Design and Evaluation of a Generative Artificial Intelligence-Based Tool for Students with Learning Disabilities in Kenya

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Abstract

Students with learning disabilities (LDs) face significant challenges in key academic areas such as reading comprehension, cognitive organization, self-expression, mathematics, and handwriting. These difficulties increase their susceptibility to discrimination and mental health related issues. Although existing studies have primarily focused on AI's diagnostic capabilities, there is limited research examining how Generative AI can be utilized to produce measurable learning outcomes and enhance learning experiences for students with LDs. Moreover, GenAI is increasingly gaining prominence in educational settings. Therefore, the relationship between GenAI tools, LDs, and instructional methods needs to be further examined. This research aims to develop a comprehensive framework for helping design and implement tools specifically tailored to the unique needs of students with LDs. A prototype based on this framework will be implemented in selected educational settings to assess its effectiveness in improving learning outcomes and providing targeted support to students with LDs. The prototype will provide mobile phone integration to ensure scalability and enhance educational accessibility. The expected findings will contribute to the promotion of more inclusive learning environments for students with LDs.

Introduction

Although there are no specific statistical reports on LDs, USAID estimates that approximately 8.9M of the Kenyan population has disability (USAID 2023). LD is a neurodevelopmental disorder that impairs cognitive processes related to focus, communication, information retention, and processing speed (American Psychiatric Association 2013). Common conditions under the umbrella of LDs include dyslexia, dyscalculia, and dysgraphia, all of which hinder learning. Students with LDs often struggle with reading comprehension, writing, spelling, and mathematical reasoning and are often expected to meet the same academic standards as their peers without accommodations. LD students are among the most marginalized in educational settings and often face mental health challenges such as anxiety, low self-esteem, and negative self-image, which are compounded by poor academic performance (Valencia, Valencia, and Relita 2021). Unfortunately, Kenyan educational institutions provide limited accessibility and support for students with LDs, resulting in significant barriers to their academic achievement and overall well-being. This lack of support can be attributed to the scarcity of specialized tools, technologies and customized curricula, together with a limited understanding of the unique learning needs of these students (Nel and Grosser 2016).

Emerging research suggests that Generative AI (GenAI) could support personalized learning and reduce teacher workload (Dwivedi et al. 2021). Furthermore, GenAI tools can help individuals with LDs such as dyslexia review their coursework for spelling and grammatical errors, providing prompt feedback — an especially challenging task for students with dyslexia due to their reading difficulties (Botchu, Iyengar, and Botchu 2023). Similarly, GenAI tools, such as Journey and DALL-E, may be helpful for students with ADHD and dyspraxia who might find it difficult to digest detail-oriented materials without accompanying images (Grant 2017). However, empirical studies on the design, application, and impact of GenAI tools for students with LDs remain limited. In addition, GenAI is outpacing existing frameworks and institutional policies. UNESCO's latest guidelines for incorporating GenAI in education emphasize the urgent need for empirical studies to guide its efficient application in various learning environments, including those accommodating disabilities (UNESCO 2023). If alignment between learning needs, tools, and pedagogical practices is lacking, it becomes difficult to develop targeted and effective solutions (UK Department of Education 2024).

Research Objectives

My research aims to address these outstanding challenges through the design and evaluation of a framework for developing a GenAI-based prototype, which will be implemented in selected educational settings to support LDs. To achieve this aim, I have outlined three objectives:

1. Identify and analyze gaps in support and accessibility for students with LDs in Kenyan universities by reviewing current practices, policies, and available resources.
2. Develop a theoretical framework for the design and implementation of GenAI-based tools aimed at fostering inclusive education for students with LDs.

3. Design and validate a GenAI prototype to support students with learning disabilities (LDs) based on the theoretical framework, assessing its impact on learning outcomes and its effectiveness in providing support.

Current Progress: Identifying Gaps and Developing a Theoretical Framework

In the first phase of this research work, I conducted a systematic review to identify research gaps and the current state of research on GenAI for supporting LDs in educational settings. From the insights gained, I have proposed theoritical framework that could be used to guide the development of inclusive GenAI based tools for students with LDs. The proposed framework includes several key components. First, it emphasizes the importance of early identification of LDs, highlighting the potential of AI-powered tools to analyze learning patterns and behaviors for timely interventions (Zingoni, Taborri, and Calabrò 2024). Second, it integrates established educational theories, such as constructivism and experiential learning, to guide the development of AI-enabled educational systems that promote differentiated instruction, engagement, and collaboration. Third, the framework recognizes the vital role of teacher support and professional development, equipping educators to design effective AI-supported learning experiences while maintaining human connection in the classroom (Felix 2020). A learner-centered approach is advocated, shifting the focus from traditional teaching methods to empower students as active participants in their learning journey (Chuang 2021). In addition, the framework addresses the need for innovative adaptive assessment and evaluation methods, in addition to promoting student awareness of AI technologies (Dwivedi et al. 2021). Lastly, it underscores the importance of institutional and governmental policies to ensure the ethical and equitable integration of AI in education, aligned with global educational goals, and addressing concerns such as data privacy and algorithmic bias (UNESCO 2023). Through this comprehensive framework, the research aims to create a structured pathway to develop and implement GenAI-based tools that improve educational accessibility and foster inclusive learning environments for students with LDs.

Future Work: Developing a GenAI Prototype

The second phase of this study includes key steps to develop a prototype of a Generative AI tool for students with LDs. The initial design of the tool will be guided by insights gathered from the framework supporting inclusive learning. This approach ensures that the tool meets the unique needs of students with LDs. To develop the prototype, we will adopt the Design Science Research (DSR) methodology, which focuses on creating and evaluating innovative artifacts to address specific problems within their context (Johannesson et al. 2021). In such a way, user feedback will be actively sought during the development process to refine the tool's features and functionalities, promoting an iterative approach that enhances usability and effectiveness. Following development, the prototype will undergo evaluation in selected educational institutions that support students with LDs. This evaluation will assess the impact of the tool on learning outcomes and the overall educational experience for students with LDs, providing valuable data for further enhancements. Through these steps, the project aims to create a robust and adaptable tool that facilitates inclusive learning environments.

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