# EduLex: An AI-Driven Multimedia Learning Assistant for Dyslexic Students

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***Abstract*—Dyslexia is a neurodevelopmental learning disorder that primarily affects reading fluency, spelling accuracy, and phonological processing, influencing nearly 10–15% of learners worldwide. Conventional text-focused educational methods often fail to address the perceptual and cognitive challenges experienced by dyslexic students, which can negatively impact comprehension and engagement. This paper introduces *EduLex*, a deployable AI-driven multimedia learning assistant designed to support dyslexic learners through multimodal content generation.**

**EduLex converts textual learning prompts into accessible multimedia outputs, including concept-relevant images, synthesized speech narration, and visually optimized captions. Instead of relying on computationally expensive model training pipelines, the proposed system adopts a lightweight architecture that integrates transformer-based keyword extraction, fast diffusion-based image generation, low-latency text-to-speech synthesis, and rule-guided caption rendering using the OpenDyslexic font. The system is implemented as a modular web application using Python and Streamlit, enabling real-time interaction and ease of deployment in educational environments. Qualitative design-oriented analysis suggests potential improvements in readability, learner engagement, and accessibility, highlighting the suitability of optimized generative AI techniques for inclusive education.**

***Index Terms*—Dyslexia, Assistive Technology, Generative AI, Multimedia Learning, Inclusive Education**

## I. Introduction

Dyslexia is a common learning disorder characterized by persistent difficulties in accurate word recognition, spelling, and decoding, despite adequate intelligence and educational exposure. These challenges are often linked to deficits in phonological processing and visual perception, making traditional text-heavy instructional approaches less effective for dyslexic learners. As a result, students may experience increased mental effort, reduced motivation, and lower academic confidence.

There is strong evidence for both a neurological and genetic basis of dyslexia. Neurologically, brain imaging studies show abnormal brain activation in areas of the brain involved in phonological processing. Familial and twin studies show dyslexia is more common in those with a family history. These biological differences predate reading experiences and are not due to a student's lack of effort or to ineffective reading instruction. Early identification and intervention will help to reduce the adverse academic effects and the social and emotional outcomes of dyslexia in the classroom and beyond.

For much of the past, dyslexia was treated with explicit and systematic instruction in phonics,delivered in small group or individual interventions. Such instruction improves literacy in dyslexic individuals, but its delivery maybe resource-intensive and time-consuming and may not be feasible in classrooms with children with diverse learning profiles. As a result, current interventions are static and fail to adapt to the learning pace and profile of each pupil.

Various assistive technologies, including text-to-speech systems, specialized fonts, and digital reading aids, have been developed to support individuals with dyslexia. While these tools offer meaningful assistance, they frequently address only individual aspects of the learning process. Educational studies emphasize that learning outcomes can be significantly improved through multimodal instruction, where visual, auditory, and textual cues are combined to reinforce understanding.

Recent advancements in artificial intelligence have enabled the automated generation of rich multimedia content for educational applications. However, many AI-based learning systems depend on resource-intensive training procedures, limiting their practicality in real-world classroom settings. To overcome these limitations, this paper proposes EduLex, an efficient and modular multimedia learning assistant that leverages optimized generative AI techniques to support dyslexic learners in an accessible and deployable manner.

In this work, we present EduLex, a learning technology that uses AI to help dyslexic learners through individualized assessment, adaptive instruction and continuous feedback. Building on the literature on dyslexia and literacy acquisition, EduLex seeks to bring evidence-based interventions for dyslexia and literacy acquisition into a scalable digital technology. The proposal envisages integrating artificial intelligence with best practices in education to promote reading fluency, help motivate students and build inclusive environments for students with dyslexia.

## II. Related Work

A range of assistive learning tools have been proposed to address the challenges faced by dyslexic learners. Systems such as Dyslex-Re and DYS-I-CAN focus on improving reading accessibility through font adaptation and structured educational exercises. Mobile-based applications like ALEXZA employ text-to-speech synthesis and visual highlighting to aid reading comprehension. Other research efforts explore the use of augmented reality and multimedia-based learning environments to enhance learner engagement.

Although these approaches demonstrate positive outcomes, most are limited to single or dual learning modalities. Additionally, several recent research-driven systems utilize generative models that require extensive datasets and high computational resources, making them difficult to deploy at scale in educational institutions. EduLex distinguishes itself by emphasizing low-latency inference, practical deployment, and the integration of multiple learning modalities within a unified framework.

## III. Proposed System Architecture

EduLex is designed using a modular system architecture that supports real-time interaction and extensibility. The process begins with a user-provided textual prompt describing an educational concept. This input is processed by a semantic keyword extraction module based on transformer embeddings, which identifies contextually meaningful terms.

The extracted keywords are supplied to a fast diffusion-based image generation module that produces representative visual content. In parallel, the original text is converted into natural-sounding audio using a low-latency text-to-speech synthesis module to support phonological reinforcement. To enhance readability, a dedicated caption rendering component generates visually optimized captions using the OpenDyslexic font, soft background colors, and color-coded emphasis for commonly misinterpreted characters such as *b/d* and *p/q*.

All generated outputs are presented through an interactive Streamlit-based web interface. The modular design ensures scalability, flexibility, and data privacy by eliminating the need to store user-specific information.

## IV. Implementation Details

The system is implemented in Python due to its extensive ecosystem for machine learning and natural language processing. Transformer-based models are used for semantic keyword extraction, while pretrained fast diffusion models are used for image synthesis to avoid computationally expensive training procedures. Text-to-speech narration is implemented using pretrained low-latency TTS frameworks suitable for real-time educational applications.

Streamlit is utilized to develop the web-based interface, enabling seamless integration between frontend and backend components. The application dynamically displays generated images, audio narration, and caption visuals. EduLex is designed with efficiency considerations to support deployment on consumer-grade hardware commonly available in educational institutions.

## V. Evaluation and Observations

The evaluation of EduLex is based on a qualitative, design-oriented analysis aligned with educational usability principles. The system architecture and interface design are informed by established dyslexia-friendly guidelines, including the use of specialized typography, visual emphasis on commonly misread characters, and multimodal content presentation. These design choices are intended to improve readability, enhance learner engagement, and reduce cognitive load by reinforcing concepts through complementary visual and auditory cues.

From a system perspective, the modular pipeline and use of pretrained, low-latency models are designed to support responsive interaction in educational environments. While large-scale empirical user studies are beyond the scope of the current work, the proposed framework establishes a strong foundation for future experimental evaluation involving educators and dyslexic learners.

## VI. Conclusion

This paper presented EduLex, an AI-driven multimedia learning assistant developed to support dyslexic learners through the generation of integrated visual, auditory, and textual content. Using pretrained generative models and rule-based accessibility strategies, the proposed system achieves an effective balance between technical capability and real-world usability. EduLex illustrates how optimized generative AI approaches can be practically applied to promote inclusive education without relying on computationally intensive training pipelines.

## VII. Future Work

Future work may include adaptive personalization based on learner preferences, multilingual support, and the integration of augmented reality to create more immersive learning experiences. Large-scale empirical studies involving educators and students can further quantify learning outcomes and system effectiveness.

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