
FROM ASSISTIVE TECH TO AI: THE NEXT FRONTIER IN INCLUSIVE EDUCATION

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KEY WORDS	ABSTRACT
Inclusive Education, Artificial Intelligence, Assistive Technology, Adaptive Learning.	Inclusive education seeks to certify that all learners irrespective of their cognitive, physical, or sensory alterations have equitable access to meaningful learning experiences and the support necessary to participate fully in the educational process. Traditional assistive technologies, such as screen readers, text-to-speech applications, and augmentative communication devices, have significantly supported students with disabilities. These tools have played a crucial role in facilitating accessibility and independence in learning environments. However, with advancements in Artificial Intelligence (AI), a new paradigm of personalized and adaptive learning experiences has emerged. AI-powered tools, including machine learning algorithms, virtual assistants, and real-time speech recognition, are transforming the educational landscape by offering individualized support, enhancing engagement, and predicting learning needs. Through data-driven insights, AI has the potential to provide customized learning materials, screen student progress, and adjust instructional strategies in real time, thus fostering an inclusive and responsive educational environment. This paper explores the evolution from assistive technology to AI-driven solutions in inclusive education, emphasiz-

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ing the benefits, encounters, and ethical considerations of AI implementation. It examines case studies of AI applications in inclusive classrooms, demonstrating their potential to foster accessibility and improve learning outcomes. AI has been integrated into speech-to-text applications, automated content adaptation, intelligent tutoring systems, and real-time feedback mechanisms. These applications have enabled students with disabilities to overcome traditional barriers to learning, promoting self-paced education and greater autonomy. The paper advocates for a balanced approach to AI integration in education, emphasizing that AI should serve as a complementary tool that augments rather than replaces the professional role of teachers. It argues that AI systems must be designed to strengthen instructional practices and support meaningful human interactions, rather than contributing to the depersonalization of the learning environment. Future recommendations focus on ethical AI development, teacher empowerment, and interdisciplinary collaboration to maximize AI's potential in creating truly inclusive educational environments. As AI continues to evolve, its responsible application in education will play a central role in shaping the future of learning for all students, particularly those with different needs.

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Introduction

Inclusive education represents a transformative shift in the way schools approach teaching and learning. It is built on the belief that every child regardless of ability, background, or socio-economic circumstances deserves equal access to meaningful learning experiences. At its heart, inclusive education strives to create classrooms where all learners feel welcomed, valued, and supported. By removing physical, social, and attitudinal barriers, it challenges long-standing practices that have marginalized students with disabilities, ensuring that every learner can thrive within a shared educational space. This paradigm shift in education moves beyond mere physical inclusion, emphasizing the need for

accessible curriculum design, adaptive teaching methods, and supportive classroom environments that cater to diverse learning needs. As societies increasingly recognize education as a fundamental human right, inclusive education has emerged as a critical pathway to achieving social equity and justice in schools and communities (UNESCO, 2020).

One of the most significant advancements in inclusive education has been the integration of assistive technologies. These tools have revolutionized how students with disabilities access and engage with learning materials, enabling them to participate actively in academic and social activities. Assistive technologies, such as screen readers, text-to-speech software, and augmentative communication devices, have bridged gaps in communication, mobility, and learning for students with various disabilities. For example, screen readers convert written text into spoken words, making digital content accessible to students with visual impairments (Dell et al., 2017). Similarly, speech-to-text applications allow students with physical or learning disabilities to express themselves effectively (Black et al., 2022). These tools not only enhance accessibility but also foster greater autonomy and confidence among learners, empowering them to participate fully and thrive alongside their peers. Despite the transformative potential of assistive technologies, their applications have often been limited by static functionalities and a lack of adaptability to individual learning needs. This is where the emergence of Artificial Intelligence (AI) marks a new frontier in inclusive education. Unlike traditional assistive tools, AI-powered systems leverage advanced capabilities such as machine learning, natural language processing, and predictive analytics to provide dynamic and personalized support. AI technologies can analyze vast amounts of data to identify learning patterns, predict challenges, and tailor educational content to meet the unique needs of each student. By doing so, AI creates an adaptive and responsive learning environment that goes beyond accessibility to foster engagement, understanding, and mastery of concepts (Holmes et al., 2021).

The emergence of AI in education is transformative for several reasons.

First, it enables personalized learning experiences by adapting teaching methods and materials to the specific strengths, weaknesses, and preferences of each student. For example, intelligent tutoring systems can provide real-time feedback and scaffolded support, helping students master complex subjects at their own pace (Luckin et al., 2016). Second, AI-powered tools enhance accessibility through real-time applications such as speech recognition, automated content adaptation, and live captioning. These innovations empower students with disabilities to overcome traditional barriers to learning and actively participate in mainstream classrooms. Third, AI offers educators valuable insights into student performance and engagement through data-driven analytics, enabling them to make informed decisions and refine their teaching strategies effectively.

The significance of integrating AI into inclusive education extends beyond its technological capabilities. At a broader level, AI represents an opportunity to address systemic inequities in education by providing equitable access to quality learning experiences. In under- resourced schools, where traditional assistive technologies may be unavailable or insufficient, AI-powered solutions can offer scalable and cost-effective alternatives (Bouck, 2020). Moreover, AI can support early intervention for students with disabilities by identifying learning difficulties at an early stage and providing timely support to prevent long-term academic struggles. For instance, predictive analytics can detect signs of dyslexia, autism spectrum disorder, or attention deficit hyperactivity disorder, allowing educators to implement targeted interventions and support strategies (Zawacki-Richter et al., 2019).

However, the integration of AI into education is not without challenges. Issues such as algorithmic bias, data privacy concerns, and the digital divide must be addressed to ensure that AI contributes to inclusive education rather than exacerbating existing inequalities. For example,

biases in AI algorithms can perpetuate stereotypes or marginalize certain groups of students if the training data is not diverse and representative (Holmes et al., 2021). Similarly, the ethical use of student data must be prioritized to protect privacy and maintain trust among stakeholders. Furthermore, disparities in access to technology and internet connectivity can limit the reach of AI-powered solutions, particularly in rural and low-income communities. Addressing these challenges requires a collaborative effort among educators, policymakers, technologists, and researchers to develop responsible and inclusive AI applications.

This paper aims to explore the evolution from assistive technologies to AI-driven solutions in inclusive education, highlighting the benefits, challenges, and ethical considerations of this transition. By examining case studies and emerging trends, the study seeks to demonstrate how AI can enhance accessibility, engagement, and learning outcomes for students with disabilities. The objectives of this research are threefold:

1. To analyse the transformative potential of AI in creating inclusive educational environments.
2. To identify the barriers and risks associated with implementation of AI in inclusive setting.
3. To propose strategies for ethical and equitable integration of AI in schools.

The significance of this study lies in its potential to deepen the growing body of knowledge at the intersection of inclusive education and emerging technologies. As AI continues to advance, understanding how its applications can be thoughtfully harnessed to support diverse learners and promote educational equity becomes essential. By calling for a balanced approach one that positions AI as a tool to enhance, rather than replace, the work of human educators this research underscores the need to design technologies that empower teachers and strengthen meaningful interactions within the classroom. Ultimately, the responsible and ethical

integration of AI in education holds the promise of transforming learning experiences for all students, particularly those with disabilities, and of moving us closer to a more inclusive and equitable educational future.

Evolution of Inclusive Technology

Traditional assistive technologies (AT) have been foundational in supporting individuals with disabilities, particularly in educational settings. These technologies aim to provide accessibility, enhance learning experiences, and foster independence. Some key examples include:

- **Screen Readers:** These assistive tools convert on-screen text into speech or Braille, enabling individuals with visual impairments to access and navigate digital content effectively. Widely used software such as JAWS (Job Access with Speech) and NVDA (NonVisual Desktop Access) support users by reading aloud text, menus, and commands, thereby facilitating independent interaction with computers and digital resources.
- **Text-to-Speech Software:** This software converts written text into audible speech. For learners with reading difficulties (such as dyslexia), text-to-speech tools like Kurzweil 3000 or Natural Reader can assist in reading textbooks, documents, and online content aloud.
- **Speech Recognition Software:** Tools such as Dragon NaturallySpeaking help users with mobility impairments by transcribing spoken words into text, enabling them to interact with digital devices without relying on a keyboard.
- **Alternative Input Devices:** These tools help individuals with limited mobility use computers or other devices. Examples include adaptive keyboards, trackballs, and switches.
- **Braille Devices:** Braille displays, such as the BrailleNote, allow individuals with visual impairments to read and write Braille in a digital format, enhancing access to education and communication.

These traditional tools, while effective, had limitations in terms of adaptability, user interaction, and the level of personalization they could offer.

Transition from Static Assistive Tools to Dynamic, AI-Powered Systems

The evolution of assistive technologies has marked a notable progression from static, one-size-fits-all tools to dynamic, AI-powered systems capable of delivering highly personalised and interactive support. With the ability to learn from user behaviour, adapt to changing needs, and respond in real time, AI has enabled the development of more sophisticated solutions. These advancements have made assistive technologies increasingly intuitive, responsive, and aligned with the diverse needs of individual learners.

- **Context-Aware Assistance:** AI-enabled systems can adapt to the user's environment and context, providing more relevant and timely support. For example, an AI-powered screen reader can adjust its reading speed and tone based on the complexity of the content or the user's preferences.
- **Machine Learning for Personalization:** With AI, assistive tools can personalize the experience by learning from user behavior. For instance, AI can adjust speech output, reading pace, or predict what tools or content will be helpful based on previous interactions.
- **Natural Language Processing (NLP):** AI's NLP capabilities allow for more sophisticated communication tools, such as voice assistants that understand and respond to nuanced commands, improving accessibility for individuals with disabilities.
- **Real-Time Translation and Subtitling:** AI can provide real-time translations or subtitling for individuals with hearing impairments. Tools like automatic captioning services have evolved to be more accurate and context-sensitive, allowing individuals to access multimedia content in

real-time.

- **Interactive Assistive Robotics:** The development of AI in robotics has led to assistive robots, such as those used in therapy or as companions for individuals with cognitive or physical disabilities.

Case Studies Showcasing Transformative AI Applications

- **Lexia Learning:** Lexia's AI-driven tools are designed to help students with reading disabilities, such as dyslexia. The software adapts to each student's learning pace, providing personalized reading instruction. The AI system analyses the student's progress and tailors lessons accordingly, offering real-time feedback and targeted interventions. This approach has proven effective in improving literacy outcomes for learners with diverse needs.
- **QTrobot:** QTrobot is an AI-powered robot designed to assist children with autism in developing social and communication skills. The robot uses AI to engage children in interactive activities, such as facial expression recognition, emotional recognition, and social interactions. QTrobot is personalized based on the child's responses, learning patterns, and preferences. The dynamic, adaptable nature of QTrobot allows for a more engaging and effective learning experience compared to static interventions.
- **Aira:** Aira is an AI-driven platform that helps individuals with visual impairments navigate the world. Using AI and human agents, Aira provides real-time assistance to visually impaired users, helping them navigate unfamiliar environments, read printed text, or identify objects around them. The AI-powered system combines computer vision with live human support, offering highly personalized and context-aware help.
- **Gaze Interaction Technology:** Using AI, gaze interaction technology allows users with motor impairments to control devices using their eye

movements. Tools such as Tobii Dynavox's devices use AI to track eye movements, enabling individuals to interact with computers, tablets, and smartphones by simply looking at specific areas of the screen, facilitating communication and access to digital content.

- **Scribe AI by Microsoft:** A real-time transcription tool that uses AI to convert spoken language into written text. For individuals with hearing impairments, Scribe AI provides real-time captions during meetings, classes, or other live events. It uses advanced machine learning algorithms to distinguish speakers, transcribe accurately, and adapt to different accents and speech patterns.

The evolution of inclusive technology has moved from traditional, static assistive tools to dynamic, AI-powered systems that offer personalized, context-aware, and adaptive solutions for individuals with disabilities. Case studies like Lexia Learning and QTrobot showcase the transformative power of AI in education, providing more effective and engaging learning experiences for students. As AI continues to evolve, it promises to create even more inclusive and accessible environments, empowering individuals with disabilities to live and learn with greater independence and confidence.

Literature Review

Assistive technology in inclusive education has gained momentum in recent years. The movement from assistive technology to artificial intelligence in inclusive education has led to various conceptual frameworks and empirical studies exploring their implications for learning.

Advancements in Assistive Technologies: Recent studies highlight the transformative role of assistive technologies (AT) in fostering inclusive education for students with disabilities. Ayushi et al. (2025) explored various technological solutions, including hybrid web browsing systems, multimodal accessible systems, and voice recognition tools, which

empower individuals with visual impairments and other disabilities. These technologies not only enhance accessibility but also open avenues for meaningful communication and employment. Similarly, Prystiananta et al. (2024) identified AT tools such as Braille technologies, JAWS, and EducaPlay as highly effective in improving language learning outcomes, particularly vocabulary and reading comprehension. The findings emphasize the critical role of AT in engaging students with disabilities and tailoring educational experiences to their individual needs.

Barriers to Implementation: Despite their potential, ATs face significant barriers to widespread adoption. Magaracha and Sibanda (2025) found that in Zimbabwe, limited awareness among educators and inadequate policy frameworks hindered the accessibility and effective use of ATs. Similarly, Eneya and Adesina (2025) reported that while academic libraries in developed countries integrate disability within broader institutional diversity initiatives, implementation in developing nations is often fragmented due to insufficient funding and regulatory enforcement. These findings underscore the urgent need for targeted interventions to bridge the gap in AT availability and support systems.

Artificial Intelligence in Inclusive Education: AI technologies have emerged as pivotal in enhancing accessibility and personalizing education for students with disabilities. Hadinezhad et al. (2024) highlighted how AI-driven systems analyze student data, such as academic performance and behavioral patterns, to identify areas requiring support. AI-based adaptive learning platforms and intelligent tutoring systems offer tailored educational experiences, significantly boosting academic outcomes (Mehta et al., 2023). Furthermore, AI-powered accessibility tools, such as voice recognition, are instrumental in supporting students with physical or cognitive disabilities.

Ethical and Practical Challenges: While AI offers immense promise, it also presents ethical and practical challenges. Tlili et al. (2024)

emphasized concerns around algorithmic bias, data privacy, and fairness, urging careful implementation of AI to prevent exacerbating existing inequities. Additionally, Mehta et al. (2023) advocated for stakeholder engagement and ethical guidelines to ensure that AI complements human judgment and promotes inclusive education.

Integration of Emerging Technologies: The integration of advanced technologies, such as virtual reality (VR), into inclusive education has further broadened accessibility for individuals with disabilities. Liu et al. (2024) explored the role of VR enhanced by AI in creating immersive learning environments for visually impaired students. However, they also noted the lack of comprehensive research on this intersection, highlighting the need for future studies. Similarly, Howorth et al. (2024) demonstrated how strategic partnerships, such as the collaboration between the University of Maine and CIDDL, enhance technology integration in teacher preparation programs, fostering the use of emerging tools like AI, AR, and VR.

To maximize the potential of AT and AI in inclusive education, Putri et al. (2025) called for systematic implementation strategies, including training for educators and development of inclusive policies. Ahmed et al. (2025) further stressed the importance of applying Internet of

Educational Things (IoET) technologies in higher education, particularly in underserved regions. These findings align with calls for global efforts to integrate inclusive practices into infrastructure, smart cities, and workplace learning (Tlili et al., 2024).

The convergence of AT and AI presents transformative opportunities for inclusive education. While advancements in these technologies offer unprecedented accessibility and personalization, significant challenges, including ethical considerations and implementation barriers, remain. Addressing these issues requires a multifaceted approach involving policy reform, educator training, and strategic collaboration. Future research

should continue to explore innovative applications of these technologies, ensuring equitable educational opportunities for all students.

Methodology

This study employs a thematic literature review combined with a qualitative framework to examine the role of assistive technologies (AT) and artificial intelligence (AI) in fostering inclusive education. The qualitative approach enables an in-depth exploration of patterns, trends, and thematic insights derived from the existing body of literature. Key academic databases such as Scopus, PubMed, Google Scholar were searched using terms like "assistive technologies," "artificial intelligence," "inclusive education," "students with disabilities," "adaptive learning," and "digital accessibility."

Inclusion criteria focused on peer-reviewed studies published between 2013 and 2025 that addressed (1) the development and application of AT and AI in education, (2) their impact on learning outcomes for students with disabilities, and (3) challenges such as ethical concerns and implementation barriers. Studies unrelated to inclusive education or lacking empirical or conceptual rigor were excluded.

Thematic analysis was employed as the qualitative framework to systematically identify, analyze, and interpret key patterns across the literature. Data coding was performed to categorize the findings into themes such as advancements in technology, barriers to implementation, ethical considerations, and future directions. This combined methodological approach provides a comprehensive understanding of the interdisciplinary landscape, offering actionable insights for researchers, educators, and policymakers in inclusive education.

Development of Theoretical Framework

The integration of assistive technologies (AT) and artificial intelligence (AI) into inclusive education is informed by various theoretical

perspectives that provide insight into how technology can transform learning experiences for students, particularly those with disabilities. This theoretical framework draws on Universal Design for Learning (UDL), the Technology Acceptance Model (TAM), the Social Model of Disability, and Constructivist Learning Theory to explore how these technologies can support diverse learners, enhance accessibility, and promote inclusive educational practices.

1. Universal Design for Learning (UDL)

Universal Design for Learning (UDL) is a framework aimed at creating educational environments that are flexible and inclusive, accommodating the diverse needs of all learners. UDL advocates for offering multiple means of engagement, representation, and expression to ensure that every student can succeed, regardless of their individual learning preferences or abilities.

At the core of UDL is the idea that educational content should not be presented in a single format or method. Rather, it should be flexible, allowing for different modes of engagement and representation, and enabling students to demonstrate understanding in a variety of ways. In this context, assistive technologies (AT) and artificial intelligence (AI) can play a significant role in promoting inclusivity.

- Assistive technologies such as screen readers, speech-to-text software, or adaptive keyboards help students with disabilities access content in ways that suit their needs.
- AI tools, including adaptive learning platforms, can personalize content delivery to match students' learning speeds, abilities, and preferences.

Both AT and AI align with UDL by offering flexible, personalized learning experiences that accommodate diverse learner needs, thus fostering an inclusive learning environment where all students can thrive.

2. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), provides a framework to understand how and why individuals accept and use new technology. In the context of inclusive education, TAM is valuable for exploring the acceptance of assistive technologies and AI tools by both educators and students.

TAM posits that two key factors determine technology adoption:

- Perceived ease of use: The degree to which an individual believes that using a particular technology will be free from effort.
- Perceived usefulness: The degree to which an individual believes that using the technology will enhance their performance or ability to achieve a task.

For AI and assistive technologies to be successfully integrated into classrooms, both students and educators must find these tools useful and easy to use. This is especially true in the case of educators, who may be hesitant to adopt new technologies without clear evidence of their benefits. The adoption of AT and AI tools in inclusive education depends not only on their perceived utility but also on the ease with which educators can incorporate them into their teaching practices.

Furthermore, educators' attitudes toward inclusive education and their understanding of the potential of AI in personalized learning are key factors influencing adoption. If these technologies are perceived as useful and easy to integrate, both students and teachers are more likely to embrace them, thus promoting greater engagement and better educational outcomes for all students.

3. Social Model of Disability

The Social Model of Disability contrasts with the traditional medical model of disability, which focuses on "fixing" the individual. The Social Model, in contrast, emphasizes reducing societal barriers that prevent

people with disabilities from participating fully in social, educational, and economic life. This model encourages a shift from viewing disability as an individual problem to recognizing it because of societal factors, including physical, attitudinal, and technological barriers.

In the context of inclusive education, the Social Model advocates for the removal of barriers that hinder students with disabilities, rather than attempting to "normalize" them. This includes ensuring that educational environments are accessible, and that students have the tools and support they need to engage with the curriculum. AI and assistive technologies directly support this perspective by offering tools that minimize barriers to learning. For example:

- AI can provide real-time adjustments to content or assessments, catering to individual learning needs and abilities.
- Assistive technologies such as screen readers or customized learning apps can make educational content more accessible for students with sensory, cognitive, or physical disabilities.

By reducing these barriers, AI and AT facilitate a more inclusive educational experience, in line with the principles of the Social Model of Disability.

4. Constructivist Learning Theory

Constructivist Learning Theory, developed by theorists such as Piaget, Vygotsky, and Bruner, posits that learners construct their own understanding and knowledge through experiences and interactions with their environment. According to constructivism, learning is an active process where students build on prior knowledge and make sense of new information in meaningful ways.

In the context of inclusive education, constructivism emphasizes the importance of student-centered learning environments that empower students to take an active role in their educational journey. AI tools can

facilitate constructivist learning by providing personalized, adaptive learning experiences that respond to each student's unique needs, preferences, and learning styles.

For example:

- AI-powered educational tools can offer students personalized feedback, adaptive assessments, and customized learning paths that promote exploration and problem- solving.
- Assistive technologies like voice recognition, interactive simulations, or visual aids enable students to interact with content in ways that support active, hands-on learning.

These technologies enable students to engage with educational materials in ways that align with constructivist principles, encouraging deeper understanding and fostering a sense of ownership over their learning.

Integration of Theories

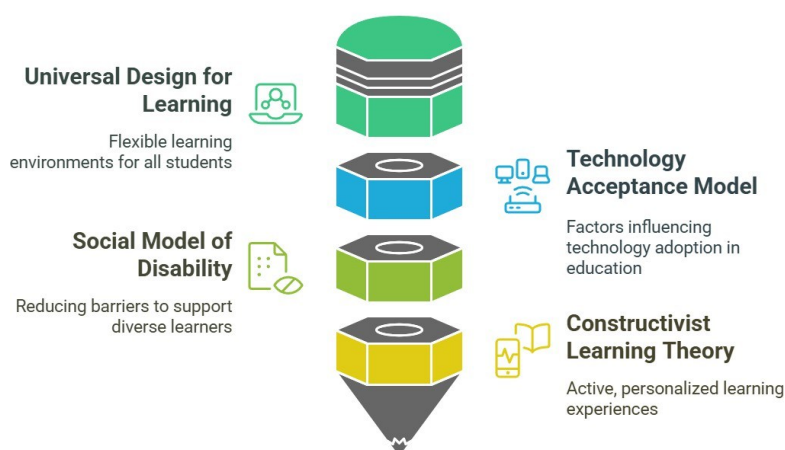
The theoretical framework for integrating AI and assistive technologies in inclusive education draws from these four perspectives to create a comprehensive understanding of how technology can enhance learning experiences for all students.

1. UDL provides the foundation for creating flexible, accessible learning environments by offering multiple means of engagement, representation, and expression.
2. TAM helps explain the factors influencing the adoption and use of AI and AT tools by educators and students, highlighting the importance of perceived usefulness and ease of use.
3. The Social Model of Disability promotes the idea of reducing barriers to learning, ensuring that educational environments and tools are accessible and inclusive for all students, including those with disabilities.
4. Constructivist Learning Theory supports the idea of active,

personalized learning, where students use technology as a tool for exploration, problem-solving, and the construction of knowledge.

Together, these theories provide a holistic framework for understanding how AI and assistive technologies can be used to create inclusive, engaging, and effective learning environments that meet the diverse needs of all students. This theoretical foundation emphasizes the importance of accessibility, personalization, and the reduction of barriers to ensure that all students, regardless of their abilities, can succeed in the classroom.

Theoretical Framework for Inclusive Education



Conclusion

The transformative potential of technology in inclusive education is unparalleled, bridging gaps in accessibility and enabling equitable learning experiences for all students. This paper has traced the evolution of assistive technologies (AT) and highlighted how artificial intelligence (AI) signifies the next significant leap in fostering inclusivity in education. Traditional AT, such as screen readers and text-to-speech software, provided the foundation for empowering students with disabilities, ensuring access to learning resources and fostering independence. However, AI has expanded these possibilities, enabling personalized, adaptive, and dynamic learning

environments that cater to diverse needs.

AI's ability to analyze individual learning patterns, predict challenges, and offer tailored solutions positions it as a game-changer in inclusive education. From intelligent tutoring systems to real-time captioning and predictive analytics for early intervention, AI facilitates not only accessibility but also meaningful engagement and improved learning outcomes. Moreover, the scalability and cost-effectiveness of AI-powered tools offer a promising avenue for addressing systemic inequities, particularly in under-resourced schools and communities.

However, the integration of AI into education is not without challenges. Issues such as algorithmic bias, data privacy, and the digital divide must be tackled to ensure that AI-driven solutions do not inadvertently reinforce existing inequalities. Ethical considerations and stakeholder collaboration are crucial to developing responsible AI applications that complement human educators rather than replace them.

Looking ahead, the successful integration of AI into inclusive education requires a balanced approach—one that emphasizes equity, ethical practices, and the empowerment of educators. As AI technologies continue to evolve, they hold the potential to transform classrooms into inclusive spaces where every student, regardless of ability, can thrive. By harnessing AI responsibly, we can reimagine education as a truly inclusive and equitable endeavor, paving the way for a future where no learner is left behind.

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