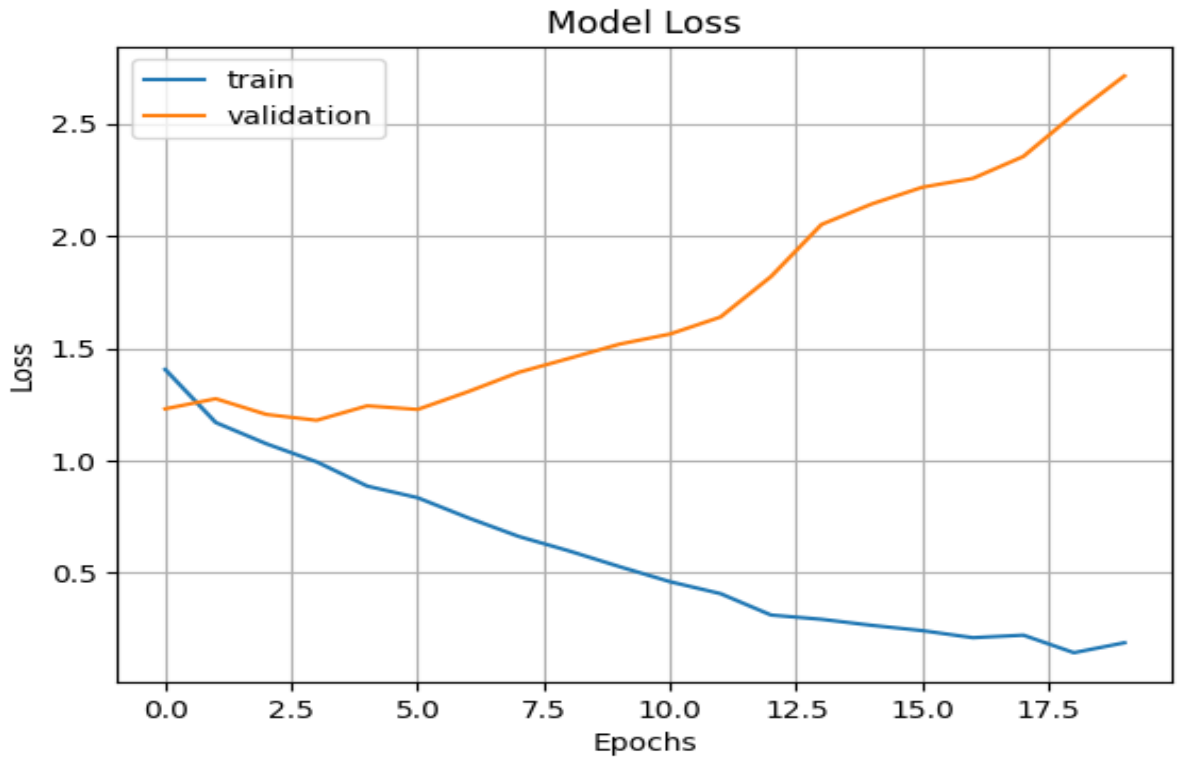

Figure 4.8 Model Loss

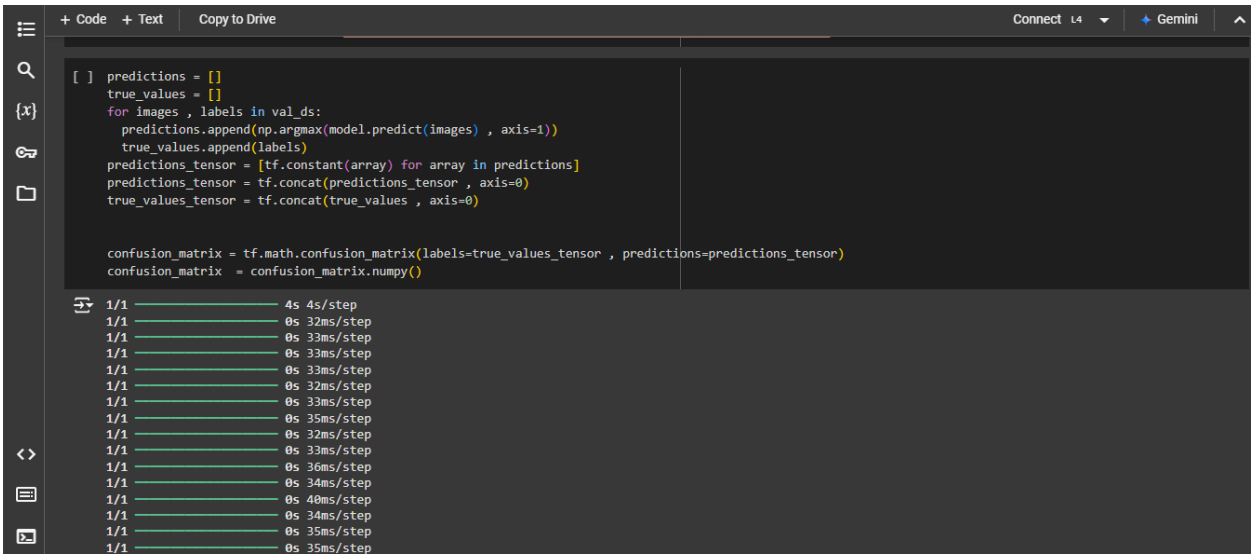

Figure 4.9 Model Training 05

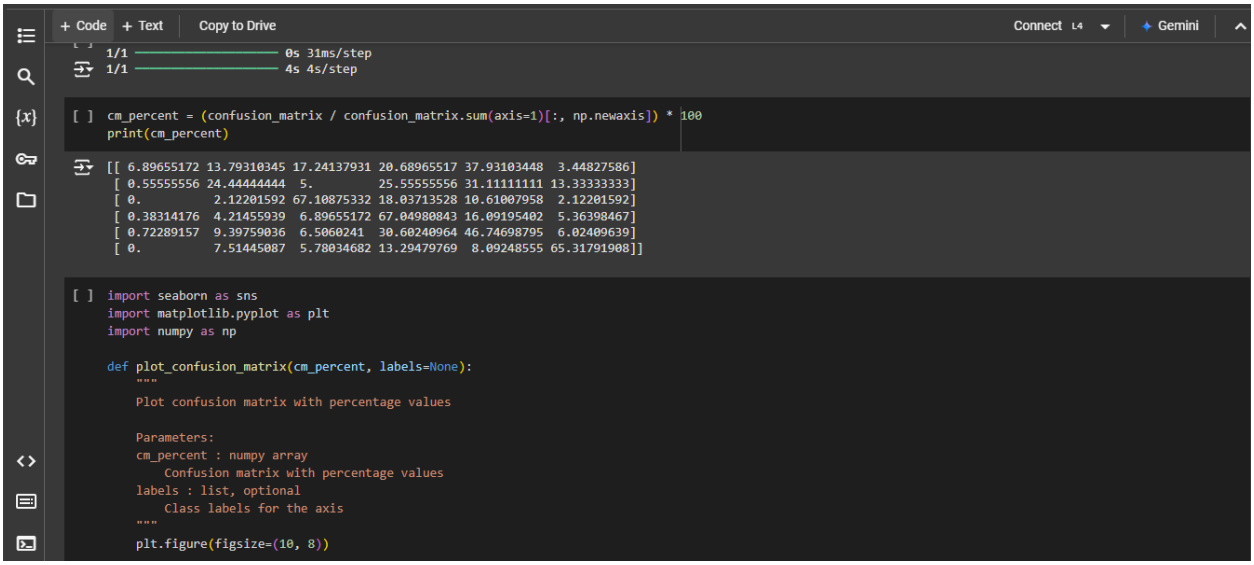

Figure 4.10 Model Training 06

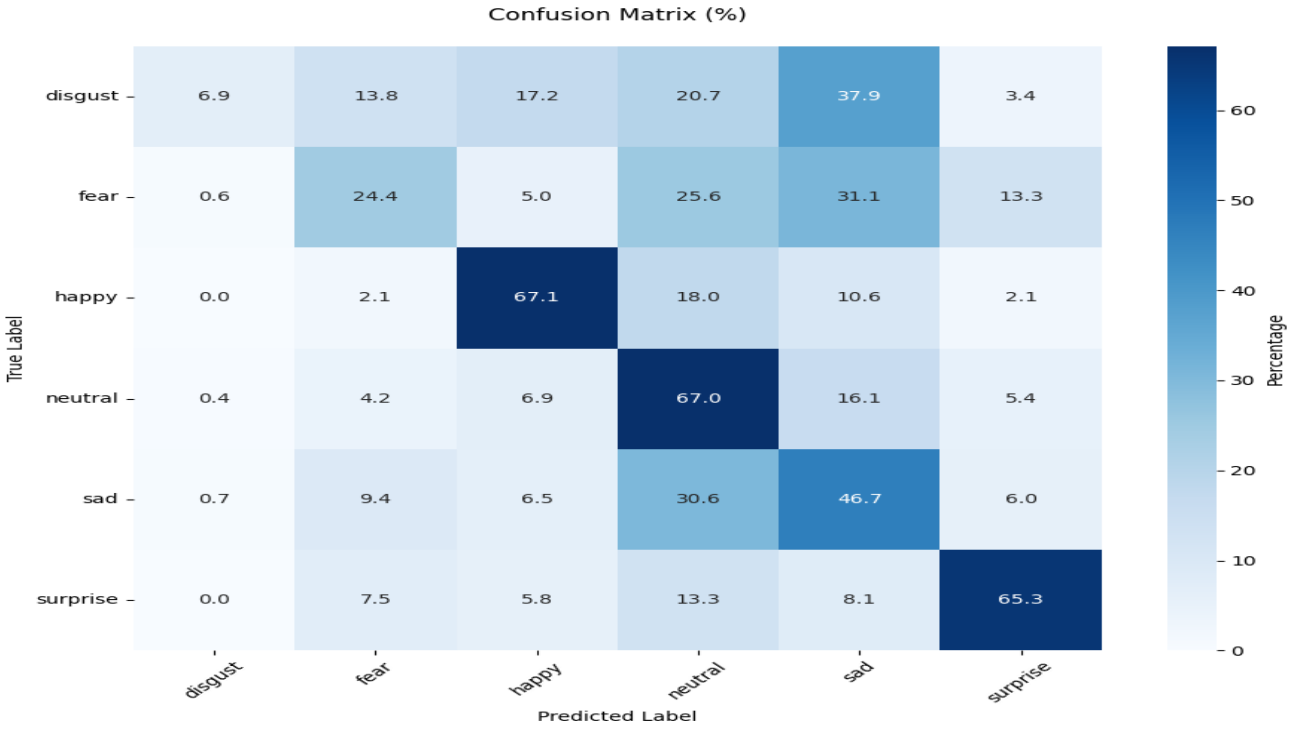

Figure 4.11 Confusion Matrix

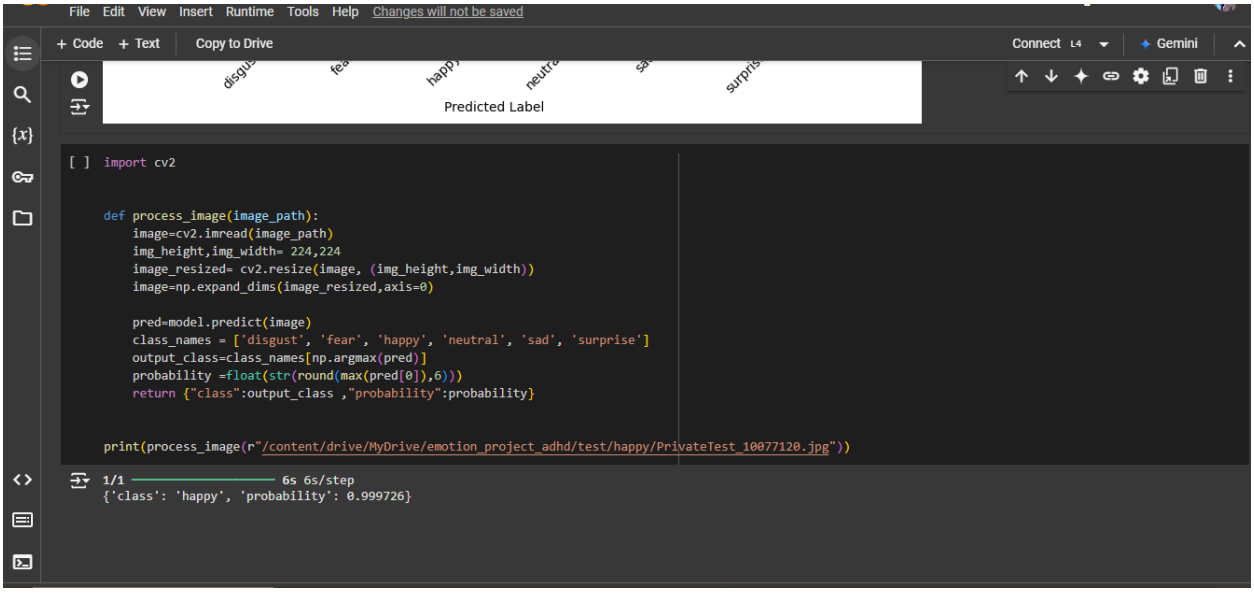

Figure 4.12 Model Training 07

5. COMMERCIALIZATION PLAN

1. Market Research and Analysis

Identify the Target Market
Primary school students in Sri Lanka and in the future other South Asian countries where both awareness of ADHD and access to diagnosis and intervention are very scarce. Add schools, clinics and parents as target customers especially those in areas where they have little or no access to specialized ADHD products.

Market Size and Growth Potential
Investigate how many children in Sri Lanka, and in the wider zone, have ADHD and estimate potential users. Specifically, growth trends in educational and healthcare digital solutions and telehealth services.

2. Business Model

Subscription Model
For parents, schools, and clinics with necessary, monthly or annual subscriptions. Offer different subscription tiers: There are three packages: Basic, which offers only assessment; Premium package that offers assessment, as well as personalized interventions and Enterprise package designed for schools and clinics where many users will be applying the program
.

Freemium Model
Have a basic free version with some of the app's functionalities. Users can pay additionally to get access to more state-of-the-art AI scanned adaptive learning and feedback.

Licensing to Educational Institutions
Provide licenses to schools to use this application with many of the students, at cheaper prices.

Partnerships with Healthcare Providers
Join pediatricians, therapists, and all other people who can use your app as a part of the complex approach to ADHD treatment.

Pricing Strategy:

- Basic Plan
- Price: Free
- Features:
  - ✓ Screening of ADHD symptoms by means of the questionnaires which are filled in interactively

- ✓ Simple looking and inattention, and hyperactivity monitoring
- ✓ Few of the progress reports are within the app.
- ✓ Simple advice on coping with ADHD behaviors
- ✓ Best for small one (parent or teacher) who do not require professional test to administer to their child or student.

- Premium Plan
- Price: $10/month
- Features:
  - ✓ Complete ADHD evaluation with the comprehension of symptoms and the ADHD subtypes (Inattentive, Hyperactive Impulsive, and Combined).
  - ✓ Computerized self-directed individualized therapies and cognitive exercises
  - ✓ App notifications and SMS alert for the need to intervene
  - ✓ Interactive progress tracking with capability of weekly or monthly scheduled reports.
  - ✓ Inattention management and impulse control through using adaptive learning games
  - ✓ Perfect for both homes and schools that in need of a solution and resource for ADHD issues.

- Group Plan
- Price: $150/month
- Features:
  - ✓ You get to enjoy all the features from the Premium Plan
  - ✓ Multiple usage up to 25 each student
  - ✓ Reporting on the group-level of analysis on the identified patterns
  - ✓ The professors are able to give and monitor multiple classes or groups from one particular console/panel.
  - ✓ Opportunity to request professional individual and group sessions with focus on ADHD approaches for teachers
  - ✓ Assigned account manager for assistance and individualized getting started
  - ✓ Recommended for schools, clinics or any institution that requires to support many children.

6. BUDGET

Table 6.1 Budget

Component	Amount
Travelling cost	10000
Server and hosting charges	25000
Internet charges	15000
Total	50000

7. GANTT CHART

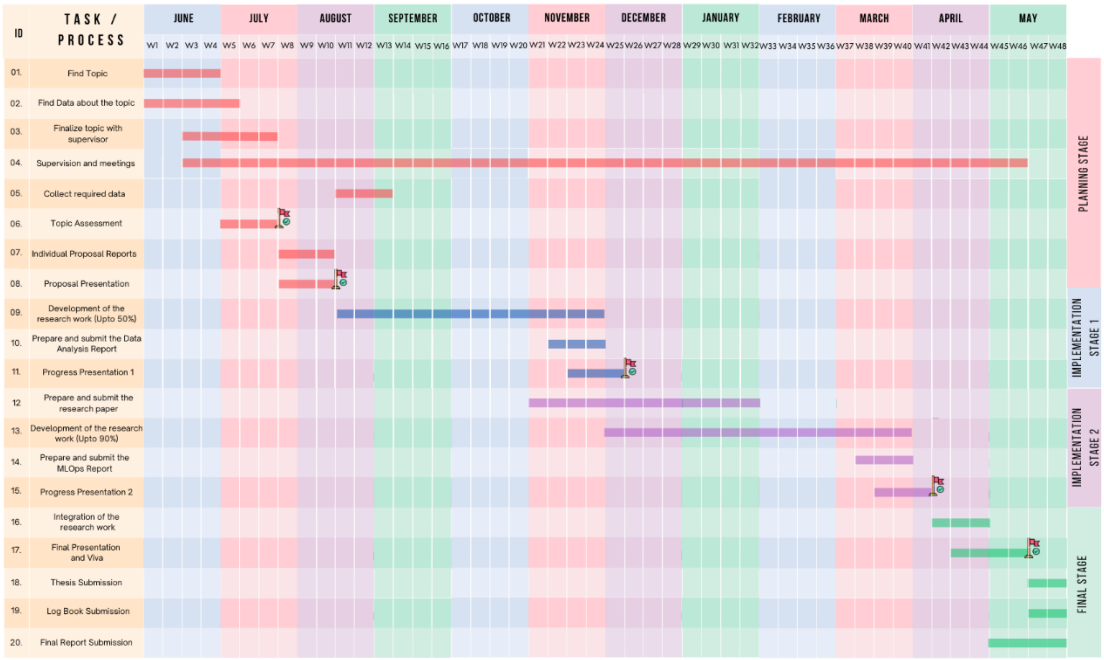

Figure 7.1 Gantt Chart

8. WORK BREAKDOWN STRUCTURE

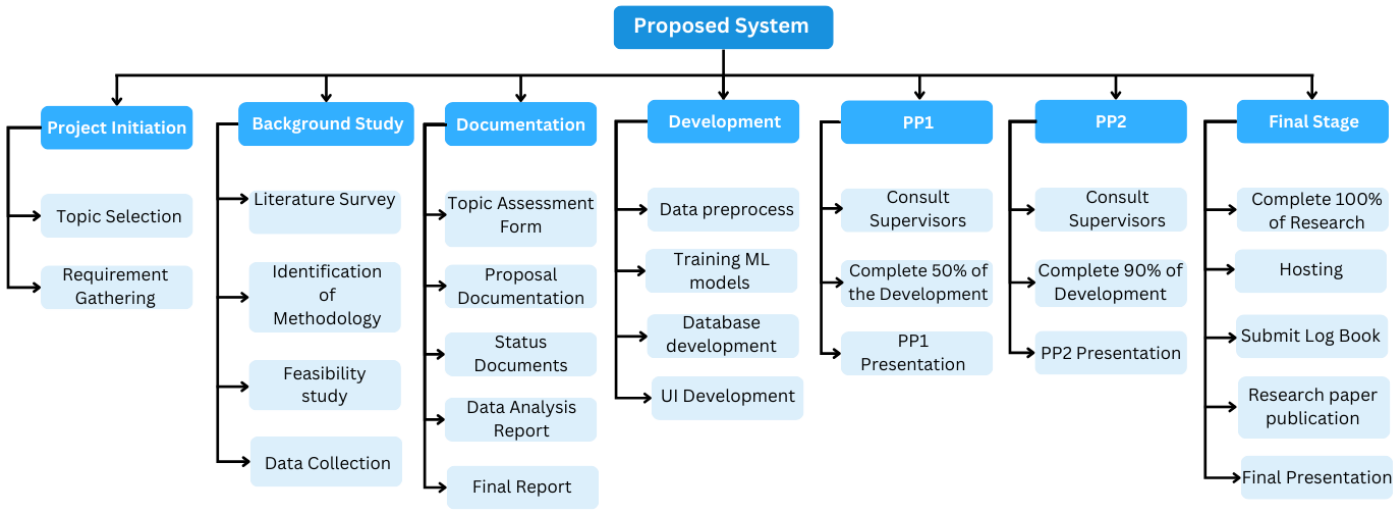

Figure 8.1 Work Breakdown Structure

9. REFFERENCES

[1] D.-5. T. F. American Psychiatric Association, Diagnostic and statistical manual of mental disorders: DSM-5™ (5th ed.), American Psychiatric Publishing, Inc, 2013.

[2] Wong KP, Qin J, Xie YJ, Zhang B, "Effectiveness of Technology-Based Interventions for School-Age Children With Attention-Deficit/Hyperactivity Disorder: Systematic Review and Meta-Analysis of Randomized Controlled Trials," p. 23, 2023.

[3] Paul Ekman, Wallace V. Friesen, " A Guide to Recognizing Emotions from Facial Clues," in *Unmasking the Face*, 2003, p. 212.

[4] Xu Y, Lin YS, Zhou X, Shan X. , "Utilizing emotion recognition technology to enhance user experience in real-time. Computing and Artificial Intelligence," p. 13, 2024.

[5] R. A. Calvo and S. D'Mello, "Affect Detection: An Interdisciplinary Review of Models, Methods, and Their Applications," vol. 1, pp. 18-37, 2010 .

[6] F. Cirillo, The Pomodoro Technique: The Life-Changing Time-Management System, Ebury Publishing, 2018.

[7] Deci, E. L., & Ryan, R. M., "The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior, Psychological Inquiry," p. 227–268, 2000.

[8] M. J. S. S. C. A. M. S. S. J. B. N. G. M. E. J. J. A. Power TJ, "A family-school intervention for children with ADHD," *: results of a randomized clinical trial. J Consult Clin Psychol.,* 2012.

[9] R. A. Barkley, Attention-Deficit Hyperactivity Disorder, Fourth Edition: A Handbook for Diagnosis and Treatment, Guilford Publications, 2014.

[10] McDougal, E., Tai, C., Stewart, T.M, "Understanding and Supporting Attention Deficit Hyperactivity Disorder (ADHD) in the Primary School Classroom: Perspectives of Children with ADHD and their Teachers.," *J Autism Dev Disord ,* vol. 53, pp. 3406-3421, 2023.

[11] K. M. Briggs, "An Evaluation Of ADHD Assessment, Intervention, And Progress Monitoring Practices," *Dissertations and Theses,* 1999.

[12] Zeinab Zakani, Hadi Moradi, Sogand Ghasemzadeh, Maryam Riazi, Fatemeh Mortazavi, "The Validity of a Machine Learning-Based Video Game in the Objective Screening of Attention Deficit Hyperactivity Disorder in Children Aged 5 to 12 Years," Cornell University, 2023.

[13] K. Schaefer, "Using daily behavior report cards as intervention for primary school students with ADHD," Eastern Michgian University , 2010.

[14] J. Hamari, J. Koivisto and H. Sarsa, "Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification," in *47th Hawaii International Conference on System Sciences*, Waikoloa, HI, USA, 2014.

[15] Chacko A, Bedard AC, Marks DJ, Feirsen N, Uderman JZ, Chimiklis A, Rajwan E, Cornwell M, Anderson L, Zwilling A, Ramon M., "A randomized clinical trial of Cogmed Working Memory Training in school-age children with ADHD: a replication in a diverse sample using a control condition. J Child Psychol Psychiatry," *Child Psychology and Psychiatry Association for Child and Adolescent Mental Health,* 2014.

[16] K. Turrill, "EARLY CLUES How your child's tantrum could be a sign of ADHD – and 6 other signs to watch for," *Plus, symptoms of ADHD that can appear in adults,* 2024.

[17] Walvekar, Shreya & Thawkar, Baban & Chintamaneni, Meena & Kaur, Ginpreet, "Recent Advances of Artificial Intelligence Tools in Attention-Deficit Hyperactivity Disorder (ADHD)," *Current Psychopharmacology,* pp. 18-29, 2022.

[18] Ekman, Paul, and Wallace V. Friesen., "Facial action coding system," *Environmental Psychology & Nonverbal Behavior,* 1978.

[19] A. G. Barto, "Reinforcement Learning: Connections, Surprises, and Challenge," vol. 40, pp. 3-15, 2019.

[20] Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., Grau, V., Lagos, F., López, X., López, V. Rodriguez, P, "Beyond Nintendo: design and assessment of educational video games for first and second grade students.," *Computers & Education,* vol. 40, no. 1, pp. 71-94, 2003.

[21] Front. Hum. Neurosci., "Primary School Children's Self-Reports of Attention Deficit Hyperactivity Disorder-Related Symptoms and Their Associations With Subjective and Objective Measures of Attention Deficit Hyperactivity Disorder," *Brain Health and Clinical Neuroscience,* vol. 16, 2022.

[22] Kofler, M.J., Spiegel, J.A., Soto, E.F. et al., "Do Working Memory Deficits Underlie Reading Problems in Attention-Deficit/Hyperactivity Disorder (ADHD)?," *J Abnorm Child Psychol ,* vol. 47, p. 433–446, 2018.

[23] Mulligan, Shelley, "Classroom strategies used by teachers of students with attention deficit hyperactivity disorder.," *Physical & Occupational Therapy in Pediatrics,* no. 4, pp. 25-44, 2001.

[24] G. J. DuPaul, "School-Based Interventions for Students With Attention Deficit Hyperactivity Disorder: Current Status and Future Directions," *School Psychology Review,* vol. 36, no. 2, pp. 183-194, 2007.

[25] DuPaul, George J., Steven W. Evans, Jennifer A. Mautone, Julie Sarno Owens, and Thomas J. Power., "Future directions for psychosocial interventions for children and adolescents with ADHD.," *Journal of Clinical Child & Adolescent Psychology,* pp. 134-145, 2020.

[26] W. Ortiz, D. Castillo and L. Wong, "Mobile Application: A Serious Game Based in Gamification for Learning Mathematics in High School Students," in *2022 31st Conference of Open Innovations Association (FRUCT)*, Helsinki, Finland, 2022.

[27] Bilan, D.S., Giglioli, I.A.C., Cuesta, P., Cañadas, E., de Ramón, I., Maestú, F., Alda, J., Ramos-Quiroga, J.A., Herrera, J.A., Amado, A. and Quintero, J, "Decreased impulsiveness and MEG normalization after AI-digital therapy in ADHD children: a RCT," 2024.

[28] Andrade, Luis Javier Serpa, Roberto Agustin Garcia Velez, Graciela Del Serpa Andrade, "Information and Communication Technologies Learning Methodologies for Children with Adhd," in *AHFE 2022 Conference on Applied Human Factors and Ergonomics International*, 2022.

[29] Gudka, Rebecca, Kieran Becker, Tamsin Newlove-Delgado, and Anna Price., "Provision of digital health interventions for young people with ADHD in primary care: findings from a survey and scoping review," *BMC Digital Health 2,* p. 71, 2024.

[30] Soto, E. F., Black, K., & Kofler, M. J, "Is hyperactivity in children with attention deficit/hyperactivity disorder (ADHD) a functional response to demands on specific executive functions or cognitive demands in general?," *Neuropsychology,* p. 699–713, 2024.

[31] Weerackody, Chamindra, and Suman Fernando, "Mental health services in Sri Lanka.," in *Critical Psychiatry and Mental Health*, Routledge, 2014, pp. 204-214.

[32] Kofler, Michael J., Lauren N. Irwin, Elia F. Soto, Nicole B. Groves, Sherelle L. Harmon, and Dustin E. Sarver., "Executive functioning heterogeneity in pediatric ADHD," *Journal of abnormal child psychology,* pp. 273-286, 2019.

[33] Groves, Nicole B., Erica L. Wells, Elia F. Soto, Carolyn L. Marsh, Emma M. Jaisle, T. Kathy Harvey, and Michael J. Kofler. , "Executive functioning and emotion regulation in children with and without ADHD," *Research on child and adolescent psychopathology,* pp. 1-15, 2022.

[34] Rutter, Michael, "Research review: Child psychiatric diagnosis and classification: Concepts, findings, challenges and potential.," *Journal of Child Psychology and Psychiatry 52,* vol. 52, no. 6, pp. 647-660, 2011.

[35] Kent Beck, Mike Beedle, Arie van Bennekum, Alistair Cockburn,Ward Cunningham, Martin Fowler,James Grenning, Jim Highsmith, Andrew Hunt, Ron Jeffries, Jon Kern, Brian Marick,Robert C. Martin, Steve Mellor, Ken Schwaber, Jeff Sutherland, Dave Thomas, "Agile Manifesto," Agilemanifesto organisation, 2001. [Online]. Available: https://agilemanifesto.org/. [Accessed 20 October 2024].

[36] Sommerville, Ian, Martin Fowler, Kent Beck, John Brant, William Opdyke, and Don Roberts., "Software Engineering," in *Instructor*, 2019.

[37] Bass, Len, Paul Clements, and Rick Kazman, "Software Architecture in Practice," in *Software Architect Practice_c3. Addison-Wesley*, 2012.

[38] Goodfellow, Ian, Yoshua Bengio, and Aaron Courville., "Convolutional networks.," in *Deep learning*, 2016, pp. 330-372.

[39] H. Xiong, "Dynamic Difficulty Adjustment: Developing an Adaptive Game AI with Machine Learning (Doctoral dissertation,," California State University, Northridge, 2019.

[40] A. Gendron, "ADHD Self-Assessment Workbook," The Mini ADHD Coach, 29 11 2022. [Online].

10. APPENDICES

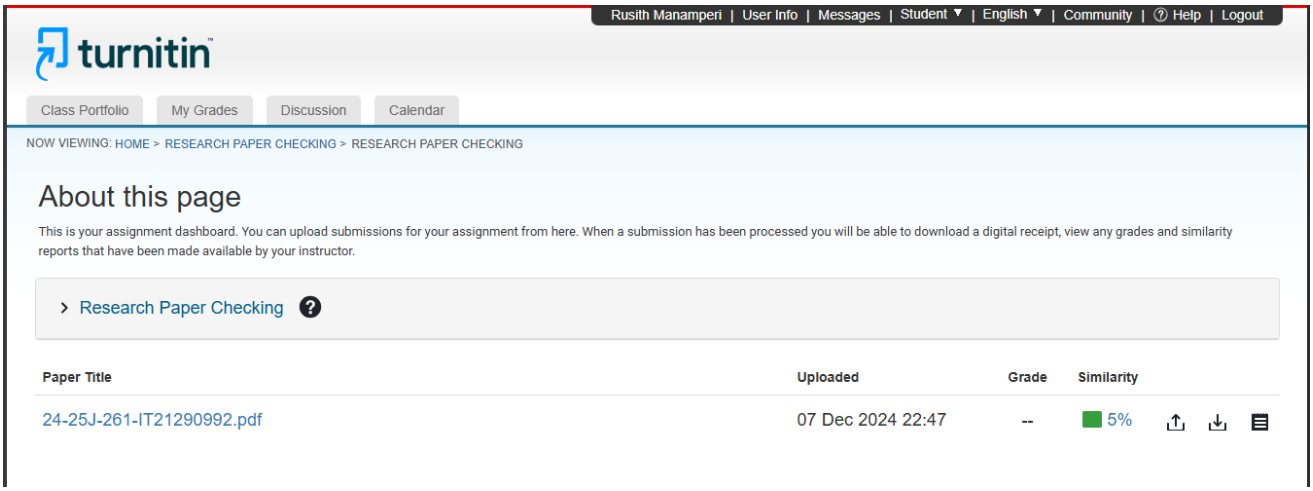

Figure 10.1 Turnitin Report

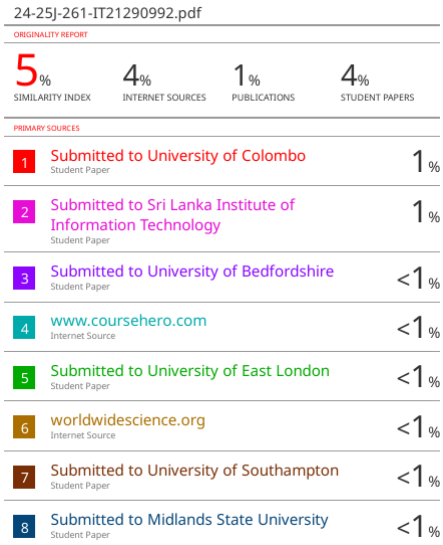

Figure 10.2 Turnitin Report