

AI-Powered Assistive Writing System for Children with Specific Learning Disabilities

Kunal Sapkale¹, Vishal Pise², Omkar Shinde³ and Padmavati Sarode⁴

¹⁻⁴Department of Computer Engineering, G H Raison College of Engineering and Management Pune, India
Email: kunal.sapkale.cs@ghrcem.raisoni.net, vishal.pise.cs@ghrcem.raisoni.net, omkar.shinde.cs@ghrcem.raisoni.net, padmavati.sarode@raisoni.net

Abstract— Artificial Intelligence (AI) technologies have made significant strides in transforming education, particularly in the development of assistive technologies for children with Specific Learning Disabilities (SLDs) such as dyslexia, dysgraphia, and Attention Deficit Disorder (ADD). The Fun Writing Assistant, a computer-based writing system, uses AI to provide corrective feedback that addresses the challenges these children face in writing. Through the use of Machine Learning (ML) algorithms, Natural Language Processing (NLP), and adaptive learning software, the system delivers a dynamic, interactive experience tailored to meet the unique needs of each child. The system continuously monitors a child's writing progress, identifying areas of difficulty and offering personalized feedback to improve spelling, letter formation. The system also incorporates gamification elements, such as progress indicators, rewards, and motivational aids, to encourage consistent practice and keep children engaged. Despite its potential, challenges remain, including unequal access to technology in disadvantaged communities, reliance on datasets that don't fully capture handwriting variability, and a lack of emotional and psychological support. Future improvements could include emotion detection, speech recognition, enhanced offline features, support for multilingual students, and integrating AI feedback with human educator assistance for a more comprehensive learning experience.

Index Terms— AI-Powered Writing System, Specific Learning Disabilities (SLDs), Disability, Machine Learning (ML), Natural Language Processing (NLP), Gamification.

I. INTRODUCTION

In the past years, development in artificial intelligence (AI) brought historical change in several disciplines, not excluding education. The most auspicious emergence may be recognized among AI-driven children with particular learning disabilities (SLDs) technology (Dumitru, 2025). Certain learning disabilities, i.e., dyslexia, dysgraphia, and attention deficit disorder, might inflict consequential complication to kids' ability to engage with the practice of reading and writing and reduce eventual schooling and development attainment (Sobolewski Michael, 2014). Traditional forms of educational intervention such as remedial programs or human support have been effective and have proven very helpful, but these solutions are costly and time-consuming and fail to provide the personalization that is important or relative to authentic learning, especially for children with SLDs (Anjana et al., 2020). In the present scenario, an AI-supported writing system would be a breakthrough technology to assist in mitigating the issues discussed above.

The study conducted in this direction examines how support is provided to children who find it difficult to write with their own handwriting, ensures instant and interactive feedback and while showing enhanced skill sets, it also builds independence and confidence (K.S., 2023). AI-based writing technologies use machine learning (ML) algorithms, natural language processing (NLP) (David Saltzman, 2020), and adaptive learning tools to provide students with an interactive, interactive learning experience depending upon their individual needs (Murray-Smith, 2015). Writing technology monitors a child's improvement in writing on a permanent basis, while also detecting areas of struggle, and giving customized feedback to aid writing capability (Tajik, 2025). AI applications can also utilize writing patterns to correct pupils in real-time for spelling, letter formation. The adaptive learning resources that are customized to the learner individual use adaptive learning to reduce the cognitive load of writing so that pupils can focus on clarity and imagination of the ideas rather (Salhab, 2024). Finally, they want to help those children overcome problems with writing due to certain learning disabilities and raise academic accomplishment and develop some forms of communication which will bring their success not only at school but also afterward (Chalk et al., 2005).

A. AI-Enabled Goals for Supporting Children with Specific Learning Disabilities:

AI-based assistive systems are aligned with a number of major goals that seek to enhance the quality of life for children with specific learning disabilities, promote their inclusion, and build personal development (Baby & Balaji, 2013).

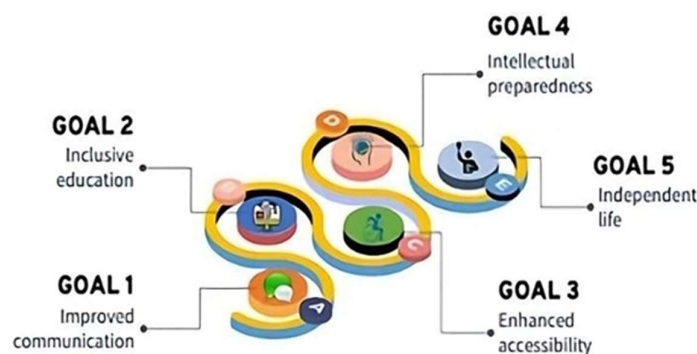


Fig 1: AI enabled goals to support children with specific learning disabilities.

The five primary goals that seek to enhance the quality of life for people with specific learning disabilities and disabilities overall.

- Goal 1: Improved Communication emphasizes facilitating the development of communication skills so that individuals become more effective at communicating in diverse contexts. It is important to individuals with learning disabilities because such barriers may stifle their schooling and social interaction (Browning et al., 2010).
- Goal 2: Inclusive Education emphasizes equal opportunities in education for learning disabled persons to ensure that they are given access to quality education that is geared towards meeting their individual needs (Messiou, 2017). This objective enhances the inclusion of all students irrespective of their capabilities into general education systems.
- Goal 3: Enhanced Accessibility emphasizes the need to make physical and virtual spaces accessible to everyone, so that participation barriers are eliminated. This involves making educational tools, websites, public areas, and others accessible (Al-Ani et al., 2020).
- Goal 4: Intellectual Preparedness emphasizes in preparing a person intellectually to tackle the issues he/she may encounter in life, equipping him/her with skills and means necessary to excel in academic and practical life (Knight et al., 2019).
- Goal 5: Independent Life seeks to nurture independence, motivating people to live self-sufficient lives. It entails equipping a person with the resources and confidence required to make his/her own choices and effectively manage his/her life on a day-to-day basis (Parry, 1986).

II. PROBLEM STATEMENT

Children with Specific Learning Disabilities (SLDs) such as dyslexia, dysgraphia, and Attention Deficit Disorder (ADD) often face significant challenges in developing basic writing skills. These difficulties include poor letter

formation, inconsistent spacing, and limited ability to receive and process feedback in real time. Traditional methods like worksheets, human tutoring, and remedial classes, while effective to some extent, are time-consuming, expensive, and lack the personalization required to address each child's unique learning needs. Moreover, most digital tools available either offer limited feedback mechanisms or reserve key interactive features for premium users, restricting accessibility for many children. There is a critical need for an accessible, intelligent system that not only assists children with SLDs in improving their handwriting but also adapts dynamically to their individual pace and learning style. The "Fun Writing Assistant" addresses this gap by leveraging AI technologies such as machine learning, OCR (Tesseract), and gamification to provide real-time, personalized feedback. Despite its promise, current limitations include inconsistent handwriting recognition, limited offline access, and the need for deeper emotional understanding of the learner. Therefore, the challenge lies in developing a scalable, adaptive, and engaging assistive writing tool that bridges the gap between conventional instruction and personalized AI-driven learning support.

III. RELATED WORK

- Sahrish et.al (2023) reviews 16 studies of AI applications for students with learning disabilities (SWLDs) (Al-Motrif, 2025). Ten studies were on dyslexia, one on dyscalculia, and others on general learning disabilities. Seven AI applications were identified by the study, with adaptive learning being the most prevalent. According to the SAMR-LD model, AI was applied at various levels to support SWLDs (Bhushan et al., 2024).
- Husna Habib et al. (2022) discusses the potential of Artificial Intelligence (AI) to revamp inclusive education with adaptive learning systems for individuals with disabilities (Lalar et al., 2024). AI-technology, such as machine learning and natural language processing, adapts education based on students' precise challenges such as visual, auditory, and mental impairment. Such developments are underlined by the report as voice-to-text technology, virtual aid, and gaming learning environments for accessibility (Hahn, 2018).
- Munikrishnaiah Sundara Ramaiah et.al (2025) explores the possibility of artificial intelligence (AI) to revolutionize learning for disabled learners using adaptive learning (Nagarajan et al., 2024). It outlines how AI technologies such as intelligent tutoring systems, speech recognition, and adaptive learning algorithms are revolutionizing education to make it more accessible. Using case studies and real-world examples, the chapter illustrates how AI can personalize support for various learning needs, improving accessibility and breaking down barriers in education (Monika Singh et al., 2024).
- Abdulaziz S. Alsolami et.al (2025) examines the use of Artificial Intelligence (AI) in special education, that is, in the acquisition of academic skills in children with mild intellectual disability (ID) (Alsolami, 2025). The research aimed to determine that AI-based interventions had a considerable impact on academic ability among 9– 12-year-old students taking special education classes (Berninger et al., 2015). Substantial cognitive skill acquisition was witnessed in the experimental group versus the control group, and all effect sizes were in the range of moderate to large (Cnossen et al., 2008).
- Blagoj Kotevski et al. (2024) emphasizes the creation of a gesture-based, computer vision, and AI libraries contactless interactive game-based application for disabled children (Majdoub Bhiri et al., 2023). The application takes advantage of augmented reality (AR) and immersive technologies to interact with children by improving motor skills and educating them about the Macedonian Cyrillic alphabet. The application has been developed with the requirements of disabled children in mind and takes the form of color, sound, and animation to provide an interesting and fun learning process (Ade- Omowaye et al., 2024).
- L. Garcia and Y. Kim (2022) explored the application of Artificial Intelligence in personalized learning systems for students with disabilities in their study titled "Using AI for Personalized Learning: Impact on Students with Disabilities". Their findings indicated that AI-based platforms significantly enhanced educational outcomes by tailoring content delivery based on real-time performance metrics. The study highlighted the role of adaptive algorithms in adjusting difficulty levels, providing corrective feedback, and tracking individual progress. Importantly, the authors noted that personalization increased student engagement and reduced frustration, particularly for learners with dyslexia and attention-related impairments. The research emphasized the importance of combining intelligent feedback with gamified environments to sustain motivation and support self-paced learning.
- M. Harris and A. Sweeney (2019) examined the integration of gamification and adaptive learning in educational technologies designed for children with learning difficulties in their article "Gamification and Adaptive Learning in Education". The study found that gamified AI environments fostered higher retention rates and better cognitive responses among children with dysgraphia and attention disorders. The research

emphasized features like badge rewards, level progression, and avatar customization as critical motivational tools that helped students stay focused and complete learning tasks. They concluded that AI, when combined with gamification, not only personalizes learning but also transforms it into a more enjoyable and less intimidating experience for children with SLDs.

IV. COMPARISON WITH EXISTING SOLUTIONS/APPROACHES

TABLE I: COMPARATIVE ANALYSIS OF HANDWRITING LEARNING SOLUTIONS

Feature	Fun Writing Assistant	Traditional Methods	Other Digital Apps
User Engagement	Interactive UI, rewards, pop-ups, live feedback	Static worksheets	Varies; some use gamification
Customization	Word input, Alphabet Mode, letter selection	Fixed content	Some offer word entry, limited customization
Feedback	Instant, encouraging messages	Manual teacher feedback	Often assessment-based, not real-time
Progress Tracking	Tracks words, streaks, writing time, challenge %	No tracking	Basic stats, sometimes premium-only
Backend Integration	MongoDB + Express.js with API support	Not applicable	Present in some premium apps
Child-Friendly Design	Colorful, easy-to-use layout with large buttons	Paper-based, no interactivity	UI quality varies
Achievement System	First Word, Streaks, Alphabet Master	None	Rarely used or limited

This table provides a comparison between the Fun Writing Assistant, Traditional Methods, and Other Digital Apps based on key educational and technical features. The Fun Writing Assistant stands out for its high interactivity, real-time feedback, detailed progress tracking, and engaging achievement system, all supported by a modern backend. In contrast, traditional methods lack dynamic features, and other digital apps vary in quality and feature availability, often limiting key tools to premium versions.

V. RESEARCH METHODOLOGY

A. Research & Problem Identification

The research identifies key challenges faced by children with Specific Learning Disabilities (SLD) in writing, including difficulties with letter formation, letter spacing, and consistency of strokes. Existing assistive tools lack real-time AI-generated feedback, which is essential for helping these children improve their writing skills. This research proposes a touchscreen-based web application named Fun Writing Assistant, designed as an alternative to hardware-based solutions. The application is aimed at providing greater accessibility and flexibility, enabling children with SLD to receive instant feedback and guidance.

B. System Architecture & Design

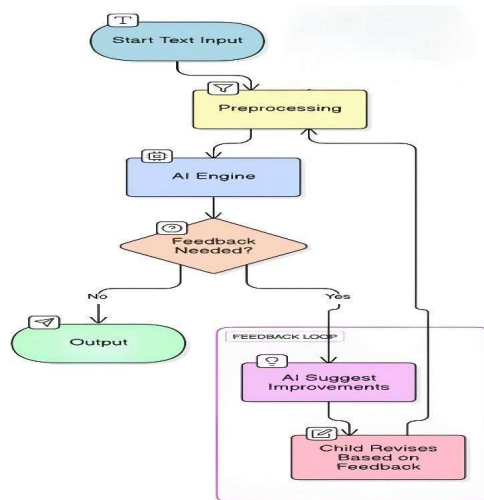


Fig 2: System Architecture & Design

The "Fun Writing Assistant" application uses a frontend built with HTML, CSS, and JavaScript for an interactive and user- friendly interface. The backend is powered by MongoDB for efficient data storage and retrieval, handling user progress, challenges, and feedback. The core AI model uses "tesseract- OCR" which involves Convolutional Neural Networks (CNN) for feature extraction and Long Short-Term Memory (LSTM) networks for sequence learning, implemented with TensorFlow and Keras. This enables real-time, personalized feedback on handwriting, such as letter formation and spacing.

Key features include:

- A touch screen pad with real-time feedback.
- Progress tracking, challenges, and personalized tips.

C. Data Collection & Preprocessing

The first step in the methodology involves gathering a diverse and comprehensive dataset that accurately reflects the writing patterns of children with various SLDs. The dataset consists of writing samples collected from educational institutions, including essays, sentences, and paragraphs written by children diagnosed with dyslexia, dysgraphia, and attention deficit disorder.

D. AI Model Selection

The model was pre-trained with fine-tuned hyperparameters that have achieved optimal performance, with accuracy and loss reduction being key evaluation metrics. The core AI Model used is "tesseract-OCR".

E. AI Feedback Mechanism

Fun Writing Assistant provides real-time AI feedback, focusing on letter formation accuracy and detecting errors in spacing, shape, and stroke pressure. The application also offers personalized suggestions to correct writing issues. To increase user engagement, gamification elements like badges and challenges are integrated, motivating children to practice and improve their handwriting.

F. Testing & Validation

Usability testing is conducted with children who have SLD to assess the application's effectiveness. Feedback from educators is gathered to refine the system, ensuring it meets the needs of its target users. Additionally, benchmarking for performance evaluates how well Fun Writing Assistant delivers real-time AI feedback and aids in improving writing skills.

VI. RESULT AND DISCUSSION

Results prove how powerful the " Fun Writing Assistant" adaptive writing AI-powered application is when it comes to offering real-time, adaptive comments, custom-made tips, and gamification options, adding zest to children's learning for the purpose of catering to special learning disabilities.



Fig 3: Interactive Writing Assistance Dashboard for Children

The image shows an interactive writing assistance interface designed for children with learning disabilities. On the left side, the child is prompted to write the word "Cat" within a designated area, with options to clear, check, or start a new word. The right side tracks the comparison history, displaying previous writing attempts and

showing the corrections made (before and after). This system provides real-Time feedback, allowing children to visually understand their mistakes and corrections, reinforcing learning and aiding in the development of writing skills.

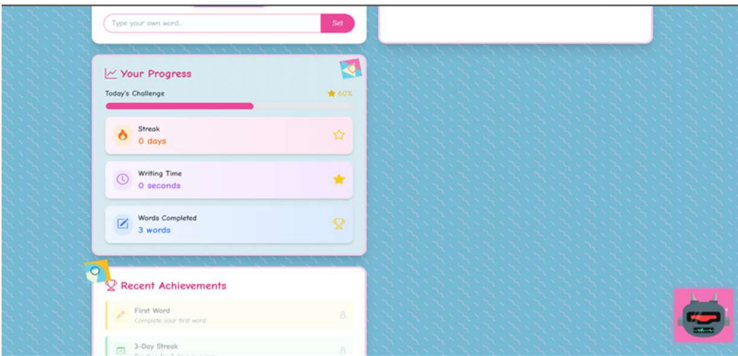


Fig 4: Progress Tracker for Writing Practice

The image depicts a user interface of an AI-powered assistive writing system aimed at helping children with learning disabilities. The dashboard displays key progress metrics, including today's challenge completion rate (60%), current streak (0 days), writing time (0 seconds), and the number of words completed (3). Additionally, it showcases recent achievements such as completing the first word and maintaining a 3-day streak. The design emphasizes gamification, motivating the child through visual progress indicators and achievements to encourage consistent engagement and improvement in writing skills.

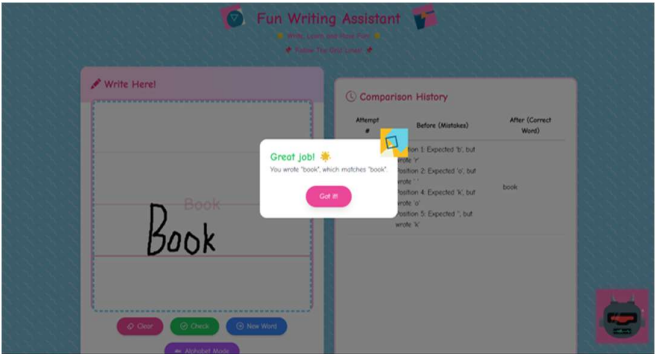


Fig 5. Writing Feedback in Fun Writing Assistant

This image captures the feedback moment in the Fun Writing Assistant after the user successfully writes the word "Book." The app offers positive reinforcement with a cheerful message saying “Great job!” and compliments the handwriting. This feature encourages young learners by acknowledging their effort and motivating them to continue practicing.

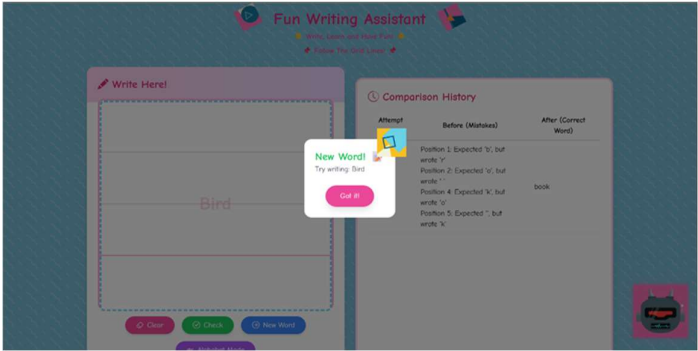


Fig 6. New Word Prompt in Fun Writing Assistant

This image shows the Fun Writing Assistant introducing a new challenge word, “Bird,” for the user to practice writing. A pop-up with the message “New Word!” encourages the learner to begin tracing the new word, keeping the learning experience dynamic and engaging. This feature helps maintain interest and supports vocabulary building through fun, interactive prompts.

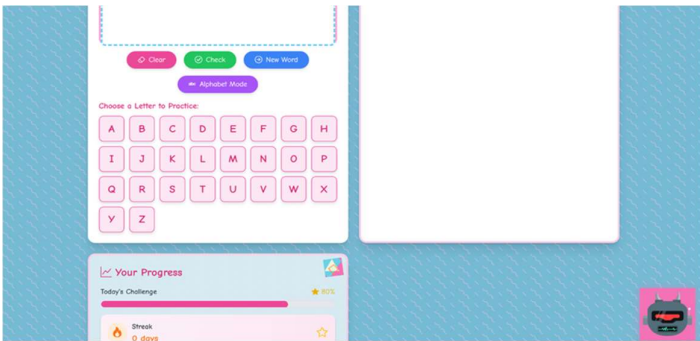


Fig 7. Alphabet Practice Mode in Fun Writing Assistant

This image presents the Alphabet Mode in the Fun Writing Assistant, where users can select individual letters to practice, enhancing their foundational handwriting skills. The interface displays clickable letter tiles from A to Z, allowing learners to focus on one letter at a time.

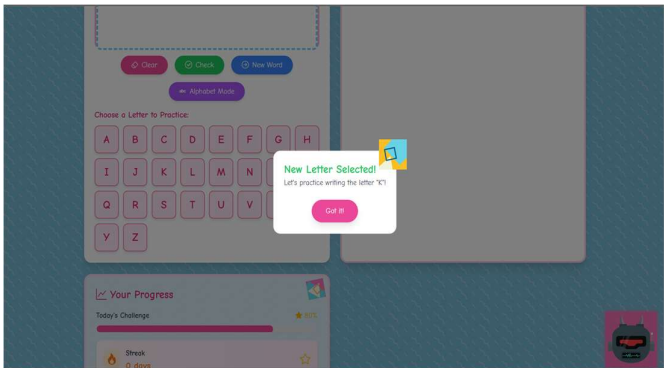


Fig 8. Letter Practice Prompt in Fun Writing Assistant

This image captures the moment a new letter, “K” is selected in Alphabet Mode within the Fun Writing Assistant. A friendly pop-up message says, “New Letter Selected!” and invites the user to practice writing the chosen letter. This interactive prompt guides learners through letter formation in a fun, supportive way that promotes confidence and mastery.

```
index.html  server.js  X
backend > # server.js
1 const express = require('express');
2 const path = require('path');
3 const mongoose = require('mongoose');
4 const cors = require('cors');
5 const progressRoutes = require('./routes/progress');
6 require('dotenv').config();
7
8 const app = express();
9
10 // Middleware
11 app.use(express.json());
12 app.use(cors());
13
14 // Serve static files (like HTML, CSS, JS) from the frontend folder
15 app.use(express.static(path.join(__dirname, '..', 'frontend')));
16
17 // API routes
18 app.use('/api/progress', progressRoutes);
19
20 // MongoDB Connection
21 mongoose.connect(process.env.MONGODB_URI, { useNewUrlParser: true, useUnifiedTopology: true })
22   .then(() => console.log('mongoose connected'))
23   .catch(err => console.error(err));
24
25 // Serve the index.html file when accessing the root URL
26 app.get('/', (req, res) => {
27   res.sendFile(path.join(__dirname, '..', 'frontend', 'index.html'));
28 });
29
30 const port = process.env.PORT || 5000;
31 app.listen(port, () => console.log(`Server running on port ${port}`));
32
```

Fig 9. Backend Code for Saving and Fetching Writing Progress

This image shows a JavaScript backend implementation using Express and Mongoose for a writing assistant application. It connects to a MongoDB database and defines a Progress schema with fields like userEmail, wordsCompleted, streakDays, and progressPercentage. The code includes two main API endpoints: one to save user progress via a POST request and another to retrieve progress data using a GET request with a user's email as a parameter.

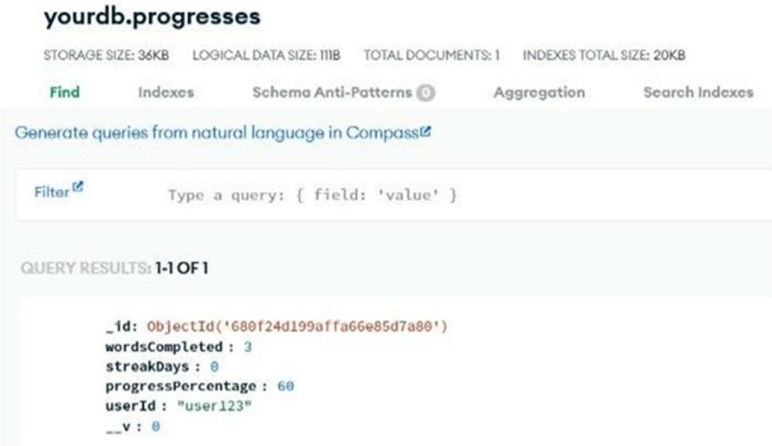


Fig 10. Database Query Results for User Progress Tracking

This image shows a query result from MongoDB Compass, where data about a user's progress in a specific activity or task is retrieved. The document presents key progress indicators for a user with the user ID "user123." The wordsCompleted field shows that the user has written 3 words, which reflects their current progress in the activity. The streakDays is 0, indicating that the user has not yet started a streak of consecutive days. The progressPercentage is 60%, which suggests that 60% of the task or challenge has been completed. The document's structure is consistent with tracking individual user progress in a database, providing essential data for performance tracking. The result shows one document corresponding to the user, identified by a unique object id.

VII. DISCUSSION

The Fun Writing Assistant application demonstrates significant potential in supporting children with learning disabilities, especially in developing writing skills. Through an intuitive interface and AI-powered adaptive feedback (Fig 3), the tool guides users in real time, helping them recognize and correct writing errors instantly. The integration of gamified elements—such as streaks, achievements, and challenge completions (Fig 4)—enhances motivation and engagement, transforming writing practice into an enjoyable learning experience. The system’s backend, built using Express and MongoDB (Fig 9), efficiently stores and manages user progress data. This enables personalized learning, as seen in Fig 10, where individual progress metrics like “words completed” and “streakDays” are tracked. Such data-driven insights allow the app to adapt to each learner’s pace and difficulties, ensuring a customized support system. Additional features, like alphabet practice mode (Figs 7 and 8) and positive reinforcement messages (Fig 5), make the learning environment encouraging and accessible. However, the app can be further improved by incorporating accessibility tools such as speech-to-text, dyslexia-friendly fonts, and multilingual support. Overall, the Fun Writing Assistant effectively combines AI, education, and gamification to create an inclusive and dynamic learning platform tailored for children with special learning needs.

VIII. CONCLUSION

The "Fun Writing Assistant" application represents a significant advancement in assistive technology for children with Specific Learning Disabilities (SLDs). By integrating artificial intelligence, real-time feedback, and gamification, the system provides a highly interactive and personalized learning experience tailored to the unique needs of each child. The application’s ability to track progress and provide instant feedback on areas such as letter formation, spacing addresses core challenges faced by children with writing disabilities. The inclusion

of features like streak tracking and reward systems helps maintain motivation, ensuring that children remain engaged in their learning process. The database management system, utilizing MongoDB, effectively stores and manages user data, making it easier to track performance over time. This data-driven approach allows for continuous refinement of the user experience and ensures that the application remains adaptable to the evolving needs of individual users. Although the application shows promising results, there is room for improvement, especially in expanding accessibility and enhancing AI-driven feedback mechanisms. Future developments should focus on optimizing the system's usability across various devices, improving its AI accuracy, and ensuring broader access for children from diverse socio-economic backgrounds. Overall, "Fun Writing Assistant" has the potential to revolutionize the educational experience for children with SLDs, offering an inclusive, engaging, and effective solution for overcoming writing difficulties and enhancing academic achievement.

LIMITATION

While the "Fun Writing Assistant" application shows significant promise in supporting children with Specific Learning Disabilities (SLDs), there are several limitations that need to be addressed to improve its effectiveness and accessibility. One major limitation is the reliance on technology, which can be a barrier in low-resource environments. Children in rural or economically disadvantaged areas may have limited access to the devices or stable internet connections required to fully benefit from the application. Additionally, the accuracy of the AI model depends on the quality of the data used to train it. The application might not always be able to accurately recognize handwriting variability, especially for children who struggle with unique forms of dysgraphia or have severe motor impairments. Although the system provides personalized feedback, it might not fully capture the complexities of each child's learning process, as writing challenges can vary greatly from one individual to another. Another limitation is the need for continuous personalization. While the app offers real-time feedback, it requires ongoing adjustments to stay relevant to each child's progress and challenges. This personalization may not always be seamless, and the application might need regular updates based on feedback from educators and caregivers to ensure that it stays effective.

FUTURE SCOPE

The "Fun Writing Assistant" AI-powered writing application has immense potential for further development and expansion, particularly in its ability to cater to a wider range of learning disabilities and educational contexts. Moving forward, the application could evolve with deeper AI algorithms that would aid in distinguish from speech recognition and emotion detection for an even more integrated learning experience. Not only could it personalize the feedback for children regarding their writing, the application could evaluate the emotional status of the child to provide support based off the emotional information available to it. Extending the application to be offline or in places of less access would seem to really close the digital divide and open access for children in impoverished or rural communities. Additionally, a wider array of learning modalities could be utilized to include interactive storytelling or adaptive quizzes that could generalize in-line with a focus on writing lessons to create a more integrated experience for children. Future updates of the application could also extend to longer language support writing systems for the application to be made accessible to multilingual learners. Occasional updates to the AI model that accompanies feedback on juvenile performance updates or updates on new educational approaches, will presumably take time to modify the adaptability to the variability in the writing styles of children and their pace to learning. Finally, considerations for human in conjunction with an AI support, established through integrated educator/therapist's feedback; might serve to even a greater opportunity to disrupt an educational ecosystem that supports equity and facilitates all children with SLDs the opportunity to grow into improved educational ecosystem.

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