



AI-driven assistive technologies in inclusive education: benefits, challenges, and policy recommendations

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ABSTRACT

This research examines the transformative role of AI-powered screen readers, voice assistants, and Natural Language Processing (NLP) interfaces in promoting inclusive education for students with visual, physical, and cognitive disabilities. The novelty of this study lies in its integrated, multi-modal exploration of assistive AI technologies across a variety of disabilities and use cases, including original case analyses that demonstrate real-world application and impact. Results reveal that AI-driven interfaces significantly improve autonomy, academic engagement, and content accessibility. Additionally, the paper highlights limitations related to accuracy, infrastructure needs, educator readiness, and ethical concerns such as data privacy and algorithmic bias.

To address these challenges, the study proposes policy recommendations and practical strategies for equitable and responsible AI adoption in education, including targeted educator training, funding for inclusive infrastructure, and development of ethical and technical standards. By bridging theoretical analysis with applied insights, this paper offers a valuable contribution to the discourse on AI-driven inclusivity and serves as a foundation for future empirical validations and technical innovation.

1. Introduction

In recent years, the intersection of Artificial Intelligence (AI) and human-computer interaction has sparked considerable innovation [33], particularly in developing next-generation user interfaces (UIs) that prioritize accessibility and inclusivity. This emerging field holds immense potential for empowering individuals with disabilities [44] by offering intuitive, personalized, and adaptable solutions tailored to users' specific needs and preferences [22]. This is evident in the realm of accessible tourism, where pre-visit virtual reality (VR) experiences and smart devices (SDs) are being investigated for their contribution to enhancing accessibility for visitors with hearing loss, suggesting practical and emotional benefits [10]. These technologies can simulate environments, provide real-time information, and facilitate communication, thus overcoming traditional barriers in travel and exploration. Moving from tourism, these advancements have significant implications for education. In educational settings, similar VR experiences and smart device applications can be leveraged to create immersive and adaptable learning environments for students with diverse needs, particularly those with hearing impairments, by offering visual

aids, interactive content, and personalized communication tools, thereby fostering equitable learning experiences [37].

This paper presents an original contribution to the field by examining how AI-driven interfaces, namely screen readers, voice assistants, speech recognition tools, and natural language processing (NLP) systems can be integrated to support inclusive education. The study goes beyond descriptive reviews by combining a synthesis of current technologies with applied case analyses, comparisons, and critical ethical insights. In doing so, it bridges theoretical knowledge with practical implementation, highlighting both the benefits and limitations of AI applications in real classroom settings. Case studies involving students with visual, auditory, and cognitive disabilities demonstrate the tangible impact of AI-driven assistive tools on engagement, autonomy, and academic success.

While the promise of these technologies is considerable, their integration also presents technical and ethical challenges. Concerns include the accuracy of AI algorithms [20], the need for robust data privacy measures [23], disparities in technical infrastructure [47], and the varying levels of instructor preparedness to adopt these tools effectively. Addressing these issues requires a multidisciplinary approach that

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encompasses pedagogy, technology policy, accessibility legislation, and digital ethics.

By reviewing existing tools and exploring their implementation challenges, this study identifies critical gaps that must be addressed to realize the full potential of AI in inclusive education. It also provides policy recommendations aimed at improving accessibility standards, supporting educators, and mitigating ethical risks. Through this comprehensive and interdisciplinary approach, the paper contributes to current scholarship and offers a valuable roadmap for stakeholders including educators, policymakers, and technologists committed to advancing equitable educational opportunities. Fig. 1 provides a mind map summarizing the core components of AI-driven assistive technologies in inclusive education.

2. Transformative role of AI-Powered screen readers and voice assistants in inclusive education

Screen readers and voice assistants powered by AI have redefined access to the educational content for students with visual and physical impairments by providing dynamic, real-time interaction with digital materials [15]. Unlike conventional screen readers that rely on pre-programmed linear text-to-speech conversion, modern AI-driven systems offer adaptive speech modulation, contextual emphasis, and even predictive navigation of learning platforms [39]. These enhancements, often supported by NLP algorithms, allow students to interact with course materials using voice commands or touchless gestures, improving their autonomy and engagement.

The integration of AI-powered screen readers and voice assistants has ushered in a new era of inclusive education [13], particularly for students with visual impairments. As a first example, we consider the case of Jane, a high school student aspiring to become a computer scientist despite her visual impairment. Before the introduction of AI technologies, Jane faced significant barriers to accessing educational materials, relying heavily on braille versions and assistance from teachers and peers. However, with the integration of AI-powered tools, Jane's educational experience underwent a transformative shift. These tools provided her with seamless access to digital content, real-time text-to-speech conversion capabilities, and interactive learning functionalities. As a result, Jane experienced newfound independence, efficiency, and empowerment in her academic pursuits. This case underscores the potential of AI technologies to level the playing field in education, offering personalized and inclusive learning experiences for students with disabilities. Further research in this area can explore the broader implications of AI integration in educational settings and its

impact on fostering inclusive learning environments for diverse student populations. Fig. 2 presents a flowchart that facilitates understanding AI-Powered Assistive Technologies Process.

Compared to earlier generations of assistive technologies, AI-enhanced tools introduce a higher level of adaptability and responsiveness. Traditional screen readers struggle with dynamic web content or scientific notations, whereas AI-based systems can interpret complex layouts, identify context-specific keywords, and even summarize long passages. Voice assistants similarly outperform basic dictation tools by facilitating multi-turn interactions, reminders, scheduling, and instructional navigation [4]. Table 1 later in this section summarizes these comparative advantages alongside documented challenges.

In the future, AI-powered advancements will enable students with physical disabilities to interact with course content using spoken commands or gestures [1]. For instance, imagine a student with limited mobility due to a physical disability. Traditional methods of interacting with course materials, such as typing on a keyboard or using a mouse, may pose significant challenges. However, with the integration of AI technologies, this student can utilize voice commands or gestures to navigate through digital platforms, access educational materials, and engage with course content effectively [11]. By simply speaking commands or making specific gestures, the student can interact with learning materials, participate in virtual discussions, and complete assignments without the need for traditional input devices. This innovative approach not only enhances accessibility for students with physical disabilities but also promotes inclusivity and active engagement in the learning process.

Innovative advancements in AI-powered technologies are revolutionizing the educational landscape [9,26], particularly for students with physical disabilities. One significant application lies in the realm of gesture recognition and voice command interfaces [14], which offer tailored solutions to enhance accessibility and foster inclusive learning environments [49]. Through the integration of AI-driven gesture recognition systems, students can interact seamlessly with digital learning materials using intuitive hand gestures. For instance, simple gestures such as swiping or pinching enable navigation through textbooks, slideshows, and multimedia presentations, empowering students to control the pace and focus of their learning experience. Additionally, AI-enabled voice command interfaces facilitate active participation in virtual discussions and collaborative projects by allowing students to contribute ideas, ask questions, and engage with peers using natural language commands [21]. Moreover, these technologies extend to assignment completion, where students can dictate responses and manipulate multimedia elements through voice-enabled dictation and

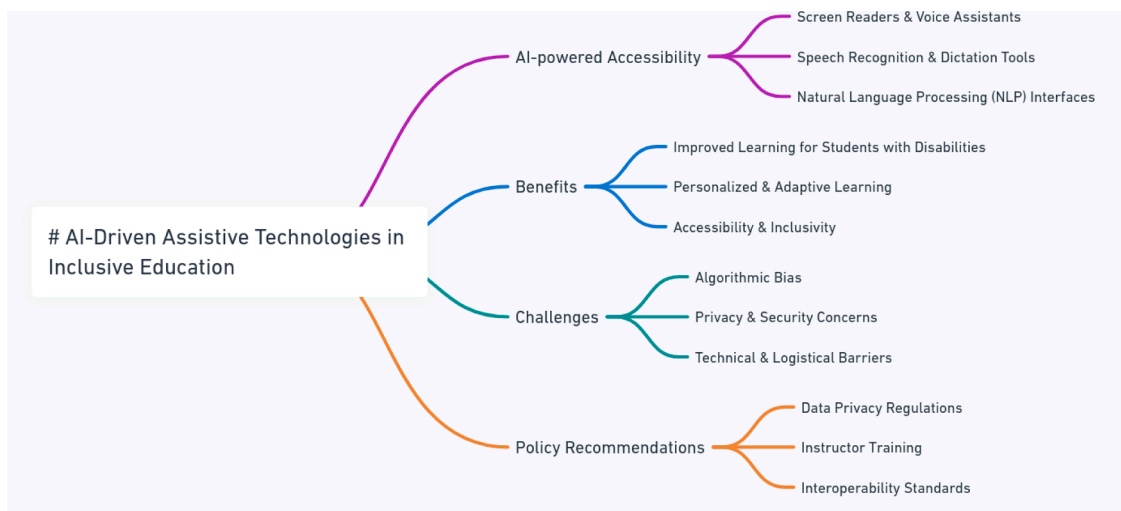


Fig. 1. Mind map of AI-driven assistive technologies in inclusive education.

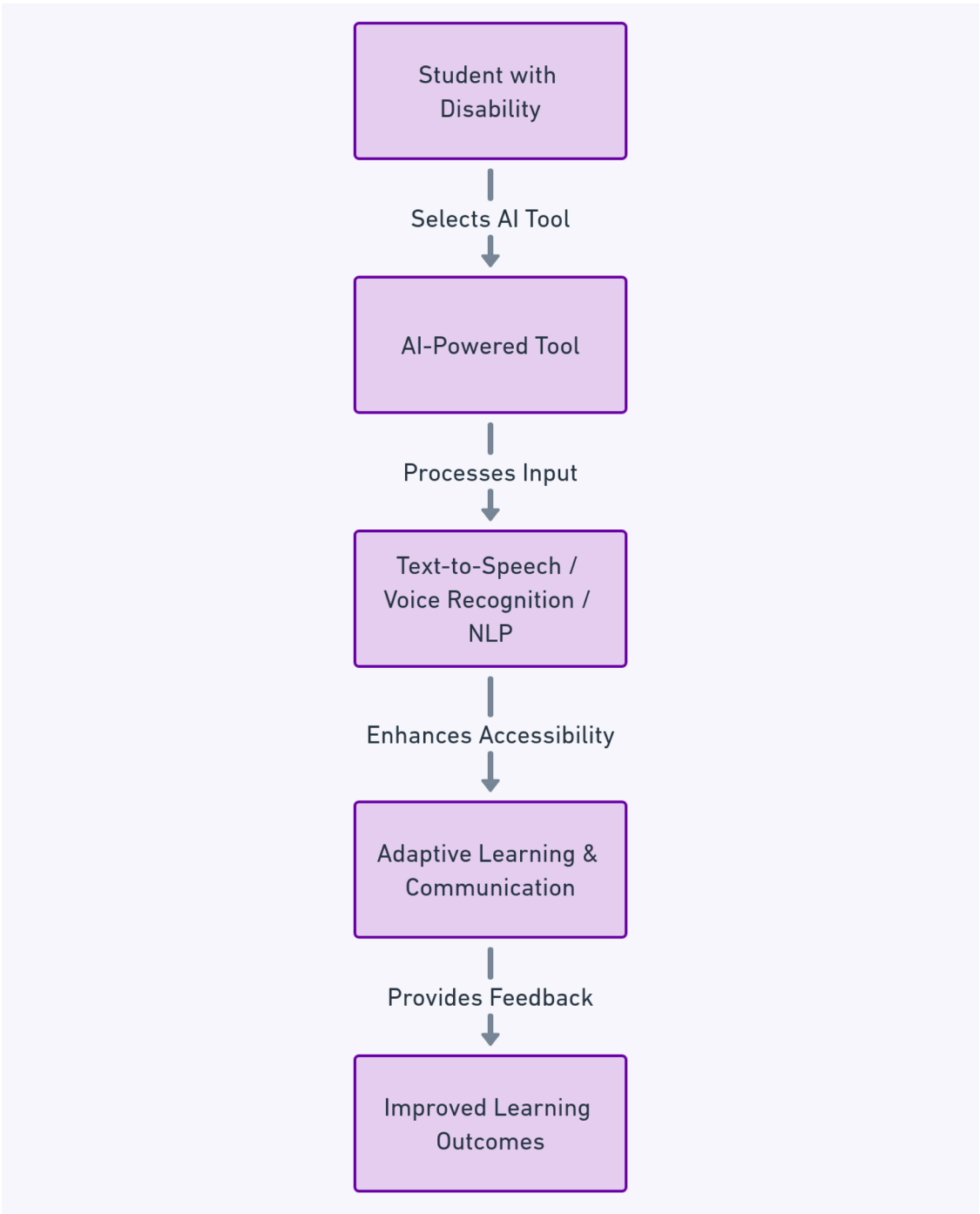


Fig. 2. Flowchart of AI-powered assistive technologies process.

Table 1
Comparison of AI-powered assistive technologies.

AI technology	Target users	Key benefits	Challenges	Example use case
Screen Readers	Visually impaired students	Converts text to speech or braille, enables digital navigation	Struggles with complex texts & multimedia	Jane, a high school student using AI-powered tools for digital textbooks
Voice Assistants	Students with mobility impairments	Hands-free learning, task organization, and communication	Accuracy issues with diverse speech patterns	AI assistant helping students organize study schedules

gesture-based input methods. By harnessing the capabilities of AI, educators can create inclusive learning environments where students with physical disabilities can participate fully in classroom activities, collaborate effectively with their peers, and achieve academic success.

Despite these benefits, successful implementation requires more than just deploying the technology. Robust technical infrastructure is essential, including compatible devices, stable internet connectivity, and cloud-based processing capabilities [20]. Without these, the benefits of

AI tools may remain inaccessible, particularly in underserved educational settings. Furthermore, educators must be trained not only in the basic operation of these tools but also in integrating them meaningfully into pedagogy. Many teachers may be unfamiliar with the affordances of AI-driven accessibility tools or hesitant to rely on technology they do not fully control. Institutional support and targeted professional development are thus critical enablers for effective use [47].

The adoption of screen readers and voice assistants powered by AI in educational settings presents significant advancements in promoting inclusive learning environments for students with visual impairments. However, several limitations of these tools warrant consideration. Firstly, while AI-driven screen readers and voice assistants offer seamless access to digital content and interactive learning materials, they may encounter challenges in accurately interpreting complex text or navigating through certain multimedia formats. For example, AI-driven screen readers may struggle to accurately read complex scientific textbooks with technical language or navigate through interactive multimedia presentations that require visual cues for comprehension. As a result, students with visual impairments may encounter barriers when accessing specialized or visually complex content, limiting their ability to fully engage with certain educational materials.

Secondly, the effectiveness of AI-powered tools in providing personalized support and assistance to students with visual impairments may vary depending on factors such as the quality of the AI algorithms and the comprehensiveness of the educational content. In some cases, students may encounter limitations in receiving tailored guidance or feedback, particularly in subjects that require nuanced understanding or interpretation.

Furthermore, the integration of AI technologies in educational settings may raise concerns related to data privacy and security [23]. As screen readers and voice assistants interact with sensitive educational information, such as student progress data and communication with instructors, ensuring robust data protection measures becomes paramount. Without adequate safeguards in place, students' privacy and confidentiality may be compromised, undermining trust in the use of AI-powered tools in educational contexts.

Lastly, the accessibility of AI-driven interfaces for students with visual impairments may be influenced by factors such as device compatibility, internet connectivity, and technical support infrastructure. In regions with limited access to technology or inadequate technical support services, students may face challenges in effectively utilizing AI-powered tools to support their learning needs.

In conclusion, as illustrated in Table 1, while AI-powered screen readers and voice assistants offer transformative benefits for students with visual and physical impairments, careful consideration of their limitations is essential to ensure equitable access to education for all learners. This section's contribution lies in demonstrating the nuanced benefits of screen readers and voice assistants through contextualized analysis and applied case insights. Rather than reviewing technology in the abstract, we explore how AI transforms daily academic interactions for students with disabilities and what systems must be in place to support that transformation. As visualized in Fig. 2 and summarized in Table 1, these tools, while powerful, must be matched by systemic readiness and professional commitment to achieve inclusive education at scale.

3. Empowering inclusive education through AI-driven speech recognition and dictation tools

AI-driven speech recognition and dictation tools have transformed learning environments for students with mobility impairments, auditory processing disorders, and motor challenges such as cerebral palsy or muscular dystrophy [32]. These tools allow students to bypass traditional input methods, using voice to interact with content, compose assignments, and navigate educational platforms. What sets current AI tools apart is their ability to adapt to individual speech patterns and

provide feedback in real time [38,42].

A practical example of this transformation is demonstrated through the case of Alex, a university student with auditory processing difficulties who struggled to keep pace during lectures due to delayed hearing comprehension and a slow writing speed. Before the integration of AI-powered solutions, Alex faced immense challenges capturing critical information, often resulting in incomplete or disorganized notes. However, with the adoption of real-time transcription technologies, Alex's learning experience underwent a radical shift. AI-powered tools allowed him to transcribe spoken content with high accuracy, highlight keywords, and summarize lecture material for review. These features significantly improved his academic performance and boosted his confidence. As highlighted in Fig. 3, this case underscores how AI tools can foster autonomy and reduce barriers for students with specific learning needs.

In contrast to earlier generations of dictation tools, current AI-based systems demonstrate far greater contextual intelligence. Legacy software often required formalized, rigid speech input, while modern tools now accommodate diverse sentence structures, background noise, and multi-accented speech. Yet, these advances are not absolute. As Jeon, Lee & Choe [19] note, accuracy continues to fluctuate depending on the acoustic environment and speaker profile, particularly for students with non-standard speech or regional accents.

AI-driven speech recognition and dictation tools represent a groundbreaking advancement in supporting students facing mobility impairments or conditions affecting fine motor skills. For instance, consider a student diagnosed with cerebral palsy, who previously required extended exam accommodations and human transcription assistance. With the integration of AI-based speech tools, the student now dictates responses directly into the system, experiencing greater independence and parity with peers. Such real-world applications highlight the potential of these technologies to reshape inclusion in assessment contexts [8,36,50].

While these tools offer immense promise, their effective deployment depends heavily on supporting infrastructure. AI-driven speech recognition typically requires high-performance microphones, compatible devices, and stable internet access, conditions that are not guaranteed in all schools [36]. Furthermore, educators must be adequately trained not just in how to use these tools, but in how to design inclusive pedagogical experiences that integrate them. As Díaz & Nussbaum [12]; Arfat et al., [3] highlight, many teachers feel unprepared or unsupported in this domain, making institutional training and technical support essential components of successful implementation.

These tools also empower students to become more autonomous learners. Dictation software with real-time feedback enables students to draft, edit, and revise their work independently. Note-taking tools, when paired with keyword tagging and summarization features, support active listening and self-paced review [35], enhancing overall engagement and academic ownership. This shift from dependency to independence not only improves academic outcomes but also fosters confidence and long-term self-efficacy in learning.

Nonetheless, these advantages must be weighed against persistent challenges. One key limitation is the reduced transcription accuracy in noisy environments or with students who have speech impairments. Even state-of-the-art tools can misinterpret voice input, leading to inaccurate notes or misunderstandings. Students with strong regional accents or atypical speech patterns may face systematic underperformance of these tools. In addition, the use of cloud-based AI services raises important concerns about privacy and data security [48]. Since sensitive audio data are often stored or processed externally, schools and institutions must implement strict data protection measures and ensure compliance with relevant legal and ethical standards [24, 30].

As summarized in Table 2, AI-powered speech and dictation tools vary in their features, accessibility benefits, and suitability for different disabilities. Their success depends not just on their technological design

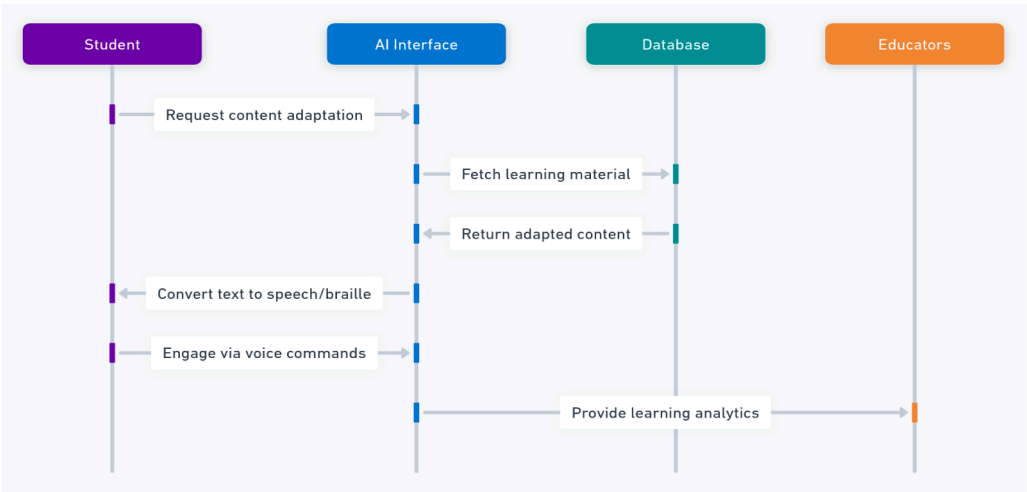


Fig. 3. Diagram of the interaction between students and AI-powered tools.

Table 2
AI-powered tools & their accessibility features.

Tool type	Accessibility features	Ideal for students with	Example
Speech Recognition	Converts speech to text in real-time	Mobility impairments, dysgraphia	AI-powered dictation software for note-taking
NLP Interfaces	Simplifies language, provides contextual definitions	Cognitive disabilities, language impairments	AI tutor for autistic students helping with text comprehension
Gesture-Based Systems	Enables navigation via gestures instead of a keyboard/mouse	Physical disabilities	Hands-free classroom interaction system

but also on the readiness of the educational ecosystem in which they are deployed.

In summary, this section highlights not only the technical capabilities of AI speech tools but also the ecosystem needed for their success. It shows that student empowerment comes from more than just technology, it relies on infrastructure, training, and the ethical use of sensitive data. This contribution bridges practical implementation with academic inquiry, offering insights into how to scale AI tools responsibly in inclusive educational settings.

4. Enhancing communication and learning: AI-driven NLP interfaces for individuals with language and cognitive disabilities

Natural language processing (NLP) interfaces powered by AI are redefining communication and comprehension for students with language or cognitive disabilities [7,40]. These tools do more than convert or translate text, they analyze user input, adapt to skill level, and generate real-time, context-specific support. This section explores how NLP interfaces address learning challenges through simplification, interpretation, and personalization, especially for students with Autism Spectrum Disorder (ASD) and other cognitive processing conditions [2, 18].

Compared to traditional support methods such as teacher aides, static glossaries, or reading guides; AI-powered NLP tools provide dynamic, individualized feedback. They adapt not only to what a student reads or writes, but how they process and respond, offering scaffolding that evolves in real time [5,45]. This adaptability allows for greater inclusion without constant adult mediation, bridging the gap between generalized accommodations and personal learning needs.

Students with ASD often struggle to express their thoughts or interpret complex content. NLP tools support these learners by breaking down dense text, offering guided prompts during writing, and providing immediate corrections and structure. For instance, a student drafting a story may receive real-time suggestions on phrasing and grammar, while

also being prompted to expand ideas. The same tool might describe diagrams aloud, translate a student’s sketch into narrative text, or generate image-based learning aids. These interactions empower students to communicate confidently, while reducing dependence on teacher intervention [17,41,46].

These AI tools not only help students complete tasks but also foster autonomy and engagement. When learners receive instant feedback, they gain confidence to revise and experiment. NLP systems that summarize passages or explain difficult words help students take control of their own learning pace. According to Kuhlmann et al. [29], tools that encourage active processing increase both motivation and retention two key components of sustained academic engagement.

Despite these benefits, NLP interfaces are not without limitations. Their accuracy and reliability vary depending on the complexity of the language input or the learner’s writing style. Feedback may sometimes oversimplify nuanced content or misinterpret informal language, leading to confusion. Additionally, AI interpretation of visual materials such as drawings, charts, or diagrams can be inconsistent, especially when inputs deviate from expected formats [41]. Students may receive irrelevant explanations that reduce, rather than enhance, their understanding.

Students also vary in their ability to use these tools effectively. Some, particularly those with ASD, may require initial support and training to engage with NLP applications. Without guidance or proper interface design, students may feel overwhelmed or confused, delaying the positive impact of the technology. Beyond usability, ethical concerns related to privacy and personalization remain significant. NLP systems often collect and process sensitive cognitive and behavioral data, which raises concerns about how that information is stored and shared. Educational institutions must implement strict safeguards to protect student privacy and ensure compliance with data protection regulations [23,25].

This section contributes by linking NLP technologies directly to specific learning disabilities, offering practical illustrations of their benefits and boundaries. It advances the dialogue by positioning NLP as both an accessibility tool and a driver of learner independence.

Ultimately, it reinforces that inclusive education is not only about access but also about empowerment and NLP tools, when implemented responsibly, can play a vital role in achieving both.

5. Ethical and technical considerations in implementing AI-powered NLP interfaces in educational settings

The integration of AI-powered Natural Language Processing (NLP) interfaces in education raises a series of ethical, technical, and infrastructural considerations that must be addressed to ensure equitable and responsible use. While these tools offer unprecedented support for students with cognitive or language disabilities, their implementation also presents risks related to algorithmic bias, data security, uneven access, and teacher readiness [6,23]. Addressing these risks is essential to ensure that AI enhances—not hinders—inclusion.

One of the most pressing ethical concerns is algorithmic bias. NLP models are typically trained on large text corpora that may not reflect linguistic diversity, including dialects, regional expressions, or speech patterns common among students with disabilities. As Guo et al. [16] and Lyerly [31] observe, these biases can marginalize students whose language usage does not conform to dominant norms, leading to misinterpretation, unfair grading, or inappropriate feedback. For example, an NLP interface may incorrectly flag a student’s response as incomplete or grammatically incorrect due to non-standard sentence structure undermining the learner’s confidence and skewing assessment outcomes.

Data privacy and security pose another significant challenge. NLP interfaces often collect and process highly sensitive information, including a student’s writing patterns, emotional tone, or cognitive responses. Without stringent data protection policies, this information may be exposed to misuse or breaches. As Kooli & Al Muftah [25] emphasize, institutions must adopt clear governance structures around consent, data storage, anonymization, and compliance with national and international privacy regulations. This is particularly important when cloud-based platforms or third-party AI vendors are involved.

Equally critical is the technical infrastructure needed to support AI deployment in classrooms. Many NLP systems rely on constant internet connectivity, high-performing devices, and cloud-based processing. In low-resource schools, especially in rural or underserved areas, these conditions are often unmet, leading to exclusion rather than inclusion [43]. Lack of bandwidth or incompatible hardware can cause lag, limited functionality, or failure to access the tools altogether. A recent study conducted by Messeni Petruzzelli et al., [34] identifies key factors contributing to innovation failures. Their findings specifically reveal how certain product features, such as its risk class, implantable nature, and the year of its application, can significantly affect the likelihood of product recalls, thereby acting as determinants of innovation failure. To mitigate our observed risks, institutions must invest not only in physical infrastructure but also in long-term maintenance and technical support systems.

Beyond hardware, the skills and readiness of educators play a defining role in the success of AI implementation. Teachers must understand how to use NLP tools not just technically, but pedagogically. This includes integrating them meaningfully into lesson planning, guiding students through use, and interpreting AI-generated feedback responsibly. Training must also prepare educators to identify when AI is misfiring or when student needs extend beyond what automation can offer [12]. Without this foundational knowledge, educators may resist adoption or use the tools ineffectively.

Issues of equity further complicate the landscape. Even within well-resourced schools, disparities may emerge between students with disabilities and their peers. Students who are not provided with AI-based supports may struggle to keep up, while others may receive poorly tailored or inaccessible tools. Moreover, some instructors may be hesitant to provide differentiated access, citing concerns about fairness or over-reliance on technology. These tensions underscore the need for

institution-wide policies that promote universal design and ensure accommodations are both available and effective.

A more nuanced ethical issue involves the recording and use of student inputs in NLP systems. These tools often learn from repeated student interaction, which introduces ethical concerns about consent and surveillance. While adaptive learning is a benefit, it may also amount to constant behavioral monitoring, especially if students are unaware of how their data is being used. Educational institutions must therefore be transparent about data collection purposes and offer opt-in frameworks that respect learner agency.

Interoperability with existing learning platforms presents a final but frequently overlooked barrier. NLP tools must be compatible with institutional Learning Management Systems (LMS), accessible formats (e.g., screen readers, alternative input devices), and other assistive technologies. Failure to integrate these systems seamlessly can lead to duplication, confusion, or abandonment of the tools altogether. As shown in Table 3, effective implementation requires alignment between technical, ethical, and pedagogical domains.

While AI-driven assistive technologies significantly enhance autonomy and accessibility for students with disabilities, caution must be exercised regarding over-reliance, particularly in light of emerging behavioral concerns such as Generative AI Addiction Syndrome (GAID) [27]. Unlike traditional technological dependence, GAID involves compulsive, co-creative engagement with AI systems that can lead to cognitive, emotional, and social impairments. This behavioral addiction blurs the line between productive use and compulsive engagement, risking diminished critical thinking, impaired creative independence, and social withdrawal. Furthermore, challenges related to AI accuracy, data privacy, and ethical use exacerbate these risks. To responsibly harness AI’s benefits in inclusive education, it is crucial to balance AI use with human interaction, provide targeted educator training, develop ethical guidelines, and implement safeguards such as usage monitoring and digital literacy programs that raise awareness of GAID and promote mindful AI engagement [27].

This section contributes to the literature by showing that ethical and technical barriers are not peripheral; they are central to the success of AI in inclusive education. It emphasizes that infrastructure and educator skills are as important as the tools themselves. Moving forward, future research should examine longitudinal outcomes of AI-based inclusion programs, investigate student perceptions and agency, and explore cross-national policy frameworks that support ethical AI at scale.

By framing AI integration as a systemic challenge requiring

Table 3
Challenges vs. policy recommendations for AI in education.

Challenge	Description	Policy Recommendation
Algorithmic Bias	AI may misinterpret dialects or disability-specific language patterns	Train models on diverse, inclusive linguistic datasets
Data Privacy & Security	AI tools process sensitive learning and behavioral data	Enforce strict privacy laws and platform-level data governance
Technical Barriers	Schools may lack compatible devices or high-speed internet	Invest in equitable infrastructure and maintenance support
Instructor Training Gaps	Teachers may be unprepared to use or explain NLP tools	Mandate AI literacy and usage-focused professional development
Equity of Access	Impaired students may receive inadequate or inconsistent support	Implement system-wide UDL (Universal Design for Learning) policies
Integration Issues	AI tools may not sync with LMS or assistive platforms	Promote interoperability standards and institutional coordination
AI Dependency & GAID Risk	Overuse of generative AI tools can impair critical thinking and social skills	Integrate digital well-being safeguards; raise awareness of GAID through AI literacy programs and ethical design standards

collaboration across educators, technologists, policymakers, and students; this section builds a roadmap for inclusive, ethical, and sustainable implementation.

6. Policy recommendations for equitable implementation of AI-Powered assistive technologies in inclusive education

To realize the full potential of AI-powered assistive technologies in inclusive education, policy frameworks must evolve to meet ethical, infrastructural, and pedagogical challenges identified throughout this study. The following recommendations offer a multi-stakeholder roadmap addressing the needs of policymakers, educators, technologists, and institutional leaders.

6.1. For policymakers and educational authorities

Policymakers must lead the way in promoting equitable access to AI-enabled educational tools by enacting regulations and funding mechanisms that address digital divides. Government bodies should prioritize investments in reliable internet infrastructure, modern hardware, and inclusive educational software in underserved schools. Public procurement policies should require vendors of AI tools to meet minimum accessibility, privacy, and interoperability standards.

Legislation should also mandate regular audits of AI-powered educational technologies to assess bias, accuracy, and effectiveness across diverse student populations. Data governance frameworks must be enforced to ensure that student data are stored securely, processed ethically, and not used for commercial profiling. Furthermore, national education strategies should embed AI literacy not only for students but for teachers and administrators as well.

6.2. For educational institutions

School boards, universities, and training colleges must ensure that AI tools are not introduced as isolated technologies but as integrated components of inclusive pedagogy. Institutions should develop local AI implementation strategies that include teacher training, digital accessibility assessments, and ethical oversight committees.

Professional development programs should be redesigned to include hands-on training for educators on using speech recognition, screen readers, and NLP tools effectively in the classroom. These programs should also build educators' capacity to evaluate AI feedback critically, identify system limitations, and adapt instructional approaches based on student interaction with AI systems.

Moreover, institutions should adopt a Universal Design for Learning (UDL) approach to ensure that AI tools are not reserved for a subset of learners, but embedded into everyday teaching and learning activities in ways that benefit all students.

6.3. For AI developers and edtech providers

Technology providers must prioritize inclusive design from the earliest stages of development. This includes engaging users with disabilities in co-design processes, testing algorithms on diverse data sets, and ensuring that user interfaces meet international accessibility standards (e.g., WCAG 2.1). NLP models must be continuously updated to accommodate regional language variations, speech impairments, and non-traditional communication styles.

Ethical-by-design principles should guide product development, especially in areas involving adaptive learning and behavioral tracking. Clear user consent mechanisms, transparent data usage disclosures, and parental or institutional control options should be built into the platform architecture.

To support seamless classroom adoption, AI developers should also focus on integrating their tools with existing Learning Management Systems (LMS) and assistive technologies already in use, avoiding

redundant or siloed solutions.

6.4. Advancing AI for human advantage in inclusive education

To ensure AI-powered tools promote human flourishing, their deployment must enhance not replace educators' roles, student agency, and the social dimensions of learning. AI should be viewed as an assistive partner, one that offers scaffolding, personalized guidance, and access, but leaves critical thinking, creativity, and empathy to the human actors in education.

Furthermore, the advantages of AI in inclusive education, such as increased autonomy, engagement, and equity, must be documented through continuous empirical research. Pilot programs and long-term impact evaluations should be encouraged to identify best practices and mitigate risks.

6.5. Looking ahead: a research and policy agenda

Future research should explore the longitudinal effects of AI-powered learning on students with disabilities, including outcomes related to academic achievement, psychological well-being, and digital literacy. Comparative studies across socio-economic and cultural contexts are also needed to ensure that inclusivity is achieved globally, not only in well-resourced systems.

Policy-wise, international collaboration is essential to develop harmonized standards for ethical AI in education, drawing on models from both the Global North and South. As AI capabilities evolve, so too must regulatory and pedagogical frameworks, ensuring that education remains inclusive, ethical, and human-centered, particularly through approaches like human-centered design and participatory development [28].

This paper contributes to the growing body of work on inclusive AI by combining a conceptual framework with real-world examples and actionable strategies. It underscores that effective implementation of AI in education demands more than innovation, it requires vision, responsibility, and collaboration. By centering the needs of students with disabilities, we can ensure that AI becomes a tool for empowerment, not exclusion.

7. Conclusion

This paper explored the transformative potential of AI-powered assistive technologies, specifically screen readers, voice assistants, speech recognition systems, and natural language processing (NLP) interfaces, in advancing inclusive education for students with visual, physical, and cognitive disabilities. By combining conceptual analysis with illustrative case studies and policy reflections, the study offered a multidimensional understanding of how AI tools can remove access barriers, support personalized learning, and enhance academic engagement.

The novelty of this research lies in its holistic perspective: rather than evaluating these technologies in isolation, it examines how they intersect with pedagogical practices, institutional readiness, and ethical constraints. Through contextualized examples and comparisons, the study demonstrates how AI tools are not only technologically advanced but pedagogically meaningful, promoting autonomy, equity, and participation among learners with diverse needs.

Despite their promise, AI-powered tools are not without limitations. Algorithmic bias, infrastructural inequities, and inadequate educator preparation continue to hinder equitable deployment. Moreover, the ethical use of student data, especially in adaptive learning systems, demands urgent attention. These concerns underscore that technology alone cannot ensure inclusion; human-centered policies and thoughtful implementation are essential.

Looking ahead, this paper identifies several key directions for future research and policy development. Longitudinal studies are needed to evaluate the sustained impact of AI on student learning, well-being, and

digital literacy. Researchers should investigate how these tools perform across different socio-economic and cultural contexts to avoid replicating systemic disparities. At the same time, policymakers and educational leaders must work collaboratively to establish inclusive design standards, teacher training mandates, and regulatory safeguards that guide the ethical adoption of AI in learning environments. Based on the analysis, the groundwork for future research should prioritize several key areas to build upon the findings of this paper. Future work ought to focus on conducting longitudinal studies to assess the sustained impact of AI technologies on the academic achievement, digital literacy, and psychological well-being of students with disabilities. It is also crucial for researchers to conduct comparative studies across various socio-economic and cultural contexts to ensure that AI-driven inclusivity is achieved globally and does not merely benefit well-resourced systems. Such research should also investigate student perceptions and agency in using these tools to ensure the technology is truly empowering. Finally, a significant line of inquiry should be the exploration of cross-national policy frameworks to help develop harmonized standards for the ethical and scalable implementation of AI in education globally.

In conclusion, AI-driven assistive technologies hold enormous promise to advance inclusive education, but only if they are implemented with care, equity, and strategic foresight. By centering students with disabilities in the design, deployment, and evaluation of these tools, we can ensure that AI serves not just as a digital innovation, but as a catalyst for human empowerment and social justice in education.

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CRediT authorship contribution statement

Chokri Kooli: Writing – review & editing. **Rim Chakraoui:** Conceptualization, Validation, Writing – review & editing.

Declaration of competing interest

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Data availability

No data was used for the research described in the article.

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