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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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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ABSTRACT

Attention-Deficit/Hyperactivity Disorder (ADHD) in children is a growing concern, especially in contexts where traditional assessment tools may lack cultural relevance and accessibility. This research addresses the problem of assessing ADHD symptoms in Sri Lankan children aged 5-10 through an AI-driven, gamified focus and impulse control module aligned with the DSM-5 criteria. The study aims to develop a comprehensive and culturally tailored assessment system, utilizing game-based methods to capture key metrics such as reaction time, sustained attention, and premature clicks. The innovative use of a "falling star" game serves as the primary assessment tool, collecting these metrics to analyze potential ADHD subtypes—predominantly inattentive, hyperactive-impulsive, or combined. If a child shows difficulty during the game, the system prioritizes questions relevant to their suspected subtype and generates a DSM-5-aligned feedback form for parents. The study employs an Agile development methodology, iteratively refining the game mechanics, data analysis algorithms, and user interfaces to ensure both child engagement and accurate symptom detection. The assessment component integrates user-friendly features like simplified interfaces for children and accessible dashboards for parents, which are crucial for user engagement and ease of use. Additionally, parent feedback plays a critical role. The system analyzes game performance and parent observations to deliver a detailed ADHD symptom profile and actionable recommendations. This integration bridges the gap between clinical assessment and everyday symptom management, providing parents with practical insights tailored to their child's needs. Preliminary results suggest that this gamified approach not only engages children effectively but also produces accurate, data-driven assessments that align with clinical standards. This research contributes to the broader field by offering an accessible, culturally relevant solution for early ADHD detection in primary school-aged children, thereby aiding early intervention and better long-term outcomes.

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1. INTRODUCTION

Attention-Deficit/Hyperactivity Disorder is considered a neurodevelopmental disorder, affecting approximately 5-8% of children of school age worldwide [1]. This neurodevelopmental disorder is characterized by persistent symptoms accompanying inattention, hyperactivity, and impulsivity that appreciably interfere with a child's ability to attain optimum achievement in educational settings, social interactions, and everyday life experiences [2]. Timely recognition and intervention for ADHD are essential means of helping children develop practical coping strategies, thus improving quality of life generally [3].

ADHD symptoms are almost always persistent across various developmental stages, leading to long-term outcomes if not appropriately managed [4]. In most low- and middle-income countries, awareness regarding the assessment and management of ADHD is generally lacking, as in the case of Sri Lanka. These further underlines the requirement for diagnostic and intervention tools that are accessible and culturally relevant. Meeting these needs during primary school can give much-needed support to young children and help reduce the negative consequences related to undiagnosed ADHD, such as failure in school, social isolation, and low self-esteem [5]. The present research suggests testing a strategy of early diagnosis of ADHD symptoms by using new software, which contains one game-like behavioral task and an adaptive questionnaire, designed according to the DSM-5 criteria of ADHD diagnosis [6].

The game interactive means that it identifies key cognitive attributes that ADHD-inattention and impulse control, and adapts the questionnaire using established tools, such as the Vanderbilt ADHD Diagnostic Parent Rating Scale 7 and the Conner’s Rating Scale 8 to enable an overall comprehensive assessment. As a part of gamification incorporated within established diagnostic tools, this increases engagement and accuracy, an asset for educators, caregivers, and health professionals alike 9. This gamified task offers children an interactive environment where they respond to different visual and auditory cues, which can help researchers grade the performance of attention, impulsivity, and hyperactivity through such measures as reaction time and sustained attention [7] [8]. By observing these behavioral signals, the application makes precious conclusions about specific symptoms of ADHD that might be affecting the child.

After the game, test subjects receive an adaptive questionnaire that can change its questions based on the subject's responses, developing a more personalized and in-depth assessment. This approach aligns with previous work that has supported gamification to maintain interest in a diagnostic task [9]. By employing data gathering techniques and machine learning algorithms, the application categorizes children based on ADHD subtypes, thus providing a detailed comprehension of the individual symptoms exhibited by each child [10]. This automated categorization aids healthcare professionals, educators, and caregivers in customizing interventions with greater efficacy, while simultaneously alleviating the pressure of ADHD evaluations on conventional healthcare

frameworks. The inclusion of machine learning enhances precision by assimilating information from the gathered data, resulting in ongoing advancements in the system's diagnostic abilities as time progresses [11]. Considering the context of Sri Lanka, where resources are limited, the initiative is notably vital. This project aspires to not only make a huge difference in early detection and intervention in ADHD with a cost-effective, easily accessible, and interactive diagnostic tool but also aims at the empowerment of children diagnosed with ADHD and their families, which makes it easier for them to seek early help and prosper above the challenges of the disorder [12] [5].

1.1. Background Literature

The specific assessment procedures to diagnose ADHD are characterized for a systematic method consists of several methods using information from several people in the patient's life such as parents, teachers and other healthcare professionals [13]. The essential diagnostic reference widely used currently in clinical practice is the DSM-5, which stands for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. The Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) was published by the American Psychiatric Association [14]and it gives a list of features that make up ADHD and describes ADHD as a neurodevelopmental disorder that comprises inattention and or hyperactivity-impulsivity [15] that cuts across development and functioning [16] [17].

DSM-5 Criteria for ADHD

The DSM-5 outlines two primary symptom categories for ADHD: Attention Deficit and Hyperactivity Disorder is also referred to as Inattention and Hyperactivity-Impulsivity. For a diagnosis, symptoms have to be observed in at least two contexts for example at home or at school and are disabling. Further, they cannot be better explained by another mental disorder [18].

- Inattention: Nine symptoms associated with inattention include; failing to pay attention to detail, poor endurance of attention, making multiple careless mistakes, and /or losing items that are needed for completion of activities. According to these guidelines, children and teenagers under the age of 16 must display at least six of the symptoms, and adults and teenagers 17 and over must display five or more of the symptoms [19].
- Hyperactivity-Impulsivity: The symptoms that fall under this category are nine and they include; fidgeting, getting out of one's seat inappropriately, talking without proper permission, difficulty in waiting for a turn, interrupting others. As with the inattention criteria, one should count six or more if a child is below 16 years old and at least five if child is 17 years or older [19] [20] [21].

- Additional Requirements: The symptoms have to be first manifested before the age of twelve years; the symptoms have to have been present for at least six months; and, the symptoms have to have caused marked impairment in social, academic, or occupational functioning [20].

ADHD assessment tools and rating scales

The clinicians use the DSM-5 criteria for purpose of systematically diagnosing ADHD by providing minimum necessary standards that all healthcare providers must meet [21]. This approach eliminates prejudice to an extent and gives a standard way of describing symptoms which results into accurate diagnosis of ADHD. Despite the inversion in structuring approaches, the traditional forms of assessment, which entail structured clinical interview assessment, observation and rating scale assessment (like Connors' Rating Scales, and ADHD Rating Scale IV) have some drawbacks in terms of information coming from parents, teachers, and the patients themselves. Also, it may involve direct observation in employing settings like schools, as a way of determining the child's behavior, but this method may not be very rich [22].

Name of tools by author(s)	Year published	Normative data by age	Cost
Specific/narrow-band			
ADHD-RS-V by DuPaul *et al*.	2016	5 to 18 years	$
ADDeS-4 by McCarney and Arthaud	2013	4 to 18 years	$
CRS-3 by Conners	2008	3 to 18 years	$
		Self-report (12–18 years)	
SNAP by Swanson	2007	5 to 11 years	Free
CAT-C by Bracken and Boatwright	2007	8 to 18 years	$
VARS by [7]NICHQ	2002	6 to 12 years	Free
BADDS by Brown	1996 & 2001	Preschooler (3–7 years)	$
		School-age (8–12 years)	
		Adolescent (12–18 years)	
		Adult (≥18 years)	
		Self-report (>12 years)	
SKAMP by Swanson *et al*.	1992	7 to 12 years	$
ACTeRS by Ullman *et al*.	1986	4 to 14 years	$
Global/broadband			
BASC-3 by Reynold and Kamphaus	2015	2 to 21 years	$
Achenbach/CBCL by Achenbach	2001	6 to 18 years	Free

Figure 1.1 ADHD assessment tools and rating scales

A number of offered images can be recognized as a brief overview of ADHD and such characteristic tools examine symptoms within various age categories. For instance, the Dutch version of the ADHD Rating Scale Revised of DuPaul et al. (2016) [23] and the Conners Adult/Children ADHD Rating Scales, short form (CRS-3) by Conners (2008) are commercial instruments used to estimate the ADHD symptoms according to the norms to children and adolescents. These tools differ in terms of child's age and the costs that come with the different tools that explain the available options for the practitioners when conducting an assessment depending on the child's age. These tools are valid and reliable; therefore, the table below can be used to show the rich array of diagnostic techniques to support the need for developmentally

appropriate measures to assess ADHD symptoms using this table, the range of diagnostic tools can be described, and the need for proper selection of methods in ADHD diagnosis can be highlighted to integrate modern standard diagnostic tools and technological applications in diagnosing and planning for intervention. This should also enable the utilization of technological based stationery like the web bases tools and mobile applications that help engineer new strategies for ADHD children through a more interactive and innovative assessment and treatment methodologies [24].

Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS)

The rating scale most commonly used and employed in this study for screen for ADHD symptoms in children and adolescents is the Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS) [25]. It was designed by the American Academy of Pediatrics to be used only by parents and caregivers for the assessment of children with ADHD, aged between 6 and 12 years, but is frequently used in children within 5-15 years age group. The VADPRS contains 55 items which reflect ADHD symptoms, oppositional defiant disorder, conduct disorder, anxiety, depression, and academic performance [26] so that it has a broad range of coverage for the core ADHD symptoms and co morbid disorders.

The VADPRS includes two sections:

- ADHD Symptom Criteria: The first six items of the questionnaire consist of 18 questions that address the criteria of DSM-5 for ADHD. These questions are divided into two subcategories with each of them containing nine questions to do with inattention and hyperactivity-impulsivity respectively. This is in consonance with DSM-5 criteria where a child needs to demonstrate six or more symptoms of the category for a diagnosis [27].

- Performance and Behavioral Assessment: The second segment examines other concerning behaviors as well as academic achievement. It involves those items corresponding to oppositional behavior, conduct problem, and anxiety/ depression. These areas are integrated to help clinicians look beyond behaviors that indicate ADHD, as well as associated conditions which are often present in children with this diagnosis [28].

These are some sample questions that includes in VADPRS [28],

		Never	Occasionally	Often	Very Often
1	Does not pay attention to details or makes careless mistakes, for example homework	0	1	2	3
2	Has difficulty attending to what needs to be done	0	1	2	3
3	Does not seem to listen when spoken to directly	0	1	2	3
4	Does not follow through when given directions and fails to finish things	0	1	2	3
5	Has difficulty organizing tasks and activities	0	1	2	3
6	Avoids, dislikes, or does not want to start tasks that require ongoing mental effort	0	1	2	3
7	Loses things needed for tasks or activities (assignments, pencils, books)	0	1	2	3
8	Is easily distracted by noises or other things	0	1	2	3
9	Is forgetful in daily activities	0	1	2	3
10	Fidgets with hands or feet or squirms in seat	0	1	2	3

Figure 1.2 Sample questions that includes in VADPRS [28]

This is a sample assessment results for a 12-year-old child [28],

Client Information

Client Name	Generic Client Jnr.
Date of birth (age)	20 May 2010 (12)

Assessment Information

Assessment	Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS)
Date administered	15 March 2023
Assessor	Dr David Hegarty
Time taken	2 minutes 20 seconds

Results

	Score	Above clinical cutoff?	Percentile
Inattentive Subtype	15	No	87.3
Hyperactive/Impulsive Subtype	14	No	88.9
Combined Subtype	29	No	89.7
Oppositional Defiant Disorder	3	No	29.7
Conduct Disorder	1	No	42.5
Anxiety/ Depression	4	No	58.1

Interpretive Text

The percentiles are based off the 11-12 year old norms.

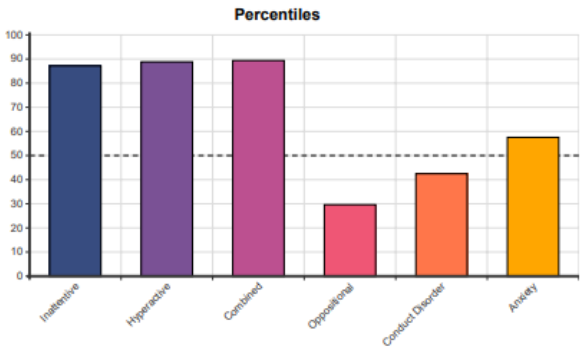

Figure 1.3 Sample assessment results for a 12-year-old child [28]

The assessment results for a 12-year-old child indicate the following regarding ADHD subtypes: for the Predominantly Inattentive subtype, the child has six or more items described as “Often” or “Very Often” on items 1-9, and one or two points on items 48-55 that indicate a performance problem. For the subtype of Predominantly Hyperactive/Impulsive the assessment scores indicate six or more items which are “Often” or “Very Often” on questions 10–18 and the question 48–55 have a problem in performance. According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM IV), the child meets the requirements for the Combined subtype; that is, he or she has symptoms of both the Inattentive and the Hyperactive /Impulsive types. Percentile scores are also shown, obtained from a community sample; the average score is 50. Higher percentile scores indicate more reported difficulties, meaning they have more difficulties

than 90% of the other children in the sample. It also gives information on the presence of other related difficulties [29]. In case of ODD, the child gets four or more points in the items ranked 2 or 3 on questions 19–26 as well as a performance problem on questions 48–55. In regards to Conduct Disorder (CD), 3 or more items are assessed with a rating of 2 or 3 on questions 27-40 as well as there are performance problems on questions 48-55. Lastly, for Anxiety/Depression, three or more items are responded to 2 or 3 on questions 41-47, combined with performance problems as indicated in questions 48-55. The children who yield total score above the clinical cutoffs for the ODD, CD or Anxiety/Depression may probably need for further evaluation for the specific disorders [28].

Advantages of the VADPRS Over Other Scales

Compared to other ADHD rating scales, such as the Conners' Rating Scale or the ADHD Rating Scale IV [30], the VADPRS offers several distinct advantages [31] [32]:

- Comprehensive Evaluation: While other scales are designed only for assessment of the ADHD symptoms, the VADPRS contains questions about other behavioral disorders and academic performance. It is especially valuable for this approach in determining that the majority of children with ADHD have comorbid conditions.
- Parental Involvement: The VADPRS is completed for the parent or caregiver, which is helpful in getting the real-life interaction view of the child
- Alignment with DSM-5 Criteria: Ensures that the information collected directly informs the ADHD diagnosis process.

In summary, the VADPRS is useful in the differential diagnosis of ADHD when the child is between the ages of 5 and 15 years old; however, it should be used together with interviews and teacher ratings. Incorporation of both the main ADHD symptoms and other coexisting behaviors offers a comprehensive understanding of the child's functioning, which makes this scale tremendously popular in many clinical settings.

For this research it is noted that both newer tools use technologies and traditional tools in achieving the objective measures and new formats that popularize assessments. For example, technological solutions can generate on-the-fly results about the child's behavior and their responses to games and exercises. These tools can provide measures such as, reaction time, working memory, impulse control, sleep patterns, and much more and provide a better objectivity and coherence of ADHD symptoms. Digital assessment also enables flexibility and standardization to be achieved thus minimizing the requirements of specialized environment or face-to-face meetings, which may take time and resources [33]. Also, the current assessment instruments reflect on recent developments of the concept by being more pleasing to the children. Information-based activities like those given online reduce the pressure when doing assessments and become more encouraging. This keeps the child engaged and makes the data collected to be even more reliable. Some of these tools have also been enhanced in artificial intelligence and machine learning to create the evaluation as flexible

and more sensitive to the learner's needs. With this shift towards these innovative assessment methods, clinicians and educators can get better diagnostic analysis and interventions for children with ADHD [34].

1.2. Research Gap

Research A: The referred studies followed the design of employing a game involved in a mobile application for the ML-based early diagnosis of ADHD among the children in Sri Lanka. This application showed the possibility of solving accessibility difficulties and enhancing ADHD recognition and control via exciting, dynamic learning activities. However, the study mainly focused on strengthening set of cognitive skills including attention and concentration; and did not include a generalized procedure for subtype identification or integration of multiple data inputs. In addition, it stressed future prospects as the subject of future developments of the app for the expansion of the list of symptoms of ADHD and the addition of sections for constant monitoring and management, as well as there is potential for further development in real-time symptom tracking analysis and personalization of individualized interventions [35].

However, our research extends these gaps by proposing a gamified ADHD assessment system that is intentionally created for the purpose of framing subtype assessments (inattentive, hyperactive-impulsive, combined) and the fusion of multiple data components such as parents' comments on their child's behavior and behavior metrics gathered from the game. Though the application works on the treatment through games, our system is designed to identify clinical-grade diagnosis following DSM-5. The falling star reaction time game records reaction time, impulsivity, and attention of a child which when combined with the adaptive questionnaires and AI analysis guarantees accurate classification of subtypes. Also, our studies concern the process of monitoring by including Intervention Modules related to the subtypes of ADHD throughout the accuracy for diagnosing and managing. Our system provided extensions catered the gaps identified in the aforementioned study; the proposed system increases the scalability and the applicability within Sri Lankan clinical practice.

Research B: The mentioned study uses the decision tree algorithm for diagnosing ADHD and its subtypes based on behavioral/ neuropsychological/ electrophysiological data with high accuracy. Nevertheless, this study shows that machine learning can be used in ADHD diagnosis, but it employs and compares highly cost- and time-consuming methods based on EEG and the IVA test. These are cumbersome techniques, which demand equipment, clinics, and personnel that are not easily accessible, especially in the developing nations. Moreover, the approach uses static database without the ensuing behavioral interaction or culturally sensitive instruments for the development of children in natural environments [36].

However, the present study aims to fill these gaps by proposing an easy to use, culturally appropriate, gamified Primary school ADHD screening mechanism for the Sri Lankan context. In a playful manner, our system thus collects real-time behavioral data concerned with attention, impulsivity and reaction time during the falling star reaction time game. The system combines this data with DSM-5 based adaptive parent questionnaires and utilizing AI based data fusion; the system is able to diagnose sparse ADHD subtypes with clinical accuracy, all through the Smartphone, without the use of any specific equipment. This makes it even possible in low resource environments the above therefore forms the basis for my proposed conceptual framework as a theoretical foundation for telehealth solutions in low resource environments. Furthermore, for the cultural fit and universality of the method, as well as for its applicability for children, the system is similarly developed to be child-oriented, scalable and interoperable, filling in the gap between intensive clinical assessment and fast, accurate, easy-to-use quick diagnostic and intervention tools.

Research C: The above-mentioned study sheds light on the limitations of Mobile Apps for parents with ADHD in children stating that the apps do not have scientifically proven features, more features or the tools useful for monitoring the symptoms at real-time and useful integrated tools for the parents for taking an effective decision. While it serves as a reminder that apps must be designed with ADHD focused issues, it does not incorporate technological advance [37].

To this end, our study fills the gap by using more sophisticated machine learning techniques including the decision tree and ensemble method, deemed to classify the ADHD subtypes, based on the behavioral data gathered from a game-based questionnaire. This module effectively tracks features such as attention level and response rate as well as impulsiveness in an entertaining way. Further still, the adaptive questionnaire is formed in DSM-5; more features according to the data obtained from children's behavior at the moment of the application. By including the above elements and using the data fusion techniques we combine the behavioral task results and parental feedback, our system offers an accurate, complete, and dynamic diagnostic approach that we think remarkably improves ADHD assistance from previous tools.

Research D: The referenced study discusses the various technological implementations of self-regulatory strategies of behaviors and emotions of children with ADHD; the described technological interfaces include wearables, augmented reality and robots. Nonetheless, on average, many technologies are developed up to the prototype level or at pre-implementation pilot stage with limited integration within live settings. For the discussed technologies in the reviewed articles, enhancing self-regulation seems to be a potential view of innovative technologies, but what has been researched mainly comprise the outside objects rather than the informative paradigm of how the diagnostic and therapeutic systems could be integrated in a more holistic, individualized and dynamic manner [38].

This study complements current research in that it goes beyond developing a prototype to making a concept a reality. It combines machine learning supported multimodal data analysis with a motivating and dynamic behavioral assessment instrument for the continuous assessment of attention and impulsivity in particular. In contrast to other available tools, we use dynamic DSM-5-based questioners designed according to the specifics of symptoms and performance for obtaining accurate results. Moreover, by applying a gamification approach and data fusion techniques, the gap between entertaining interventions and evidence-based solutions is provided by using input from children's behaviors and parental feedback. This offers an efficient large-scale applicable diagnostic and therapeutic model of ADHD that is beyond self-regulation concepts for a more clinically oriented approach.

Table 1.1 Research Gap

Feature	A [35]	B [36]	C [37]	D [38]	Proposed System
Use of gamification	✓ Yes, but dynamic learning activities	✗	✗	✗	Falling Star Reaction Time game tailored for subtype assessment and data collection.
Cultural appropriateness	✗	✓	✗	✗	Developed specifically for the Sri Lankan context.
Subtype identification	✗	✗	✓ But limited in generalization	✗	Gamified subtype-specific assessment (inattentive, hyperactive-impulsive, combined) using DSM-5 framework.
Integration of multiple data inputs	✗	✗	✗	✗	Real-time behavioral data (reaction time, attention, impulsivity) fused with adaptive parental input.
Personalization and real-time monitoring	✗	✗	✗	✗	Personalized interventions based on real-time symptom tracking and data fusion techniques.
Intervention modules	✗	✗	✗	✗	Includes subtype-specific intervention modules alongside diagnosis.

DSM-5 compliance	✗	✗	✓ Focuses on machine learning-based methods but lacks DSM-5 compliance.	✗	Fully DSM-5-compliant assessment and diagnosis system.

1.3. Research Problem

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most prevalent neurodevelopmental disorders affecting children, characterized by symptoms of inattention, hyperactivity, and impulsivity [20]. These symptoms can have a profound impact on a child's academic performance, social relationships, and overall quality of life [39]. Early identification and intervention are essential to manage ADHD effectively, as they can help mitigate these adverse outcomes. However, the main problem lies in the lack of accessible, engaging, and culturally relevant assessment tools for ADHD, particularly in regions like Sri Lanka, where mental health resources are limited, and awareness of ADHD is relatively low [2]. Traditional ADHD assessments generally rely on subjective self-reports and observations from parents, teachers, or clinicians, which may not fully capture a child's behavioral tendencies. This subjectivity, combined with the fact that many existing assessment tools were developed in Western contexts, presents significant challenges in diagnosing ADHD accurately and efficiently in Sri Lankan primary school-aged children.

The central issue driving this research is the question: Focusing and impulsive control gamified module based on DSM-5 criteria for determining the symptoms of ADHD in children aged 5-10 years The purpose of this problem is to fill the existing gap that demands development of a new more effective form of an assessment that no longer relies on a conventional, often bias, approach but an enhanced and scientific one. An innovative, fun and interactive, the AI-assisted gamified module can define genuinely and promptly the vital ADHD symptoms such as inattention and impulsivity [21]. The project also benefits from this alignment by maintaining clinical relevance of this tool in assessing the children's behaviors based on DSM-5 criteria while utilizing the benefits of technology to present more detailed behavioral patterns of each child. Such an approach does not only have a possibility of enhancing the diagnosis accuracy but also makes observational understanding of ADHD symptoms more enriched within the given cultural background of the Sri Lankan children. This work seeks to close the research gap that currently exists between

conventional ADHD diagnosis and the modern use of technology paving way for quicker, more efficient and culture sensitive diagnostic tool for early Childhood intervention [21] [18].
The previous ADHD assessment methods are a limitation as assessments were not specific to the cultural and educational context of children in Sri Lanka [12]. Even the available assessment tools for ADHD are of western origin, which implies that they may not applicable when culturally different norms on behavior, expectations, and language proficiency are obtained from other regions. This inflexibility of culture might eventually result in underdiagnosis, or misdiagnosis because some signs associated with ADHD could be defined in other cultures in a different way. For example, a child who is likely to be diagnosed with ADHD in the US may be perfectly normal in a Kenyan village. Thus, applying developed in the West ADHD diagnostic instruments in Sri Lanka will lead to incorrect diagnoses, and children will not receive the necessary help despite their condition.

Moreover, the conventional ADHD tests tend to be time-consuming where they involve an elaborated set of questions or interview, thus children find the process unpleasing and boring and especially if it involves young children. This can be a problem, especially during the assessment process, when kids may just get tired of answering questions and decide not to respond at all for miscellaneous reasons. In addition, observations on which such assessments are often based, may be subjective and reflect only the impressions of parents or teachers, which can by no means guarantee the descriptive adequacy of the child's symptoms. However, in Sri Lanka the knowledge about ADHD, its signs, symptoms, and causes and treatments options are very low among parents and teachers and therefore they are very hesitant to get their children assessed for ADHD due to stigmatization and misconceptions on the disorder. Consequently, ADHD remain undiagnosed or labelled as behavioral disorders rather than a true neuro developmental disorder and consequently therefore do not receive the appropriate help and treatment when they should [12].

The fourth drawback of currently used ADHD assessment and rating scales is the absence of a objective and interaction, which is crucial for children of most ages. Some traditional tools are not effective in including enrollment of real time data of the child, for instance, reaction time, ability to sustain attention and controlling impulsive behaviors that may serve as an objective measure of ADHD symptoms. It could be argued that a problem with prior work lies in the lack of threshold and or constant monitoring type assessment that are not only infrequent, but also anxiety provoking for children, that could actually be solved with a gamified testing approach. Nevertheless, there are few applications that are particularly designed to identify ADHD symptoms, and the available ones are rarely translated into a cultural context of Sri Lankan kids. They therefore found a big gap especially in terms of standardized, culturally appropriate, fun and properly designed assessment tools to diagnose ADHD symptoms among the native population [16].

In order to overcome these challenges, the present work will establish an aid designed as a video-game based assessment for ADHD, which incorporates real-time parental feedback. The key part

of this tool is a reaction-time game that estimates outcomes providing an objective evaluation of symptoms associated with inattention and impulsivity, including reaction time, the number of premature clicks, and the ability to sustain attention. This game is for children of primary school age play to increase the efficiency of the experiment with informal survey of parents and teachers concerning the child behavior associated with the ADHD. The data, which will be gathered in the course of the game, will help to define the concrete types of ADHD symptoms: inattentive, hyperactive-impulsive or combined, depending on child's reactions to the game. If the child's performance raises clear suspicion of a particular subtype of ADHD, the parent's questionnaire will be created based on the DSM-5 criteria and will consist only of the questions related to the identified symptom type. After the parent finishes this questionnaire, the results will be compared to the game metrics to accurately identify the child's ADHD subtype.

Further, this tool will generate a parent feedback report, which will present the outcome of the assessment in a culturally appropriate, easily comprehensible, and practical manner to the parent of the child with ADHD. Specific ADHD symptom types which will be delineated in the report will also be described along with the recommendations for coping with the symptoms at home and in school. This component is designed to promote informative and instructive support to parents because there's always a gap between receiving a diagnosis and learning how to manage the symptoms of ADHD every day. This project aims, therefore, to improve the identification of ADHD in Sri Lankan children by providing easy and fun fill- in set that is not only neutral but culturally sensitive and free from stigma as well, with a hope to increase sensitization and bring awareness that will in turn advances the delivery of an early effective intervention.

Therefore, the main question of the present study is concerned with the absence of universally available and culturally appropriate as well as clinically focused ADHD stimuli for children in Sri Lanka. This project sits in this gap by designing an assessment tool in which apart from acquiring factual behavioral information from the parents of children with ADHD, they receive feedback that informs them on how best to manage ADHD in their child. That way, through this inventive method, the tool will help work toward correct ADHD diagnosis and be fun for the children and informative for the parents in order to improve mental health for Sri Lankan families.

2. OBJECTIVES

2.1. Main Objective

To create an AI-based, game-inspired screening tool to assess children's ADHD using real statistics according to DSM-5 and determine the type of ADHD (inattentive, hyperactive-impulsive or combined) and feedback for the parents. It aims to improve the usability and utility for children and their families to help create the optimal climate for helping children with ADHD. Unlike a traditional behavioral survey that would seek to elicit certain responses from the parent and child, the integration of gamification will not only come up with data-oriented results in a fun and engaging way but will also provide information and advice for parents to act on, to modify the child's behavior, and in the process be informative as well as functional.

2.2. Sub Objective

- **Design and Implement a Gamified ADHD Assessment Module**

  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 an 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 in order 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

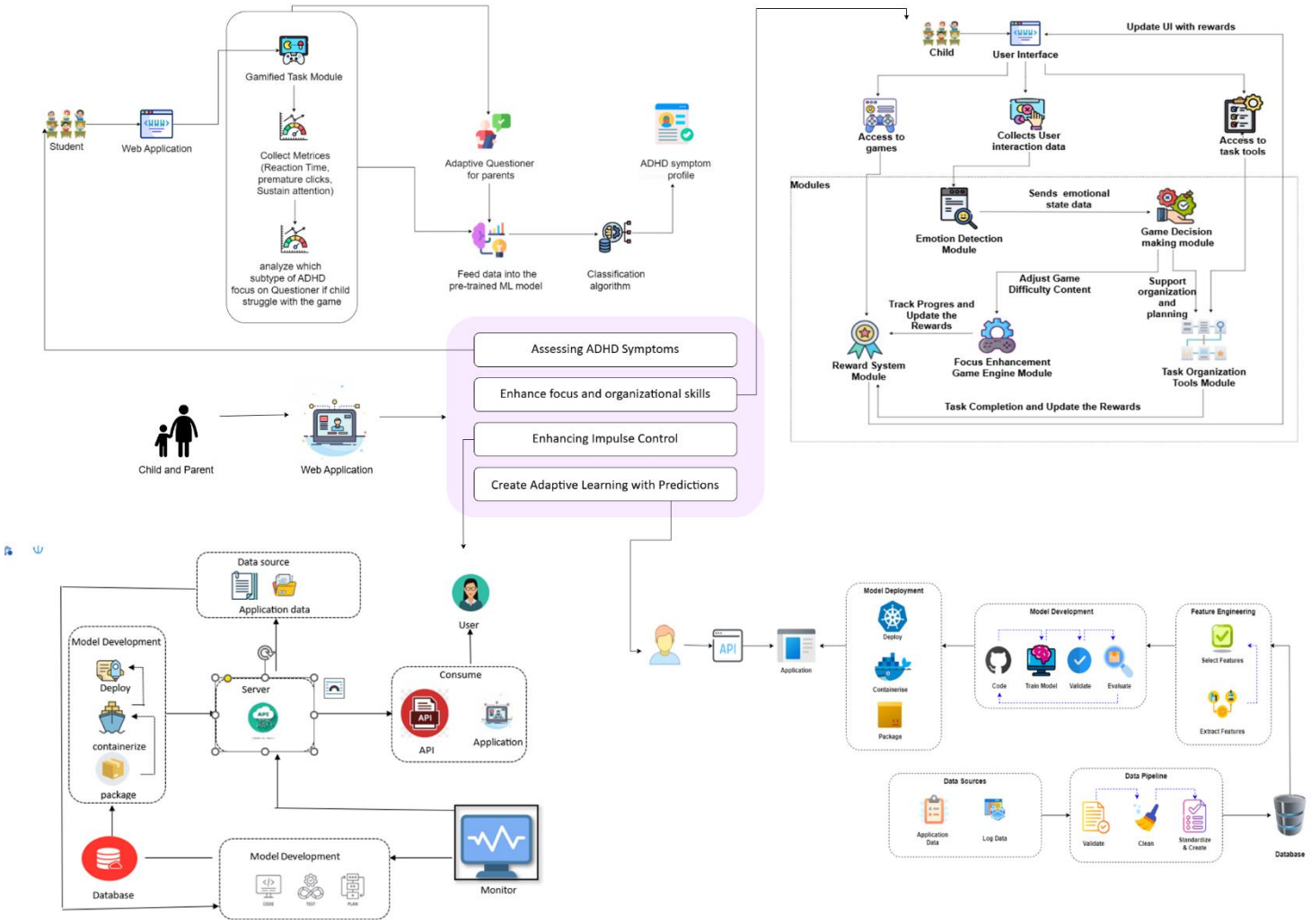

Figure 3.1 Overall System Architecture Diagram

The decision of using the ADHD assessment and intervention application for Sri Lankan primary school students has been done with a strong system architectural focus to enable proper diagnosis as well as assessment and management of the ADHD students in the schools. The design comprises of four main modules with each capable of offering particular functions based on clinical and technological best practices. This Gaming inspired application provides Culturally informed, fun and evidence-based approach to ADHD for children, parents and teachers through incorporation

of gamified modules, adaptive learning, intervention based daily routines, and AI based predictive analytics.

The first part is an AI gamification concept for ADHD symptoms assessment based on DSM-5 criteria to make the actual screening outcome for ADHD symptoms more effective. This module employs a game format similar to the "falling star" reaction time game to acquire quantitative performance information indicative of key aspects of ADHD, namely response time, duration of focus and impulsiveness manifested in early clicks. This format of delivery makes it very easy to engage the child, and in the process their symptoms are self-reported through the games played. In addition to the gamified task, the parents fill in the adaptive DSM-5 questionnaire that can be the Vanderbilt ADHD Diagnostic Parent Rating Scale [40] [32]. This questionnaire changes depending on the answers, focuses on actions that could be signs of ADHD, and gives another aspect to the evaluation based on what the parent sees. The data collected from the game-based task and the survey are further fed for analysis to a pre-trained machine learning model that can distinguish certain types of ADHD, such as Inattentive, Hyperactive-Impulsive, or a combination of both. In this regard, a preliminary diagnosis can also help in development of intervention programs as well as informing parents of assessment results based on clinical norms.

The second one is called Focused on Enhancing Attention and Organizational Skills for children with predominantly inattentive ADHD. This module uses adaptive educational strategies to assess, approach, and carry out activities with the child based on his learning style, attitude, and mood. Use of reward systems like stars/trophy, level system, and daily on-goings – like badges are incorporated in the activities to ensure that there is always constant usage. Further, through the use of adaptive technology, behaviors and emotion are recorded in real time to optimize challenges and content to the students' respective moods and attentiveness. Such an approach makes the intervention not only contingent of the child's current cognitive and emotional development needs but also compounding the effect of reward-based practice on sustained attention and organizational skills, thus leading to long term changes in focus and learning behaviors.

In the third component, the system deals with Impulse Control Through Structured Routines for students with predominantly hyperactive-impulsive ADHD. This module provides the parent with a variety of structured timetable and schedules that help the child conquer impulse control as well as manage his or her hyperactivity. Everything that takes place in the particular module is performed with the intention to promote positive energy outlets and to strengthen self-controlling skills. The common ones include exercises, practicing mindfulness, and completing routines that would give some pre-planned structure to one's day. Affordable Five Choose from these suggested five schedules for caregivers and educators that have been configured in a way that these routines may be modified in several bases on the children's needs and preferences. This component assists the children to internalize compliance within the fun activities hence developing discipline to overcome impulsive behavior while implementing a well-planned but elastic structure of behavior.

The last component is an AI-Driven Adaptive Learning and Intervention System which tracks the progress of the child and intervenes in response to data acquired in real-time. Such main performance indices as response time, the rate of completion of specific tasks, duration of attention, behavioral data are collected in this module to capture developmental progression of the child. Based on this data, more sophisticated algorithms are applied that permit the foreseen future complications and change intervention measures. The ideas which are obtained are shown from the well-organized interface which are good for both the child and the teacher to comprehend the child's useful abilities or improvement required, and the learning achievements. In order to help a caregiver or an educator, individual feedback is offered, which is based on analyzed changes in the child's activity patterns and can be used to create individual recommendations on how to approach the child in the next period of development. Programs in this continuous, adaptive learning model ensures that the existing interventions are effective all the time because they complement the development of individual children with ADHD.

As a conclusion, this ADHD assessment and intervention system integrates the concept of game-based assessment, the concept of learning adaptive, the structure of routine, and the applied predictive analytics and artificial intelligence to elaborate a comprehensive and personalized management mode of ADHD. Here layout of each component is consistent with OH clinical standards whereas modification of the components to fit the Sri Lankan context and match the cultural and learning realities of the population of primary school students is a mean of bridging between raising awareness in clinical sense and intervention into the day-to-day problem solved by the members of the target group. Being based on the data, but at the same time being a highly entertaining tool, this approach fosters a highly personalized approach to addressing the wide range of symptoms that may stem from ADHD which will ultimately increase its practicality, use, and efficacy for children, parents, and educators out there.

3.1.2. Component Specific System Architecture Diagram

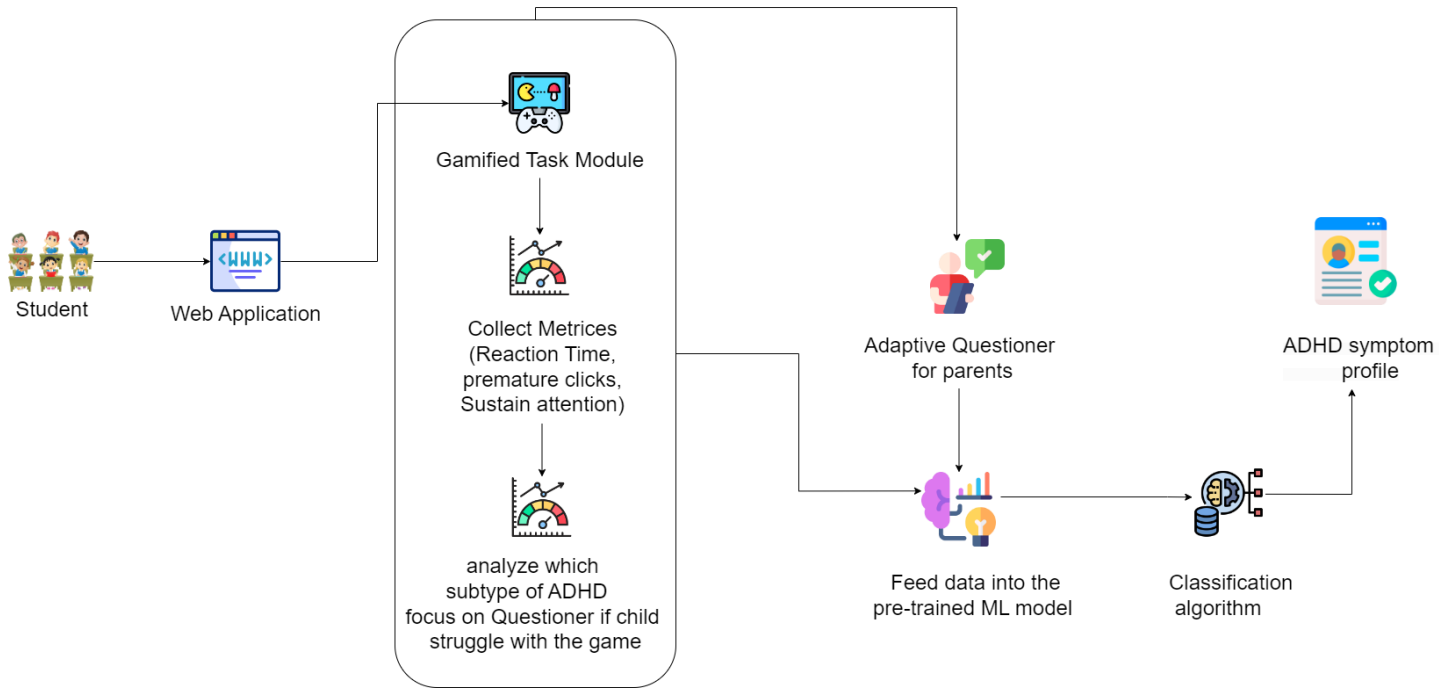

Figure 3.2 Component Specific System Architecture Diagram

As part of this research work one component offers an engaging, newly developed module for identification of the ADHD symptoms in children based on the DSM-5 criteria which is incorporated in a task incorporated as a game [21]. The primary focus is one of a reaction time game Also known as the falling star game where the subject is expected to be able to effectively point at a star falling across the screen while other non-ADHD participants make simultaneous movements on the screen, this is in order to effectively determine attention as well as impulse control. The system strives to decrease the level of anxiety often present in traditional investigated assessments by incorporating this activity into a gaming format. Not only does the integration of a gamified task promote engagement from children, but it also collects behavior data in near-real time to assess ADHD related symptoms.

The falling star game works in such a way that; it offers the children with tasks that involve fast and accurate response that may be an essence of testing their attention span and impulse control. That is, during the fall of stars, children are to identify and select them within a given time duration; the program provides information on the child's reaction time, endurance, number of premature responses and impulsive responds. Reaction time is central to assessment since children with ADHD are usually slower in their response than normally developing children. Concentration is determined by bearing in mind the child's effort to concentrate on the task at different intervals,

any interruptions implying the child could be inattentive. In terms of response', the total number of premature clicks is used to determine the degree of impulsivity whereby children click before the target is ready.
The information gathered during gameplay is then used to deduce whether a child presents features that are typical of a given ADHD subtype. For example, he stated that if the child displays slow responses and does not pay attention, this suggests inattentive ADHD or a inclination towards inattentive ADHD. On the other hand, a high level of impulsivity together with a fast rate of responding may indicate the presence of hyperactive-impulsive subtype. In case both types of symptoms are seen, it may be an indication of a mixed ADHD picture. This makes the system to self-adapt and be able to detect specific ADHD like behavior in the child and write the right assessment for the specific child.

After the assessment which involves a game, the system goes to the parent feedback module. Using this component in the assessment is important because it enables incorporation of observation data from home environment in the behavior of the child. At the end of the game, the system is able to automatically create a parent feedback form depending with the child's performance. When game analysis defines a specific type of ADHD, the questionnaire first focuses on questions about this type, so the parent is asked questions that can be associated with inattention or hyperactivity-impulsivity or with both.

The parent feedback form developed for this study is based on the DSM-5 ADHD criteria; its questions do not cause offense while being presented in their simplest form; they include behavior that parents may come across during their daily activities [4]. This form is intermediary between the assessment with games and real-life observations that help the parent provide an appreciation of the child's attentiveness, ability in terms of impulse control, and general behavioral predispositions. After the parent fills and submits the form, the system interprets the data together with the metrics obtained from the game and provides feedback that includes both observational and behavioral information.

Such an approach for data gathering in game-based environment along with the comparison to parent ratings attenuates the ADHD assessment. This way, the system compel-sates for the potential complications associated with ADHD depending on the context, since its presentation changes. The above method offers a better and personalized manner of evaluation to the system, thus offering better possibilities of differentiating subtypes of ADHD. Moreover, the choice of the system's layout is responsive to the local culture and demographic situation in Sri Lanka to provide ADHD evaluation services ideally for the residents of the country.

The feedback report produced at the end of the assessment is holistic in nature and is deliberately clear and easily executable. This report also helps parents identify the type of ADHD symptoms that have been observed, if any, and how a parent can manage those symptoms.

Before conclusion, therefore, this component of the research project applies gamification in combination with multimodal data integration to design an efficient tool for ADHD assessment in children. Hence, the falling star game is not only entertaining for children and creates a good ethic for children's game, but also offers good behavioral data necessary for the ADHD diagnosis. Taking into consideration parents' input following DSM-5 criteria, the system will provide a more detailed, objective, and culturally suitable assessment, thus connecting the clinical evaluation with perceived symptoms' management. This approach is a major advancement in ADHD assessment and overall ADHS, that incorporates the use of ICT solution and at the same time is not only sensitive but inclusive as well.

3.2. Software Solution

3.2.1. Development Process

Engaging Agile approach to developing the ADHD assessment tool can prove to provide a good approach that complements research-based projects. It is effective when managing the iterative process and to amalgamate the feedback throughout the project development life cycle to promote effective cooperation among team members, thereby producing a well–designed product that meets the end user needs.

In A, the process of gradual accumulation that is characteristic for agility helps the research team to develop the ADHD assessment tool in stages. Each time, a version of the component like the falling star game or the parent feedback form can be shown to the stakeholders. This feedback, collected from academic advisors, potential users or end users, or child psychology specialists, allows for adjustments that depend on the 'real world' usability constructive feedback and effectiveness enhancing the notion's accuracy and guaranteeing its relevance to the target culture. Of particular interest from the research perspective, Agile flexibility enables the research team to implement changes when certain insights arise, which is crucial in research premises where developments might be needed. For example, when doing user testing and identifying the need for different types of the interactive activities or improvement of the feedback form according to DSM-5 criteria, the changes can be easily made in the following iterations.

Communication with teams and other stakeholders and integration form part of the facets of Agile. Regular meetings and status reports ensure the team gets to put across information, disseminate information, and address problems when they occur. This information is especially significant when implementing various components of projects, for example, application of artificial intelligence, tests according to the DSM-5, and appealing interface for child users and their parents. The short and strict sequences of scrum work (the sprints usually take from 2 to 4 weeks) allow to focus the development efforts on particular features or components. At the beginning of each

sprint, a Sprint Planning meeting decides the focus like on the reaction time game or the parent feedback form or the ADHD-type analysis logic. Daily Stand-Up Meetings are meetings where each team member allows others to see what he or she is working on, as well as other objectives of the project.
One of the key principles of functioning used in Agile is the comprehensiveness of testing – such problems must be identified as early as possible. This methodology can work well with unit testing, integration testing and user acceptance testing during every sprint [41]. Through the collection and analysis of user feedback both on the prototype and feedback from stakeholders and performance metrics after each iteration the team can develop each component and enhance the effectiveness of the ADHD assessment tool.

One of the benefits of adopting the Agile approach is that research teams can easily switch if they discover new data or if stakeholders have given feedback that runs counter to the initial plan in a research project. This can be done easily – for example, make the modifications on the questions of the feedback form or change the degree of difficulty for children and adults to play the game.
Agile makes it possible to give first consumers functional segments, as development is divided into equal portions. For instance, the first version of the falling star game can be launched while some of the components such as the parent feedback analysis component are being developed. It frees users sooner to use the product, while feedback can be even stronger for subsequent updates. Decision-makers appreciate frequent status reports and progress briefs to have an unrestricted look into what goes on and foster a better relationship with end users. This creates a co-authorship environment where parents or teachers, for instance, are able to observe the system progress and give input to each of the stages of its development.

That is why the choice of the specific approach Agile to emphasize for the development of an ADHD assessment tool is more than relevant. It allows to work in a rigorous manner yet still offering an opportunity to design a powerful, research-based solution that might be further refined based on the results of the regular testing, feedback, and iterations.

3.2.2. Requirement Gathering

- Interviews

Talk with Child Psychologists to elaborate on the symptom indicators and the diagnostic criteria. Interview the teachers as they can advise of the in-school behaviors that are relevant to this ADHD problem. The parents will be best placed to inform regarding their experience with the assessment given to their children and what information would prove valuable.

- Surveys and Questionnaires

Quantitative data collection can be done by distributing surveys to parents and teachers. These would focus on the manifestation of ADHD symptoms in children. Surveys can also include questions to ask parents about types of feedback that are useful and the extent of detailing desired in the assessment results

- Focus Groups

Conduct focus group with parents mainly, teachers, and child psychologists to identify the necessities of the assessment tool for ADHD. It can be used to confirm or refute first concepts such as the falling star game idea; as well as which changes to the feature set or adjustments to the numbers would make it even more feasible and of higher diagnostic.

- Observational Studies

Trials per-formed with children playing with an early prototype of the game in 1-1 sessions. Pay attention to how they will respond to certain aspects of the game, whether they seem to like it, and how they will respond to graphical or sound rewards. Also, pay attention to such points as could create confusion or instabilities that would be used to help refine the surface of the user interface.

- Document Analysis

Analysis of the DSM-5 criteria in detail to find out the correlation between the features of the assessment and the standardized symptoms. Self-developed questionnaire, academic papers, clinical guidelines and existing screening tools should be reviewed in order to have a clear picture of the frequently utilized techniques and indicators and therefore find out where this tool can provide a new or improved solution.

- Prototyping

Develop the falling star game and parent feedback form on paper. These prototypes will be shared with a selected group of users, such as teachers and parents, for testing purposes and should solicit responses in terms of engagement, usability, and clarity. Refine the prototype based on suggestions provided by the users to make sure that the prototype meets the needs of the users.

4. PROJECT REQUIREMENTS

4.1. Functional Requirements

- User Profile Management

  The system shall enable creation of accounts per child individually so that the child, the parent or the guardian can log and monitor the child's gameplay over time.

- Gamified Falling Star Activity for ADHD Symptom Assessment

  The system shall include a falling star game in which children need to click on stars as they fall, implying forced attention and short response time. The game shall capture measures including reaction time (time taken in order to click on the star), temporal constancy (consistency in responding over time), and pre mature response clicking (response clicking before the star can be clicked). The system shall vary the speed and the frequency of the falling stars corresponding to the child in real time manner.

- Adaptive Game Flow

  The system shall reduce the speed, duration and the frequency of falling stars as it detects the child's reaction time and his/her ability to sustain on a particular level. This feature of the game shall enhance the learning process if a child is performing well the game shall increase the speed of the stars; when the child is doing badly the game shall slow down the stars in other to get better.

- Parental and Teacher Input

  The system shall enable the parent and the teacher to enter observations about the behavior of the child outside game environment, so the assessment is broader. This test is developed depending on the way child has played the game. Parents/teachers shall supplement information given by the child to make the report more comprehensive on the child's attention and impulse control.

- Real-Time Feedback Mechanism

  The system shall inform the patient immediately the right size is clicked through visual effects such as star emission when the correct size is clicked as well as sound emissions to determine the time factor involved. Any wrong or early click shall produce a polite beep or a visible signal so as to assist the child correct his or her timing.

- Machine Learning-Based Analysis

  The system shall utilize statistics and machine learning on the reaction time, consistent attention span, and early clicks of tasks, apparent behavioral signs of ADHD and, Input

from parents & teachers. According to the gathered information, it is expected that the system will generate the ADHD symptom profile concerning the identified subtypes.

- DSM-5 Criteria Alignment

  The falling star game shall be equated to DSM-5 criteria for ADHD by counting the number of times a participant clicked before it was their turn (impulsivity) and the number of times a participant missed their turn or lagged behind the others (inattention), as well as their performance during sustained attention assessments. The system should produce a report that will indicate how the child's game performance compares to DSM-5 criteria.

4.2. Non- Functional Requirements

- Performance

  According to the convenience of the game, the game shall be able to respond to the actions of the end user in less than few seconds. Users in the system shall be managed seamlessly in a way that will be, in either case, free from lag or interruption.

- Scalability

  The systems options shall allow for the extension to cater for more users at any given time as well as further features in the area of assessment and reportage.

- Reliability

  The availability of this system shall be at 99.9% to guarantee that both the game and the assessment features are always accessible. Perspective: All game data shall be saved automatically every minute for the purpose of protecting the data, should there be an abrupt shut down.

- Usability

  Further, it should be navigational for children within the age of 5-10 and should contain basic controls and directions. This shall be facilitated by the use of child-friendly icons and visuals.

- Security

  A user account shall have to incorporate a secure form of authentication mechanism to gain access.

- Compatibility

  Thereby, the system shall be compatible with a range of computing devices, mobile and stationary, with such OS as Apple and Android, and Microsoft windows.

- Accessibility

  The game shall thus comprise features for modified sound and graphic to suit the child with disabilities in order to play with children with other abilities.

- Maintainability

  The system shall be constructed out of modules where changes to the code will be easily made on the particular module that requires the update.

4.3. Software Requirements

1. Phaser (Game Development Framework):

   - Application: Used for developing gamified behavioral tasks to assess attention span, impulsivity, and hyperactivity.
   - Features: Offers a lightweight, 2D game development platform for creating engaging, interactive tasks tailored to children with ADHD.
   - Integration: Real-time task modifications based on user behavior.

2. Node.js (Backend Framework):

   - Application: Provides the backend logic for managing workflows, API development, and real-time task management.
   - Features: Non-blocking I/O enables high scalability and fast interactions between components like tasks, questionnaires, and user dashboards.

3. Python with Flask (Additional Backend Framework):

   - Application: Used for implementing machine learning models (e.g., ADHD subtype classifiers) and serving these models via REST APIs.
   - Features: Flask's lightweight structure is ideal for integrating AI models into the broader Node.js-based backend.

4. MongoDB (Database):

   - Application: Stores user profiles, task performance, questionnaire results, and ADHD subtype classifications.

- Features: Supports flexible schema-less storage, accommodating diverse and evolving data types.

5. React.js (Frontend Framework):

    - Application: Builds the user interface for tasks, questionnaires, and performance reports.
    - Features: Responsive design ensures compatibility across devices and dynamic interaction with backend services.

Algorithms:

1. Machine Learning Models (Deployed with Flask):

    - Random Forests and Support Vector Machines (SVM): Process data from behavioral tasks and questionnaires to identify ADHD subtypes.
    - Integration: Flask APIs serve model predictions to the Node.js backend for real-time feedback and decision-making.

2. Adaptive DSM-5 Questioning Algorithm:

    - Dynamically adjusts the questionnaire based on task performance and prior responses to improve accuracy in ADHD subtype identification.

3. Rule-Based Task Difficulty Adjustment:

    - Predefined rules modify game/task parameters (e.g., time limits, complexity) to match user progress and skill levels.

4. Performance Tracking and Statistical Analysis:

    - Tracks metrics like response time, task completion rates, and accuracy over sessions, generating detailed insights for reports.

4.4. User Requirements

- For Children:

    Children shall be able to play a game whereby by interacting with digital media through tapping, on a screen a falling star, their attention span and impulse control shall be provoked into better performance. Each game can have several rounds so that the game adapts to the children's previous performance at each specific round.

- For Parents and Guardians:

  Parents must be allowed to give other observations and additional comments on the child's behaviors other than when in the game setting.

- For Teachers:

  This way, teachers shall be able to feed into the system observation of the child's conduct in class to supplement information gathered by the game.

4.5. Test Cases

Table 4.1 Test Case 1

Test case ID: Test_01				
Test title: Falling Star Game - Reaction Time Recording				
Test priority (High/Medium/Low): High				
Module name: Falling Star Game				
Description: Verify that the system accurately records the reaction time when a child clicks on a falling star				
Pre-conditions: The system has registered the child				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_01	1. Start the falling star game. 2. Wait for a star to fall. 3. Click on the star as soon as it appears within the clickable range	The time interval between the star appearance and the click is measured and then stored.	The time interval between the star appearance and the click is measured and then stored.	Pass

Table 4.2 Test Case 2

Test case ID: Test_02
Test title: Falling Star Game - Sustained Attention Assessment
Test priority (High/Medium/Low): High
Module name: Falling Star Game

Description: This way ensures that the system monitors and assess the ability to pay attention for a longer period during different rounds of the game.				
Pre-conditions: The system has registered the child				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_02	1. Begin the game session, then play several more games. 2. Some tips about the gameplay Let's complete each round with the same level of accuracy concerning the clicking on the falling stars.	The system collects data for remain on attention throughout the rounds, it also captures decline or enhance in the levels of focus.	The system collects data for remain on attention throughout the rounds, it also captures decline or enhance in the levels of focus.	Pass

Table 4.3 Test Case 3

Test case ID: Test_03				
Test title: Falling Star Game - Premature Click Detection				
Test priority (High/Medium/Low): High				
Module name: Falling Star Game				
Description: Make sure that the system gauges and logs early clicks before the star symbol is clickable.				
Pre-conditions: The system has registered the child				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_03	1. Start the game session. 2. On the screen before any star appears, or if you click outside the clickable area.	The system captures the premature click and states that this is an impulse control violation.	The system captures the premature click and states that this is an impulse control violation.	Pass

Table 4.4 Test Case 4

Test case ID: Test_04
Test title: Adaptive Difficulty in Falling Star Game

Test priority (High/Medium/Low): Medium				
Module name: Falling Star Game				
Description: Make sure that difficulty increases or decreases depending on how the child performs in the game in real time				
Pre-conditions: The system has registered the child				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_04	1. Do a few sets with relatively high scores all the time. 2. Check out for variations especially on the rate of descent of the falling stars. 3. Adjust the level of complexity as you play the game and try not to aim as you do this so that you can check how game complexity change.	The speed of the stars increases constantly with high accuracy and decreases when the child has low accuracy to perform well.	The speed of the stars increases constantly with high accuracy and decreases when the child has low accuracy to perform well.	Pass

Table 4.5 Test Case 5

Test case ID: Test_05				
Test title: Feedback Form Generation that focus on particular symptom				
Test priority (High/Medium/Low): High				
Module name: Feedback Form Generation				
Description: Make sure you use elements proving that the system generates an adaptive feedback form of questions based on child in-game performance that focuses only on questions corresponding to DSM-5.				
Pre-conditions: Child has finished a game session, he/she exhibited signs that correspond to one or more types of ADHD.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**

Test_05	1. End the game playing with a child profile. 2. Subsequently users should log into the parent account and open the feedback page. 3. Note down the questions in the feedback form	The feedback form shows questions about the ADHD types the child is likely to portray depending with what he/she is doing in the game.	The feedback form shows questions about the ADHD types the child is likely to portray depending with what he/she is doing in the game.	Pass

Table 4.6 Test Case 6

Test case ID: Test_06				
Test title: Parent Feedback Form Submission				
Test priority (High/Medium/Low): High				
Module name: Parent Feedback				
Description: Make sure that parents must be able to populate the observation about the behavior of the child outside the game.				
Pre-conditions: The system has registered the child. Parent is logged in and has access to the feedback form.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_06	1. Go to the section of feedbacks usually located under the parent's panel of the platform. 2. Document behavior notes pertinent to a patient in the observation fields. 3. Submit the form.	It retains the feedback submission thus it will be part of the child's report.	It retains the feedback submission thus it will be part of the child's report.	Pass

Table 4.7 Test Case 7

Test case ID: Test_07
Test title: Last Determination of the Kind of ADHD Based on Multiple Analysis

Test priority (High/Medium/Low): High				
Module name: ADHD Type Analysis				
Description: Ensure that child game performance metrics and parent feedback together give a broad ADHD type diagnosis.				
Pre-conditions: Parent has filled the feedback form while child has also played a game with observed data gathered.				
Test ID	**Test Steps**	**Expected Output**	**Actual Output**	**Result (Pass/Fail)**
Test_07	1. Analyze the child's gameplay using the time data with emphasis on reaction, ability to sustain attention and cases of premature click. 2. Complete the symptom-specific questions before filling the parent feedback form. 3. Begin the process of integrating the parent feedback and the game performance of children.	The system produces the final report containing the ADHD type: inattentive, hyperactive, or a combination, as well as the analysis of the child's game performance, and the parent's questionnaire	The system produces the final report containing the ADHD type: inattentive, hyperactive, or a combination, as well as the analysis of the child's game performance, and the parent's questionnaire	Pass

4.6. Design

4.6.1. Use Case Diagram

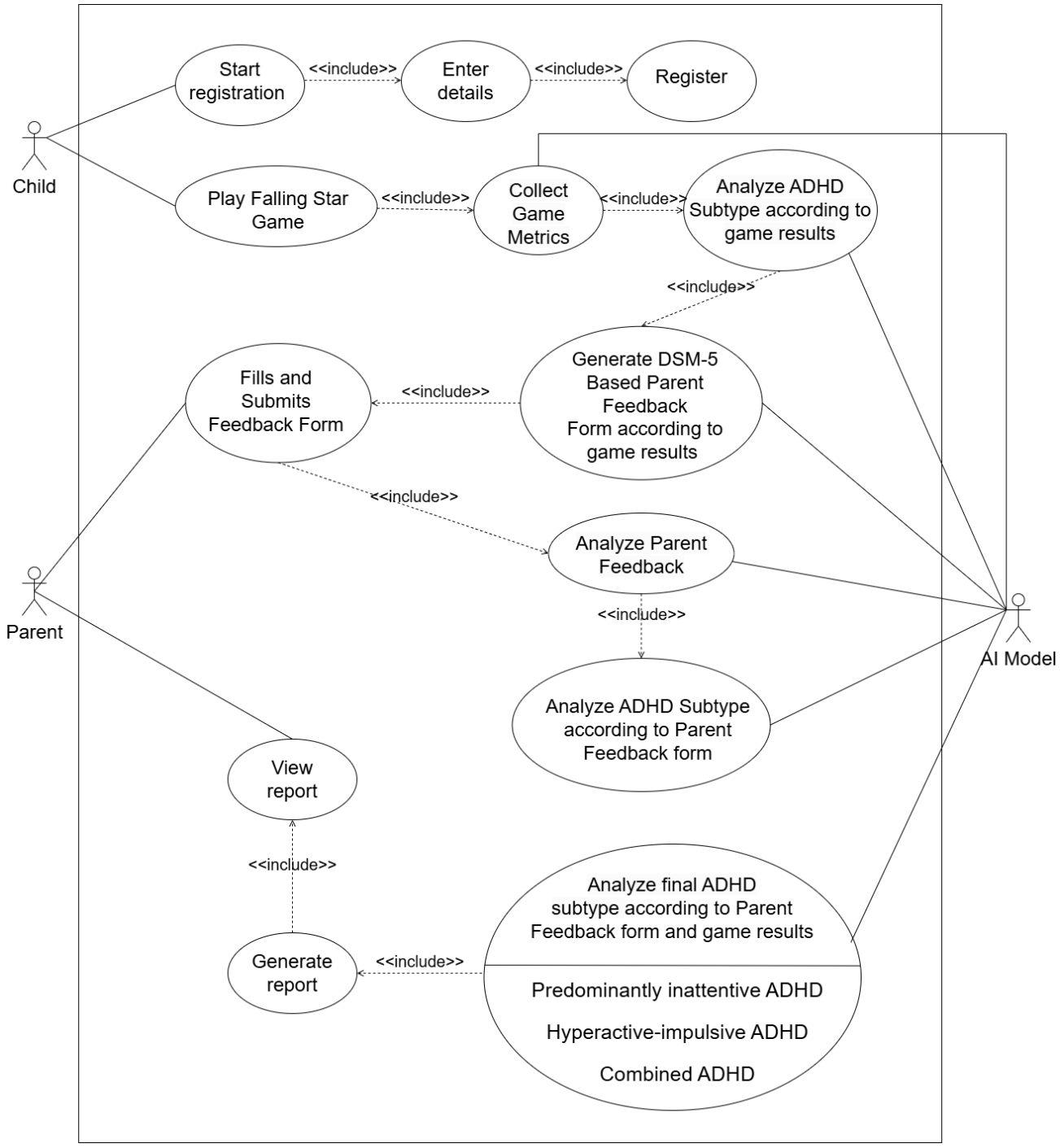

Figure 4.1 Use Case Diagram

4.6.2. Sequence Diagram

Figure 4.2 Sequence Diagram

4.6.3. Wireframes

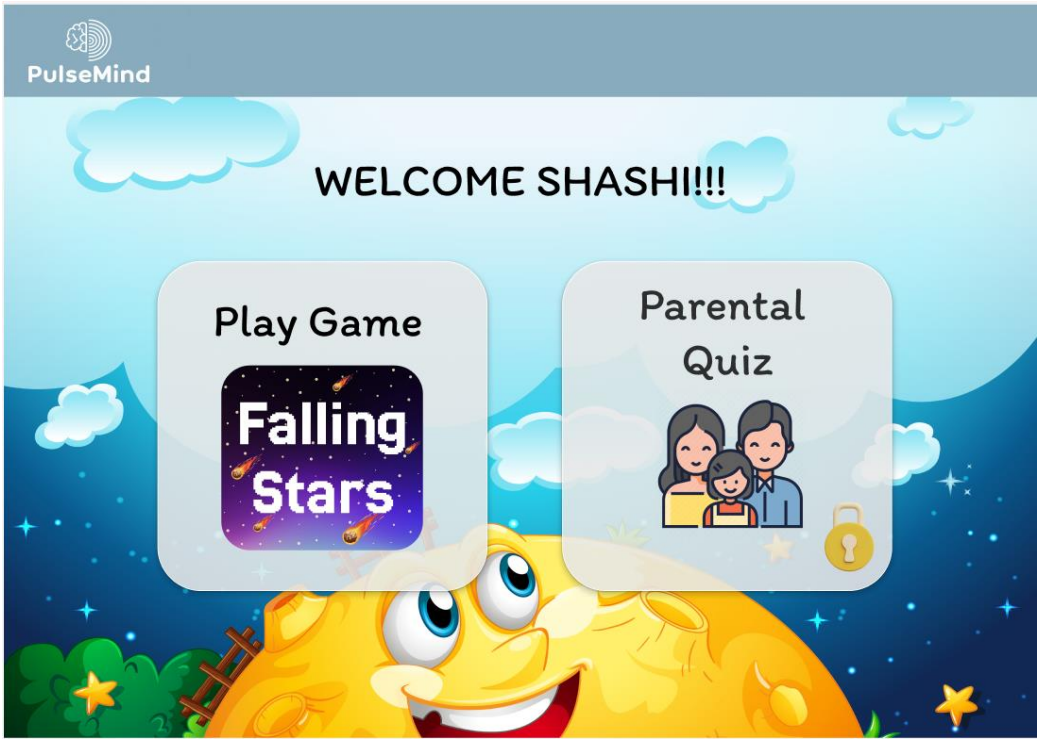

Figure 4.3 Dashboard

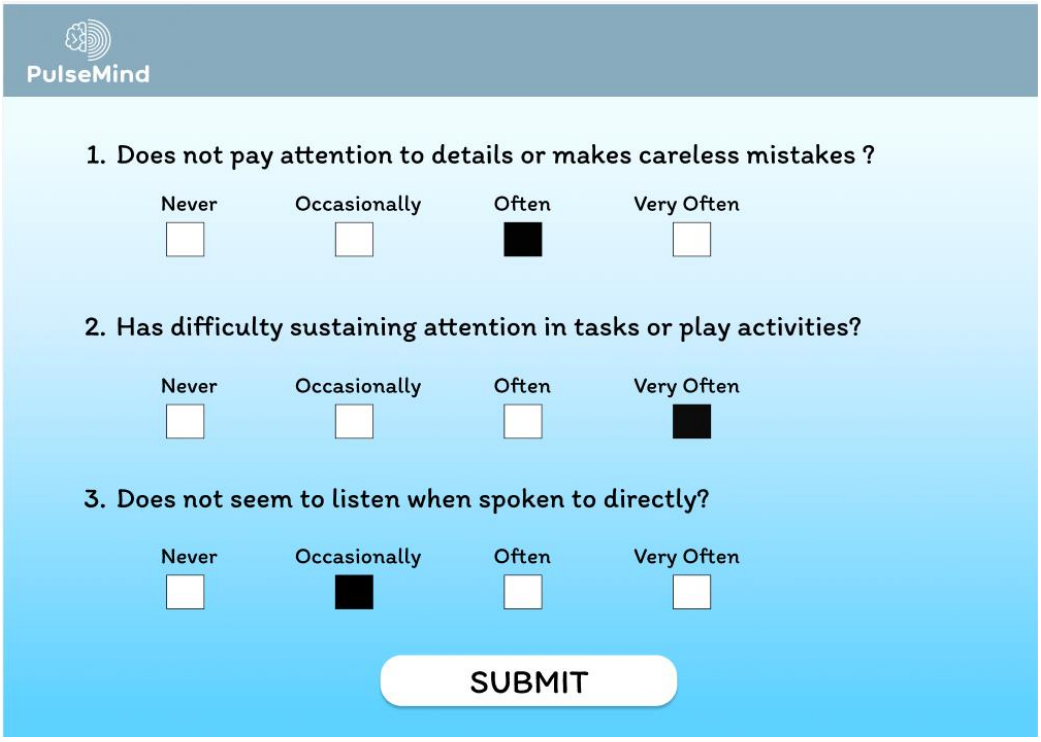

Figure 4.4 Parent Quiz

Figure 4.6 Falling Star Game

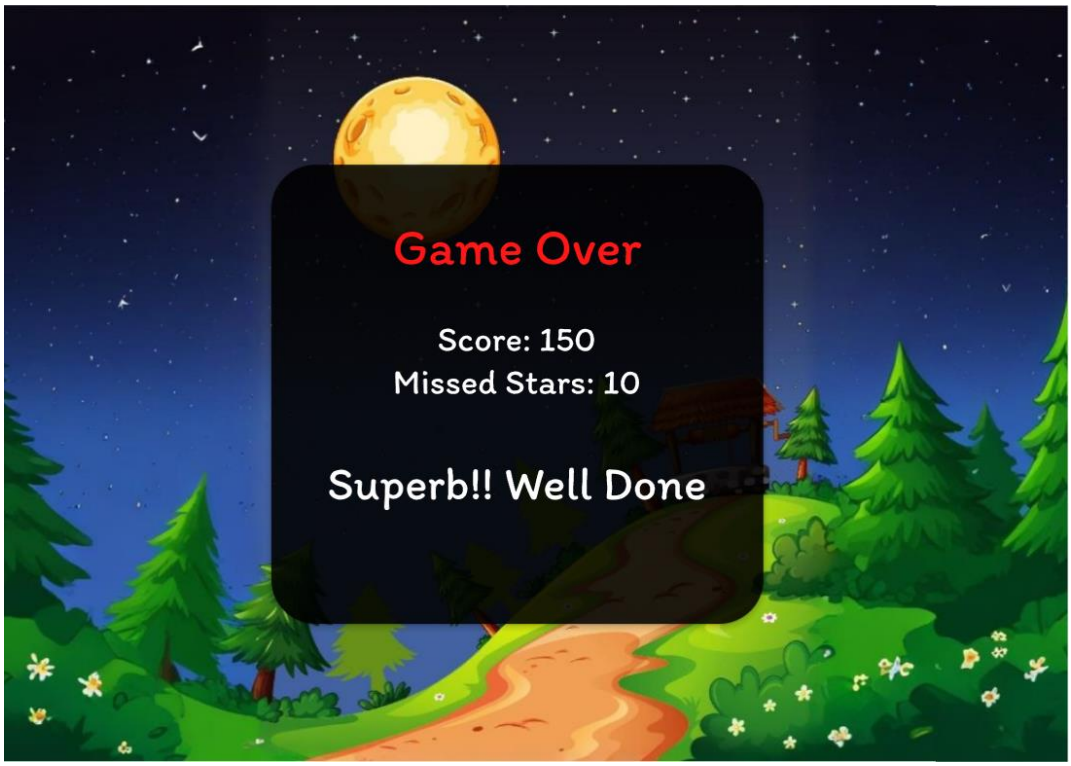

Figure 4.5 Game Over Interface

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. Be specific on 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 feedbacks.

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

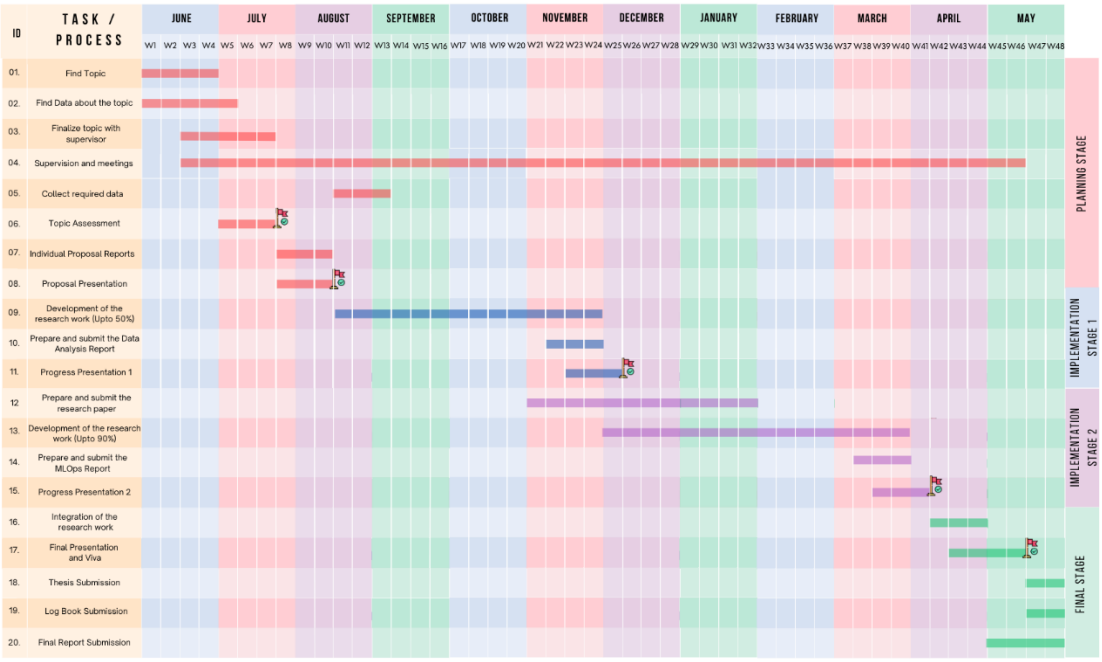

Figure 7.1 Gantt Chart

8. WORK BREAKDOWN STRUCTURE

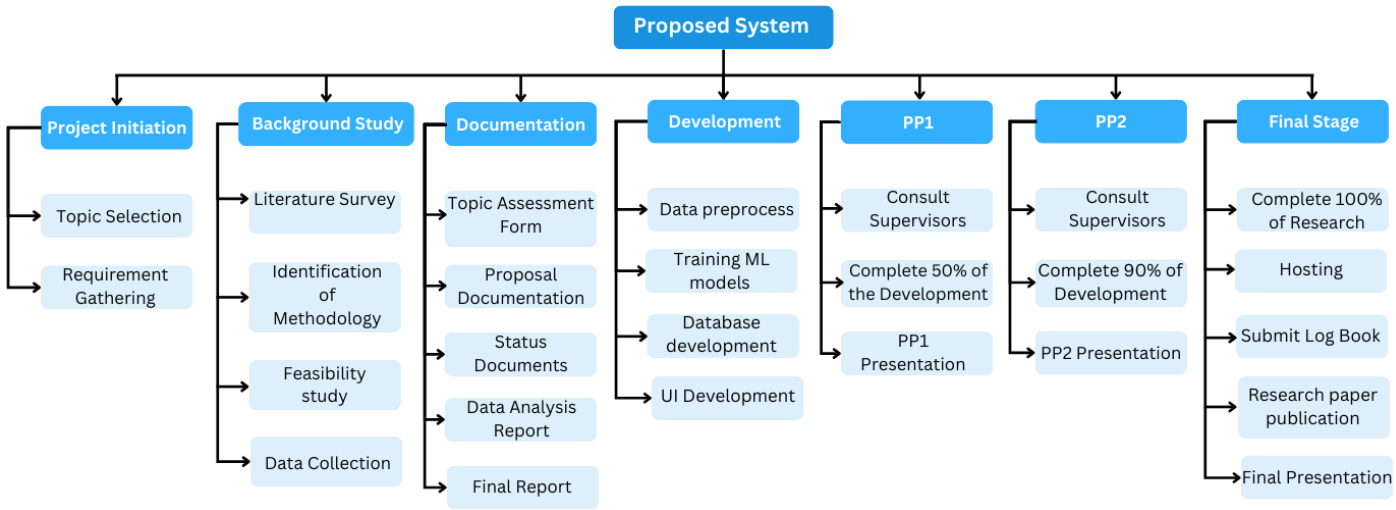

Figure 8.1 Work Breakdown Structure

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APPENDICES

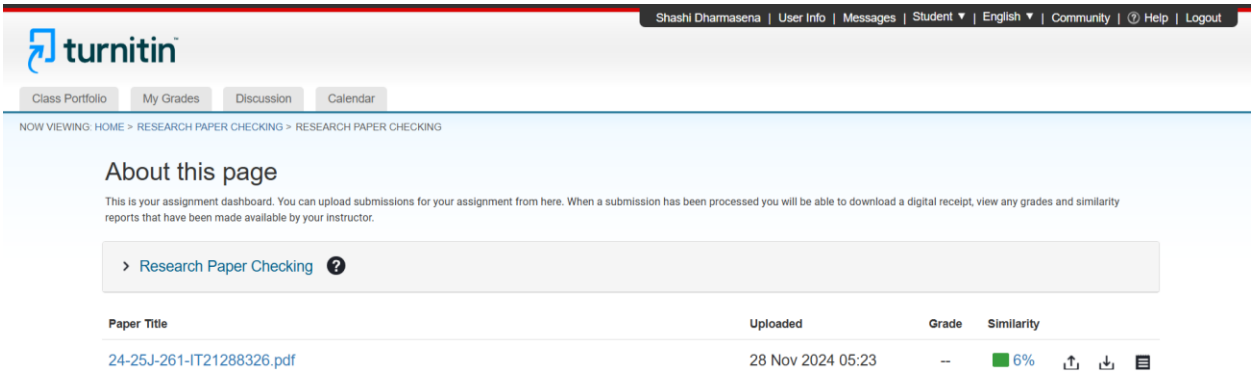

Figure 0.1 Turnitin Report

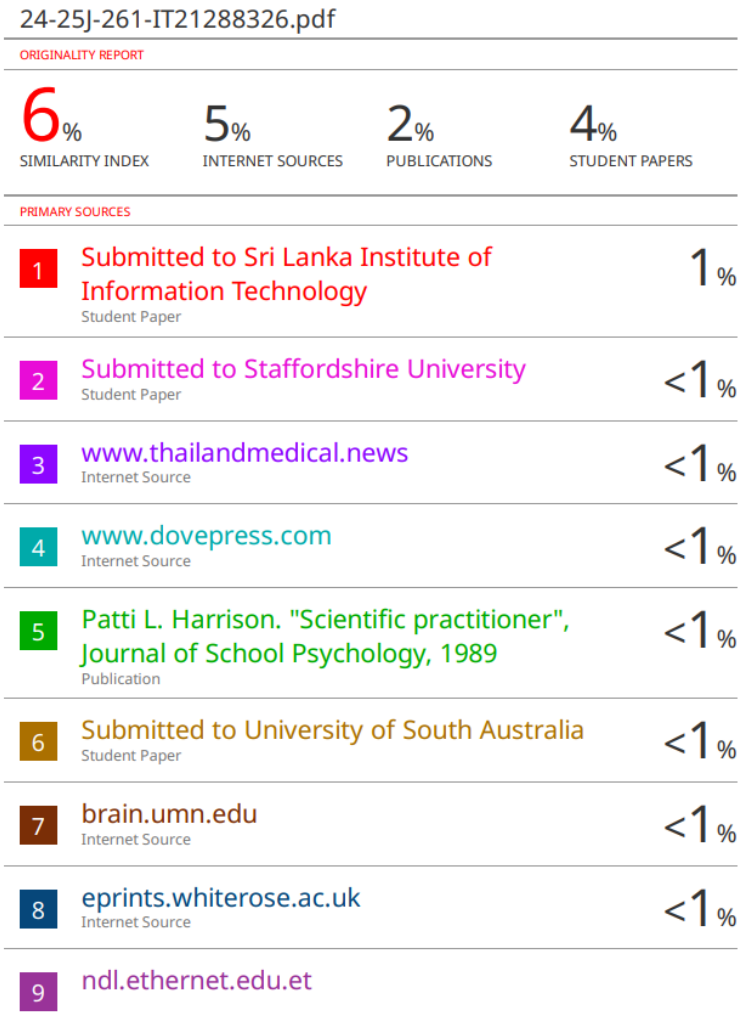

Figure 0.2 Turnitin Report 2