

Project - VEDA: AI-Assisted Dyscalculia Screening and Learning Support

Definition

Dyscalculia is a specific neurodevelopmental learning disorder that affects an individual's **numerical comprehension, mathematical reasoning, and problem-solving ability**. It is often compared to dyslexia but impacts mathematical skills rather than language. Research suggests that **5–7% of the world's population** is affected by dyscalculia, with most cases going **undetected or misdiagnosed** due to low awareness among parents, teachers, and healthcare professionals.

Despite its long-term academic and psychological consequences — such as poor mathematical confidence, anxiety, and reduced career opportunities — **there has been very limited research and technological innovation** in this area. Existing diagnostic processes are either **manual, time-consuming, or not accessible** to schools and parents, leading to a lack of scalable and affordable screening solutions.

To address this largely ignored issue, our team developed **VEDA (Visual Engagement for Dyscalculia Assessment)** — an **AI-driven digital platform** that provides **early screening, awareness, and personalized learning support** for children showing signs of dyscalculia. The platform analyzes visual and interactive responses to detect early symptoms and generate a preliminary report that can guide educators and parents toward professional intervention.

Since **early identification is critical**, as dyscalculia becomes much harder to manage once cognitive pathways are established, **VEDA focuses on early-age screening** (typically 6–12 years). Our goal is to make dyscalculia detection **feasible, research-backed, and widely accessible**, empowering schools, parents, and psychologists with an easy-to-use, scalable screening solution.

Industry Domain

The **VEDA platform** operates at the intersection of the **Education, Healthcare, and EdTech** industries, focusing primarily on the **academic and psychological assessment** domain. It is designed to be implemented within **schools, learning centers, and child development programs** for the **early screening of dyscalculia** among children aged **5 to 10 years**.

By providing a **web-based interface**, VEDA ensures that the screening process is **accessible, scalable, and convenient** for educators, parents, and

psychologists. The solution seamlessly integrates into academic settings, enabling teachers and specialists to identify learning difficulties at an early stage and guide affected students toward appropriate interventions.

Through its focus on early detection and awareness in educational environments, VEDA bridges the gap between **academic performance assessment and cognitive health**, contributing meaningfully to the growing **EdTech-for-neurodiversity** ecosystem.

Solution

The **VEDA (Visual Engagement for Dyscalculia Assessment)** platform provides an **AI-assisted, game-based screening and awareness system** for early detection of dyscalculia in children aged 5–10 years. The solution integrates **machine learning, full-stack web technologies, and intelligent analytics** to create a seamless, engaging, and research-backed experience for both children and educators.

At the core of VEDA lies a **machine learning model** trained on a curated dataset of cognitive and behavioral features such as *Exact Enumeration*, *Symbolic Comparison*, *Visuo-Spatial Working Memory*, *Efficiency Scores*, and *IQ-based metrics*. The model uses a **RandomizedSearchCV - optimized ExtraTrees Classifier**, wrapped within a preprocessing pipeline that includes **imputation, scaling, and feature encoding**. The pipeline undergoes **cross-validation, isotonic probability calibration, and permutation-based feature importance diagnostics**, achieving high accuracy and stability in predicting dyscalculia risk levels. The final trained model is serialized using joblib and integrated into the live platform for real-time inference.

The front end of the platform is implemented as a **web-based interface** using **Node.js, Express.js, and modern JavaScript frameworks**, while the backend hosts the predictive model and user management services. The system also integrates **LLaMA-based AI components** for conversational guidance, enabling an interactive and adaptive experience for users.

To ensure engagement and effective screening, VEDA features **four interactive games** that map directly to the core assessment parameters:

1. **Number Friends** – introduces children to number recognition and basic quantity association.
2. **Counting Fun** – builds object–number correspondence and sequential counting abilities.

3. **Shape Match** – enhances visuo-spatial and symbolic comparison skills.
4. **Math Stories** – presents scenario-based problem solving to evaluate numerical reasoning.

Following gameplay, the platform generates **Learning Reports** with insights into a child’s performance, progress, and risk indicators. These are supported by **AI-powered Smart Insights** that provide **personalized recommendations** for parents and educators, helping them plan appropriate interventions or further assessments.

Through its **data-driven, game-based, and highly scalable design**, VEDA delivers an innovative and accessible solution for **early dyscalculia screening**, bridging the gap between **educational technology and cognitive healthcare**.

Expected – Quantifiable Metrics

The **VEDA platform** is designed to bring measurable improvements in how dyscalculia is identified and understood at an early stage. While large-scale user testing is yet to be conducted, the system is expected to have the following key impacts once deployed:

- **Reduced Screening Effort:**
VEDA simplifies the traditionally complex and time-consuming process of dyscalculia screening into an **interactive and automated workflow**, enabling faster and more consistent preliminary assessments.
- **Enhanced Feedback Quality:**
The platform’s **AI-based analysis** and **automated learning reports** are expected to provide clearer, data-backed insights to educators and parents, helping them understand a child’s mathematical challenges and strengths more effectively.
- **Increased Accessibility:**
Being a **web-based solution**, VEDA can be accessed remotely by schools, parents, and professionals, eliminating geographical and resource-based limitations that typically hinder early screening.
- **Improved Engagement:**
The **game-based approach** transforms assessment into a fun, non-intimidating experience, encouraging children to participate more willingly and naturally during the screening process.

- **Scalability and Awareness:**

By integrating intelligent analytics with a friendly interface, VEDA aims to **raise awareness about dyscalculia** while providing a **scalable and affordable tool** that can be adopted by schools and learning centers at various levels.

In summary, VEDA is expected to make **early dyscalculia screening more engaging, accessible, and insightful**, contributing to improved awareness and better support for children facing mathematical learning difficulties.

Current Status

The **VEDA platform** has been successfully **deployed as a publicly accessible web application** and is currently live at joinveda.com. The system presently features **four fully functional interactive games** that assess essential mathematical and cognitive abilities related to dyscalculia. These game modules form the foundation of VEDA's **early screening framework**, offering children a friendly and engaging environment for mathematical interaction.

The platform's **AI-enabled reporting module** is operational and provides detailed insights into a child's performance, helping educators and parents identify potential learning challenges. This feature is currently being enhanced to deliver **more detailed visual analytics, personalized feedback, and interpretability improvements**.

Future updates will focus on implementing a **score-tracking system** that enables continuous progress monitoring and performance comparison over time. The platform architecture is built on a **Node.js and Express.js full-stack framework**, integrated with a **Python-based machine learning backend** powered by a calibrated ExtraTrees model. This setup ensures **real-time analysis, scalability, and seamless user interaction**.

In its current phase, **VEDA functions as a live working prototype**, showcasing both **technical feasibility and practical potential** for broader educational deployment.

Future Plans and Relevance

Future Plans

Building on the current prototype, the next phase of development for the **VEDA** platform includes the following key initiatives:

- Expansion of the training dataset: We will collect and curate additional high-quality data from diverse populations to improve the robustness and generalisability of our machine-learning model.
- Enhancement of game content: More interactive and developmentally appropriate games will be added to cover a broader range of cognitive and number-sense skills relevant to dyscalculia.
- Expert consultation & domain collaboration: We plan to engage with educational psychologists, cognitive neuroscientists, and special educators for guidance in refining the screening algorithms, game design, and diagnostic validity.
- Implementation of score tracking and longitudinal monitoring: A module will be introduced to enable weekly performance tracking, enabling children's progress to be monitored over time and providing deeper insights into learning trajectories.
- More detailed reporting and personalised suggestions: The platform will evolve to generate richer feedback reports, including actionable suggestions for parents and teachers to support the learner based on performance patterns.

Relevance

The target audience for VEDA comprises children aged **5 to 10 years**, a critical period for foundational numeracy development. Early detection and support during this window can significantly improve outcomes for learners with mathematical difficulties. While there are screening tools and digital games addressing number-sense and math learning challenges, the number of solutions specifically combining **machine-learning-based dyscalculia screening, game-based assessment, and web deployment** is limited. For example, tools such as Meister Cody provide screening and training for children, but their focus is more training-oriented rather than end-to-end screening + reporting + longitudinal tracking. This relative gap underscores the opportunity for VEDA to occupy a differentiated space, offering an accessible, scalable, and comprehensive screening and support platform

Business Model

At its current stage, **VEDA** operates as a **completely free-to-use platform**, accessible to anyone through its public deployment. The objective during this phase is to **maximize reach, gather user feedback**, and validate the platform's technical and functional effectiveness within real-world learning environments.

In the long term, the project aims to evolve into a **sustainable, partnership-driven model**. Collaborations with **schools, educational institutions, hospitals, and non-governmental organizations (NGOs)** are envisioned to extend the platform's accessibility and impact. Schools can use VEDA as a **screening aid** for identifying students who may require additional mathematical support, while hospitals and clinical experts can leverage it as a **preliminary assessment tool** to assist in diagnostic evaluation.

Future versions of the platform may adopt a **freemium or institutional licensing approach**, where basic screening remains free for individuals, while advanced analytics, detailed progress tracking, or institutional dashboards could be offered under a premium model.

This partnership-oriented business strategy ensures **social impact first**, while creating room for **long-term financial sustainability and research collaboration**.

Type of Support Available / Required

At present, **VEDA** is an independently developed initiative without formal external sponsorship. The project has reached a functional deployment stage through the efforts of the student team, leveraging publicly available resources and open-source technologies.

To advance the platform further, the team seeks **expert guidance and domain mentorship** from professionals in the fields of **cognitive neuroscience, educational psychology, and special education**. Such collaboration would help refine the assessment parameters, improve the interpretability of screening outcomes, and ensure scientific accuracy in future iterations.

Additionally, the project requires **support in obtaining larger, cleaner, and more reliable datasets** related to dyscalculia and mathematical learning behavior. Access to authentic, ethically sourced data will strengthen the underlying **machine learning models** and enhance screening precision, ultimately improving the reliability and research value of the system.

The team remains open to **institutional partnerships, mentorship programs, or academic collaborations** that align with the goal of making early dyscalculia screening both accurate and accessible.

Risk Area	Description	Mitigation Strategy
1. Data Quality and Availability	The availability of large, reliable, and ethically sourced datasets related to dyscalculia is limited. This may affect the model's generalizability and accuracy.	Collaborate with schools, research institutions, and healthcare organizations to access verified data. Continue refining the dataset through controlled user studies and simulated data generation techniques to improve model reliability.
2. Expert Validation and Clinical Accuracy	Without expert review, the AI-driven screening outputs might lack clinical validation or be misinterpreted by non-specialists.	Establish partnerships with cognitive psychologists, neuroscientists, and educational experts to review and validate assessment logic, ensuring the platform aligns with recognized diagnostic standards.
3. Awareness and User Adoption	Dyscalculia is a lesser-known condition, and educators or parents may not immediately recognize the need for such tools, leading to slower adoption.	Conduct awareness campaigns through schools, NGOs, and social media. Emphasize early detection benefits and provide simplified training or demo sessions for educators and parents to improve usability and trust.

Project Team Details - **Team VEDA**

Sr No	Name	Branch and Year	Photo
1)	Tanish Gupta	AI-DS(TE)	
2)	Pranav Patil	AI-DS(TE)	
3)	Vrishabh Chadchan	AI-DS(TE)	
4)	Aryan Kadam	AI-DS(TE)	

Project Mentor Details

Name : Dr Vinayak Kottawar

Department : AI&DS

Designation : Head of Department

College: D Y Patil College of Engineering, Akurdi, Pune