An Explorative Study on AI-driven Tools for Equitable, Accessible, and Quality Education of Visually Impaired Students in the Inclusive School

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Abstract

The 21st century has become the era of Artificial Intelligence (AI). The fast-growing trend of AI is influencing every aspect of human life. The emergence of AI in educational technology has the potential to bridge equity gaps in inclusive classrooms. This paper explores the transformative impact of AI-driven tools on the access, equity, and quality of education for visually impaired students in inclusive schools. The objectives of the research study were to review research literature regarding present difficulties faced by visually impaired students in inclusive classrooms; to explore and analyze the role of various AI-driven tools for equitable, accessible, and quality education; and to analyze the limitations, challenges, and ethical issues of using these tools. An explorative research methodology was used to gain insight into the research problem and identify solutions. Existing literature and case studies on accessibility challenges, the learning processes involving AI-driven tools, and the associated ethical concerns have been reviewed thoroughly.

The systematic review revealed that visually impaired students face significant accessibility difficulties regarding learning materials, and few schools have access to assistive devices such as screen readers and braille display monitors. Inadequate teacher training, social isolation, and traditional classroom layouts were identified as major hurdles to inclusive and equitable education. Furthermore, the researcher analyzed the role of various AI-driven tools—such as Braille Translation Software, Natural Language Processing (NLP) tools for personalized learning, AI-Powered Glasses, AI Voices, Be My Eyes, and ChatGPT—in enhancing learning experiences and mitigating navigation and learning challenges. However, these AI-driven tools require a high-quality data supply for continuous training and improvement. Additionally, high costs and insufficient training for both teachers and students currently hinder the rapid implementation of these technologies. While data privacy and ethical issues remain significant, they can be minimized by applying proper precautions during use.

Keywords

Visually impaired students, Inclusive education, AI-driven Tools, Access, Equity

Introduction

Education has become the fundamental right of every child. As per the Salamanca Statement and Framework for Action on Special Needs Education (1994), the right of every child to education is proclaimed in the Universal Declaration of Human Rights and was forcefully

reaffirmed by the World Declaration on Education for All. Education for All is a democratic and ethical approach towards the teaching-learning process, bringing all learners, including disabled and marginalized children, under one roof. Inclusive education allows all learners to learn together and participate in various activities in a joyful and encouraging environment. It provides equal opportunity to all learners regardless of their cognitive and psychomotor abilities.

The concept of inclusive education has been emphasized in the Indian Education System across various commissions and policies, including the Indian Education Commission (1964-66), and the National Policies on Education of 1968, 1986, and 2020. The Persons with Disabilities (Equal Opportunities, Protection of Rights, and Full Participation) Act, 1995, was implemented by the government of India to strengthen the provision of free education for children with disabilities up to the age of 18 years. It emphasized the need for the integration of children with special needs into mainstream educational settings.

According to the World Health Organization (WHO, 2021), an estimated 19 million children have visual impairments worldwide. In India, as per the 2011 Census, the majority of the disabled population is affected by visual impairment (48.55%), followed by movement disability (27.87%), mental disability (10.33%), speech disability (7.49%), and hearing impairment (5.76%). The NEP 2020 emphasizes the importance of including children with disabilities from early childhood education to higher education, with provisions for assistive devices and appropriate teaching and learning materials.

Artificial intelligence (AI) has brought revolutionary changes to the learning experiences of *Divyang* (disabled) children. AI enables computers and machines to simulate human learning, comprehension, problem-solving, decision-making, creativity, and autonomy. These tools hold immense potential to minimize equity gaps in inclusive classrooms for visually impaired learners. By enhancing accessibility, enabling personalized learning, and supporting educators, these technologies can transform the educational landscape. However, achieving true equity requires addressing barriers to adoption and ensuring ethical implementation.

AI has significantly transformed the educational field, particularly in enhancing the teaching and learning process for children with special needs. The journey of AI in education began in the 1960s , a time when researchers explored the potential of computers to enhance learning. Computer-based instruction (CBI) systems emerged, providing interactive learning experiences through programmed instruction. These early systems laid the groundwork for integrating AI in education by incorporating adaptive feedback and individualized instruction.

In the 1970s and 1980s, AI technologies such as Intelligent Tutoring Systems (ITS) began entering classrooms. ITS utilized AI algorithms to adapt learning materials and the pace of instruction based on individual performance. Another significant development was the use of Natural Language Processing (NLP) in language learning applications. NLP allowed students to interact with programs using natural language, improving skills in an immersive manner. Today, the evolution of AI in education is poised to minimize learning hurdles for visually impaired students in inclusive schools , potentially becoming a strong pillar for easy access and optimum equity in education.

Rationale

In terms of population, India is the second-largest country in the world , and the literacy rate is increasing with each census. Despite this, the fulfillment of the diverse needs of students remains unsatisfactory in the inclusive classrooms of Indian schools. AI offers a transformative opportunity to solve these problems. By harnessing the power of AI in an inclusive education system, pedagogy can be transformed for children with diverse needs. AI-driven tools can significantly improve the learning experience of visually impaired students by providing personalized assistance, increasing independence, and improving the accessibility of educational content. The researcher aims to explore the difficulties and barriers faced by visually impaired students and identify AI-driven tools that may overcome these challenges , ensuring equitable, accessible, and quality education.

Objectives

1. To review research literature about present difficulties faced by visually impaired students in inclusive schools.
2. To explore and analyze the role of various AI-driven tools for equitable, accessible, and quality education of visually-impaired students in inclusive schools.
3. To analyze the limitations, challenges, and ethical issues of using AI-driven tools for visually impaired students.

Research Methodology

In the present paper, the researcher used an explorative research methodology to gain insight into the research problem and identify solutions. According to L.R. Gay (1992), exploratory research is a preliminary type of research conducted to clarify and define the nature of a problem or to gain insights and familiarity with a topic. The researcher thoroughly reviewed existing literature and case studies regarding accessibility challenges, AI-driven tools for visually impaired learners, and the limitations and ethical concerns of using these tools. Recent reports from government organizations like NCERT, NCFTE 2009, policy papers, UNESCO, and WHO were also reviewed.

Findings and Discussion

Objective 1: Difficulties faced by visually impaired students in inclusive schools.

After an in-depth study of related literature and policies (such as NCF 2005, NEP 2020, NCFSE 2023), it is evident that visually impaired students in India and abroad often lack satisfactory infrastructure and classroom environments. Few schools are equipped with modern technologies that can assist these learners. The researcher has identified the following key difficulties:

- **Classroom Layout and Environment:** Traditional classroom layouts in India often lack the design required for inclusive education, posing navigation challenges. There is an urgent need to remodel schools and collaborate with architects to ensure new constructions follow inclusive building standards.
- **Inadequate Assistive Technology:** While assistive technologies like screen readers and Braille displays can transform education, their availability remains limited. Most schools rely on basic tools like voice recorders or white canes. Although AI tools can be costly, basic versions should be made available to government and private schools to ensure equitable learning.

- **Poor Teacher Training:** The training of pre-service and in-service teachers for inclusive setups is a critical issue. According to the NCFTE (2009), the majority of teacher education institutions are private organizations, and many fail to provide quality training. While SCERTs provide training at the state level, the quality is often compromised due to the high volume of teachers being trained simultaneously.

A Case Study of Poor In-service Teacher Training in Bihar

From 2023 onwards, the Education Department of Bihar has started in-service teacher training in mission mode. SCERT of Bihar is compelled to utilize freshers as resource persons to train secondary and senior secondary school teachers. These freshers possess only an M.Ed. qualification and lack significant experience or exposure to disabled students in inclusive setups. This often results in the exclusion of visually impaired students from key classroom activities such as group problem-solving and games.

- **Social Isolation and Peer Pressure:** *Divyang* children often face difficulties intermingling with peers, which can harm their emotional well-being and social integration. Visually impaired students may struggle with social cues like eye contact and body language. Negative interactions, such as bullying, can lead to isolation. Teachers must create a welcoming, joyful environment to foster friendship and buffer against peer pressure. Sensitization programs organized by administrators can help foster an inclusive culture.

Discussion on Objective 1: Studies by Joe Kachong'u Zangi and Penda Annie (2021), and Halima Tahiri (2023) corroborate these findings, highlighting challenges ranging from infrastructure to a lack of specialized teachers. Zelalem Temesgen (2018) identified environmental inaccessibility and inflexible financial guidelines as major hurdles. Furthermore, Susanne Kaluke et al. (2022) emphasized that social acceptance is crucial for academic performance and emotional well-being.

Objective 2: Role of AI-driven tools for equitable, accessible, and quality education.

Recent advancements in AI have led to innovative tools that address the challenges faced by visually impaired students effectively. While conventional tools like Braille are useful, they may not fully address dynamic technological needs. AI tools leverage machine learning, NLP, and computer vision to create personalized experiences.

- **Text-to-Speech (TTS) and Screen Readers:** Tools like NVDA and JAWS enable access to digital content. Microsoft Narrator and Apple's VoiceOver use AI to improve context awareness and reading accuracy.
- **Braille Translators:** Software like Duxbury DBT converts electronic text into Braille with minimal errors, which can then be printed using a Braille embosser.
- **Computer Vision (Object and Text Recognition):**

- o **Be My Eyes & Be My AI:** Originally connecting users to sighted volunteers, this tool now partners with OpenAI to offer "Be My AI," powered by GPT-4. It provides detailed descriptions of surroundings and images, offering an alternative to human volunteers. This fosters independence in accessing textbooks and navigation.
  - o **Seeing AI:** Developed by Microsoft, this free tool narrates the world, identifying classroom objects and describing images. It is noted for processing images faster than some alternatives.

- **Natural Language Processing (NLP):** NLP enables computers to understand human language. Voice assistants like Siri and Alexa allow visually impaired students to interact, ask questions, and receive instant feedback, aiding in content generation.
- **Haptic and Tactile Feedback:** AI-powered haptic devices simulate tactile sensations, helping students explore graphical content like maps. Tactile Pro Printers and 3D printers create learning aids that are easy to identify through touch.
- **AI-Powered Smart Glasses:** Devices like OrCam MyEye use AI to extract information from the visual world and audibly describe it to the wearer. This allows users to read documents, recognize friends, and navigate independently.

Discussion on Objective 2: It is clear that AI tools empower visually impaired students to access educational content independently. Instant conversion of text to speech reduces lag in accessing materials , and adaptive algorithms tailor content to individual learning styles.

Objective 3: Limitations, Challenges, and Ethical Issues.

While AI advancements provide new possibilities, they are not without drawbacks.

- **Technological Limitations:** AI tools require high-quality data. Biased or inadequate datasets can lead to inaccuracies in object recognition. Furthermore, many tools require consistent internet connectivity, which is not always available in remote areas.
- **Usability Challenges:** Complex interfaces can be difficult for visually impaired users to navigate without proper training. Frequent updates may disrupt functionality.
- **Implementation Challenges:**
  - o **Cost:** The expense of software licenses and hardware makes these technologies unaffordable for many institutions, particularly in developing countries.
  - o **Skill Gaps:** There is a significant gap in training among educators regarding how to effectively integrate these tools.
- **Ethical Issues (Data Privacy) :** AI tools collect user data to personalize experiences, raising privacy concerns for vulnerable populations. Unauthorized access or breaches could lead to exploitation.

Discussion on Objective 3: AI-driven tools rely on software applications that must be installed on devices to function. Tools like ChatGPT may record user interactions to train their models, making data privacy a critical issue. Excessive reliance on these tools may reduce learner autonomy; therefore, they should complement, not replace, essential skills like Braille literacy and mobility training.

Conclusion

In the 21st century, AI-driven tools offer immense promise for visually impaired learners in inclusive classrooms. Without sound knowledge and proper use of these technologies, bridging equity gaps for learners with disabilities remains difficult. Tools such as Braille Translation Software, NLP, AI-Powered Glasses, and applications like Be My Eyes and ChatGPT are significant assets. While these tools can ensure equitable and quality learning , they require high-quality data for improvement. High costs and poor training present temporary hurdles to implementation. By addressing limitations and ethical concerns, stakeholders can use AI-driven tools as a bridge toward accessible education rather than a barrier. Ultimately, these tools should be used as complementary resources rather than creating full dependency.

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