iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: https://doi.org/10.22214/ijraset.2025.69474

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

EduCare: Assistive Technology for Children with Learning Disabilities

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Abstract: ***Traditional education systems often fall short in addressing the unique needs of children with learning disabilities such as Dyslexia, Dysgraphia, Autism Spectrum Disorder (ASD), and Cerebral Palsy (CP). These challenges are especially prominent among children aged 8 to 13, a critical period for foundational learning in literacy and numeracy. The absence of inclusive and personalized learning tools further widens the educational gap for these students. Assistive Technology (AT) has emerged as a powerful solution to support individualized instruction and promote better learning outcomes. This paper presents EduCare, an assistive learning system developed to teach English and Mathematics to children with learning disabilities. EduCare employs a multisensory approach—incorporating visual aids, auditory cues, and interactive activities—to introduce core concepts such as alphabets, words, sentences, and numbers. It also offers personalized evaluations and generates detailed progress reports for parents and teachers. By adapting to diverse learning styles, EduCare fosters greater engagement, comprehension, and supports inclusive education.***

Index Terms: Assistive Technology, Learning Disabilities, Dyslexia, Dysgraphia, Autism Spectrum Disorder (ASD), Cerebral Palsy (CP), EduCare, English and Mathematics Learning, Pictorial Learning, Customized Assessments, Adaptive Learning, Special Needs Education, Educational Technology.

I. INTRODUCTION

A Learning Disability (LD) is a neurological condition that affects an individual's ability to acquire, process, and retain information effectively. It describes a broad category of developmental disorders that can impact skills like reading, writing, math, and problem-solving, and can vary significantly in their effects from one person to another. [1] People diagnosed with learning disabilities exhibit lack of self-esteem, eagerness and anxiety as they are not able to mingle with the society. [2] Early identification of learning difficulties enables teachers to implement appropriate and focused interventions. Assistive technology refers to software systems that help individuals with disabilities perform tasks that might otherwise be difficult or impossible. It is an effective tool for promoting children's educational needs with specific learning disability (SLD), and the integration of technology helps children with learning disabilities to become more efficient learners. [4]

The integration of assistive technology in educational settings is not only a means of providing support but also a way to foster independence, increase engagement, and promote inclusivity in learning environments. Thus, the aim of this paper is to introduce an assistive technology platform for teaching English and Mathematics to children with learning disabilities by using multimodal techniques like images and sounds as well as assessing student progress and providing detailed feedback for parents and teachers. [4] [6]

II. LITERATURE REVIEW

A comprehensive background study has been conducted to explore the challenges faced by children with learning disabilities, focusing on the use of technological assistance to enhance learning and writing skills, as well as identifying specific usability issues associated with these technologies.

Ahmad Haiqal Abd Khalid et al. [1] conducted a systematic literature review using Kitchenham and PRISMA approaches, analyzing 28 primary studies from 1994 to 2021. The review provides a comprehensive overview of various assistive technologies and their applications, categorizing them by type, purpose, techniques, and delivery systems for different learning disabilities. Viner et al. [2] reviewed both low-tech and high-tech assistive devices, discussing the historical evolution of AT and its increased adoption due to the accessibility of computers and digital resources. They emphasized the necessity of teacher professional development for effective AT integration into contemporary learning environments.

Tony [3] examined teacher perspectives on AT effectiveness in supporting children with specific learning disabilities (SLD). The study analyzed six scholarly articles, finding AT beneficial for reading and writing comprehension but highlighting the need for enhanced professional training. Fernández-Batanero et al. [4] explored AT's role in fostering inclusive education, demonstrating its effectiveness in improving accessibility, engagement, and learning outcomes. However, they also identified key barriers such as inadequate teacher training and institutional support.

El Kah et al. [5] conducted an experimental study assessing the benefits of AT for students with dysgraphia and dyslexia. Their findings indicated that digital learning tools significantly improved students' writing, copying, and dictation tasks, enhancing both usability and task efficiency. Lynch et al. [6] reviewed the application of educational technology (EdTech) for learners with disabilities in low- and middle-income countries. While EdTech demonstrated potential in improving learning outcomes and fostering inclusion, the study highlighted challenges such as limited teacher training and resource constraints, necessitating contextually relevant interventions.

Senjam and Mannan [7] explored AT adoption in India, identifying a significant gap between high demand and limited availability. They cited challenges such as a lack of organized AT production systems, insufficient funding, and governance issues, advocating for increased awareness, local R&D initiatives, and international collaborations. Svensson et al. [8] investigated the impact of AT on students with reading and writing disabilities. Their study found that applications such as text-to-speech and speech-to-text significantly improved reading abilities, motivation, and overall engagement among students facing severe literacy difficulties.

AI-based AT solutions have gained prominence in recent years. Kaisar [9] proposed a methodology encompassing data collection, pre-processing, feature extraction, system training, and performance evaluation to enhance AT accuracy through diverse data sources and language-independent methods. Panjwani-Charania and Zhai [10] conducted a systematic review of AI applications for students with learning disabilities, identifying adaptive learning as the most prevalent AI application while emphasizing the need for further research beyond identification and diagnosis.

For Autism Spectrum Disorder (ASD), Syriopoulou-Delli and Gkiolnta [11] examined the use of socially assistive robotics (SARs) in training children with ASD. Their study found that SARs effectively improve social skills, communication, and reduce stereotypical behaviors, underscoring their potential in ASD interventions. Syriopoulou-Delli and Stefani [12] conducted a systematic review assessing AT's role in developing communication, social, and vocational skills for individuals with ASD. Their findings highlighted the effectiveness of mobile devices, software applications, and virtual/augmented reality environments in skill development.

Al-Hendawi et al. [13] explored AT interventions for individuals with ASD in Arab countries, concluding that AT enhances communication, social, and functional skills. However, they identified barriers such as caregiver uncertainty and low professional awareness, calling for more rigorous studies across diverse populations. Pergantis and Drigas [14] examined AT applications designed to detect, prevent, and alleviate stress and anxiety in children with ASD. They categorized AT solutions into low-tech and high-tech devices, identifying a significant research gap regarding real-world integration. Their study emphasized the importance of cost-effective and accessible AT solutions for managing ASD-related anxiety.

Iannone and Giansanti [15] analyzed the integration of artificial intelligence (AI) with AT for autism care. Their review found AI-driven wearable devices, such as smart glasses, to be effective in enhancing social skills and communication. They highlighted the potential of AI-AT integration for personalized ASD interventions while also emphasizing the need for further research to address existing challenges.

III. METHODOLOGY

A. *Initial Setup*

To systematically address our problem statement, we conducted a real-time survey at *Little Hearts School*, an NGO supporting children with learning disabilities. This visit offered direct insights into the learning processes followed, teaching methodologies adopted, and the assistive technologies currently in use. As part of this survey, we explored the effectiveness, limitations, and personalization of existing tools, their alignment with government-aided syllabi, and their support for holistic development—including cognitive, emotional, and social aspects. In parallel, we conducted a manual review of digital libraries such as Scopus, IEEE Xplore, Wiley, Springer, Taylor & Francis, and Emerald to collect relevant studies. The screening included only full-text, English-language papers, focusing on engineering and computer science applications in assistive technology. Studies not related to learning disabilities, addressing adult education, or focusing solely on physical impairments were excluded. Our target group consisted of children aged 8 to 13, and our approach combined firsthand observations with academic research to evaluate the accessibility, impact, and technological frameworks of assistive learning solutions.

B. Observational Study and Analysis

Our survey analyzed the learning processes of students with disabilities, identifying gaps in teaching methods and assistive technologies. The study assessed their effectiveness, alignment with curricula, and impact on learning outcomes, engagement, and independence. Additionally, we evaluated whether these tools support holistic development or are limited to academics, as well as their level of personalization and accessibility. The table below summarizes observations of children using assistive tools based on their disabilities:

Learning Disability	Curriculum	Key Improvements
Global Delay	English, Math, EVS	Reduced crying, completes tasks
Hearing Impairment	Pratham C	Body stability
Autism Spectrum Disorder	Pratham A	Cooperative, calm behavior
Developmental Delay	Sentence level, CVC words	Reduced crying, group participation
Mild ASD	Sentence level, CVC words	Patience, independence
Moderate ASD	Sentence level, CVC words	Writing skills, reduced escaping
Intellectual Disability	2-3 letter words	Increased interaction
CP-Cerebral Palsy	2 letter words, CVC words	Reduced crying, pinching
Seizures	Pratham B	Concentration, interest

Table I. Sample Dataset

This structured approach provided a comprehensive understanding of existing technologies and their role in enhancing learning experiences for children with disabilities.

C. Proposed System

Our proposed assistive learning system consists of two main components: Learning and Assessment. It employs a multisensory approach, integrating visual, auditory, and interactive elements to cater to diverse learning needs.

1) Learning Section: The Learning section is divided into three subsections: English, Mathematics, and Verbal Skills. In the English subsection, children are introduced to alphabets from A to Z in both uppercase and lowercase, with step-by-step writing guidance. Each letter is accompanied by phonetic pronunciation and pictorial associations to reinforce recognition and recall. The Mathematics subsection focuses on number identification and number names, using auditory cues and visual representations to enhance comprehension. The Verbal subsection builds on the English section by introducing vowels, two-letter, and three-letter words to establish a foundation for reading and spelling. Interactive sound-based exercises encourage pronunciation practice and vocabulary development, ensuring a personalized and engaging learning experience.

2) Assessment Section: The Assessment section evaluates learning outcomes through customized tests designed for each module. These assessments help identify strengths and areas requiring reinforcement while tracking individual progress over time. The system records and analyzes results to generate detailed feedback reports for parents and teachers, facilitating targeted support and intervention.

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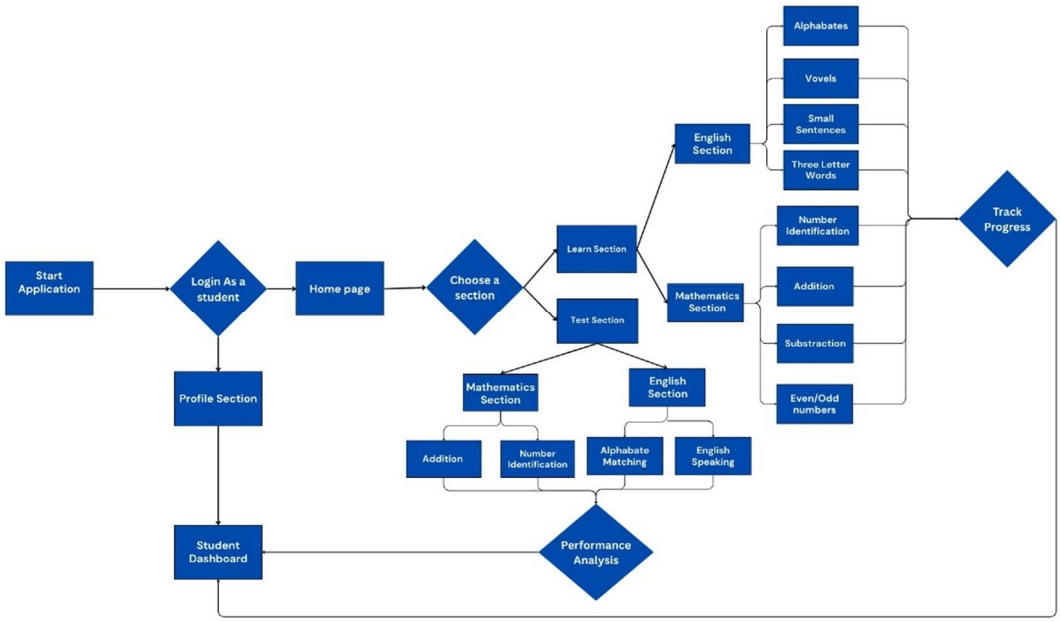

Figure I. Proposed System

By fostering continuous assessment and personalized feedback, our system ensures meaningful learning while supporting both academic and cognitive development. EduCare provides a holistic educational approach, balancing engagement and assessment to empower children with learning disabilities. By addressing individual needs through tailored teaching methods, it fosters both academic success and personal growth.

IV. EXPERIMENTATION

To evaluate the effectiveness of the proposed system, we designed a hypothetical experimental setup simulating real-world classroom conditions. This setup involves 50 children with diverse learning disabilities from Little Hearts School, divided equally into two groups of 25 students each. The control group follows the traditional teaching methods currently used at the NGO. These include standard verbal instructions, textbook-based learning, and occasional teacher-led interactive activities. In contrast, the experimental group uses the EduCare platform, which provides multisensory, interactive instruction using a blend of visual, auditory, and tactile learning techniques. The curriculum for both groups is standardized and aligned with the existing syllabus of the NGO, along with elements drawn from government-aided learning programs, namely Pratham A and B. This ensures consistency across both groups in terms of content, while the method of delivery remains the key differentiating factor.

Both groups are hypothetically observed over a fixed learning period, after which assessments tailored to their learning modules are administered. The assessments cover fundamental topics from English and Mathematics, such as alphabet recognition, phonetics, vocabulary, number identification, and basic arithmetic. For the experimental group, these tests are conducted digitally through the system's in-built evaluation feature, while the control group undergoes manual assessment. Post-assessment, data would be hypothetically analyzed based on individual and group performance. Key performance indicators include accuracy, task completion time, attention span, participation, and consistency in responses. In addition, qualitative feedback such as emotional responses (reduced frustration, increased interest) and behavioral changes (increased interaction, improved focus) are also considered.

V. CONCLUSION

Our system utilizes interactive, multisensory techniques to enhance the learning experience for students with special needs, fostering better engagement and comprehension. Its alignment with established curricula, including the NGO's syllabus and government-aided programs like Pratham A and B, ensures relevance and smooth integration into existing educational settings. Hypothetical testing suggests that EduCare has the potential to improve learning outcomes when compared to traditional teaching methods. Additionally, the system encourages collaboration between parents, teachers, and students by offering tailored assessments and constructive feedback. However, real-world implementation is necessary to validate its effectiveness and assess its scalability across diverse educational environments.

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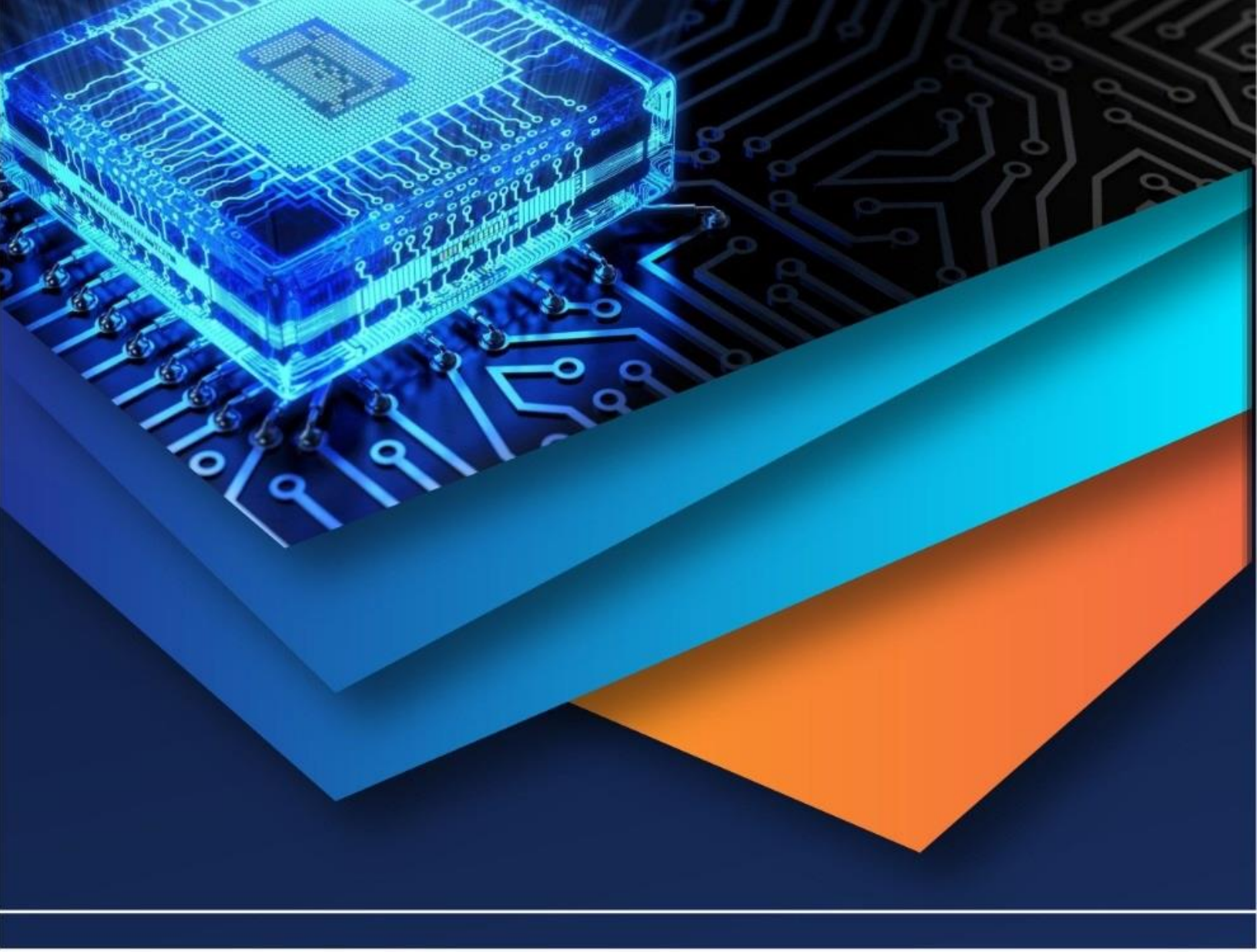

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