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Use of AI in teaching mathematics to persons living with disabilities: The Context of the United States

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Abstract

This narrative literature review investigates the integration of Artificial Intelligence (AI) in mathematics education for students with learning disabilities (SLDs) in the United States. Employing a narrative literature review methodology, the study synthesises peer-reviewed articles, policy documents, and grey literature published between 2020 and 2025, sourced from academic databases such as Google Scholar, Science Direct, Emerald, ERIC, and JSTOR. The review is grounded in Universal Design for Learning (UDL) and Constructivist Learning Theory, providing a theoretical framework for evaluating the role of AI in inclusive education. The selection criteria prioritised studies focusing on AI applications that enhance accessibility, personalisation, and early detection of learning difficulties, with special attention to tools like Photomath, Mathway, Socratic, Century, and the MACS Curriculum. The findings highlight AI's capacity to support differentiated instruction, automate feedback, and facilitate early screening for conditions such as dyscalculia and dysgraphia. The review also identifies persistent challenges, including inconsistent classroom adoption, infrastructural and policy limitations, ethical concerns, and gaps in accessibility for some AI platforms. Comparative insights from international contexts, notably China, further underscore the importance of supportive policy frameworks and teacher training. The study concludes that while AI holds significant promise for transforming mathematics instruction for students with disabilities, realising its full potential requires sustained investment in accessible technologies, ongoing research, and collaborative policy development. The review advocates for responsible, equitable, and pedagogically sound AI integration to ensure all learners benefit from technological advancements in education.

Keywords: Artificial Intelligence (AI) in Education; Assistive technology; Inclusive education; Mathematics instruction; Students with Learning Disabilities (SLDs)

1. Introduction

Artificial Intelligence (AI) has rapidly become a pivotal tool in transforming education, offering innovative ways to enhance learning, automate tasks, and personalise instruction. Defined as machine-based intelligence that mimics human cognition, AI systems, particularly large language models (LLMs) like ChatGPT, are reshaping how knowledge is created and delivered (Ding et al., 2024). Pioneered by thinkers like Alan Turing through the development of the Turing Test (Luger, 2021) and anticipated by Leibniz's Scientia Generalis (Grabiner, 1995; Rizos & Gkrekas, 2023), AI continues to evolve into a complex tool capable of assisting educators with content creation, feedback, and lesson planning. Yet, despite global advances, integration in classrooms, especially for students with special educational needs, remains limited and inconsistent.

The principle of inclusive education underscores every student's right to equal and meaningful participation in learning (Foykas, 2024b; Kenny et al., 2023; McQuillan & Mayo, 2024; Yaroshenko et al., 2024). Differentiated instruction, supported by information and communication technologies (ICT) and manipulative materials, has led to improved

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outcomes for students with disabilities (Drolia et al., 2022; Rizos & Foykas, 2023a, 2023b). These inclusive practices allow lesson plans to be tailored to individual learner profiles (Anteneh & Anshu, 2024; Hutchison et al., 2023; Kokkinos & Gakis, 2021), supporting the active participation of all students (Lindner & Schwab, 2020; Scarparolo & MacKinnon, 2022; Sharp et al., 2020). Social pedagogy promotes student voice and collaboration with teachers in the learning process, shifting away from authoritarian teaching (Luoma & Kosunen, 2024; Nam et al., 2023).

AI tools such as ChatGPT can enhance this inclusive vision by generating individualised content, such as math worksheets tailored to students' interests and learning challenges. Despite their promise, many educators remain uncertain about how to use such tools effectively in classrooms (Dindler et al., 2020; Griffiths et al., 2022; Moorhouse & Tiet, 2021). This research contributes to filling that gap by exploring how ChatGPT-generated worksheets on square roots and irrational numbers were used to support two students with special educational needs in a general education classroom. The goal is to offer practical guidance for teachers on using AI to support personalized and differentiated instruction.

Nevertheless, ethical and operational challenges must be addressed. Research has revealed concerns about the authenticity and fairness of AI-generated educational content. Theocharopoulos et al. (2023, 2024) demonstrated the effectiveness and risks of LLMs in detecting AI-generated texts, highlighting the importance of preserving academic integrity and avoiding bias. Broader issues like algorithmic bias, data privacy, and unequal access further complicate AI's role in education (Swiecki et al., 2022; Schwartz et al., 2022; Wu et al., 2024). As the Global Risks Report (2024) urges, countries must embed AI tools equitably in education systems to avoid widening disparities, especially for students with disabilities. Responsible integration, guided by research and inclusive practices, is essential to ensure AI enhances rather than hinders learning.

2. Theoretical Framework and Literature Review

2.1. Theoretical Framework

This study is grounded in Universal Design for Learning (UDL) and Constructivist Learning Theory, both of which provide a robust conceptual basis for integrating artificial intelligence (AI) tools like ChatGPT into inclusive educational practices.

Universal Design for Learning (UDL) was developed by David H. Rose and Anne Meyer in the 1990s at the Center for Applied Special Technology (CAST). Rooted in cognitive neuroscience, UDL promotes designing learning experiences that accommodate individual learner variability by offering multiple means of representation, multiple means of action and expression, and multiple means of engagement (Rose & Meyer, 2002). UDL has been widely cited in the fields of special education, instructional design, and inclusive pedagogy (Hall, Meyer, & Rose, 2012; King-Sears, 2009). In the context of this study, UDL is especially relevant as it aligns to create math worksheets that address the unique learning profiles of students with special educational needs. By using AI to customise content delivery and student engagement strategies, the study operationalises the UDL principles to promote equitable access to mathematical concepts such as square roots and irrational numbers.

Jean Piaget initially formulated Constructivist Learning Theory in the 1930s and later expanded by theorists such as Lev Vygotsky and Jerome Bruner. Piaget emphasised that learners actively build knowledge through interaction with their environment, while Vygotsky highlighted the social nature of learning and the importance of tools (such as language and scaffolds) in cognitive development. Bruner introduced the concept of the "spiral curriculum," in which learners revisit topics with increasing complexity. Constructivism has since become foundational to educational research and practice, especially in advocating for student-centered learning environments (Fosnot, 2013; Jonassen, 1999). In this study, Constructivism supports the use of AI-generated worksheets as a scaffold that allows students with special needs to build mathematical understanding at their own pace and according to their individual preferences. It affirms the pedagogical value of allowing students to engage actively with content rather than passively receiving instruction.

Together, UDL and Constructivist Learning Theory justify the design and implementation of differentiated instructional materials through AI. UDL provides the structural rationale for accommodating learner diversity, while Constructivism explains the cognitive process of how students learn when given the right tools and context. These theoretical lenses ensure that the integration of AI into special education is both inclusive and pedagogically sound, making them highly relevant and appropriate for the current research focus.

2.2. Literature Review

Artificial Intelligence (AI), once a speculative idea, is now a transformative force in global education. Defined as machine-based intelligence that mimics human cognitive functions, AI is increasingly used to automate tasks, personalise content, and support decision-making in various sectors, including education. From Alan Turing's foundational contributions to today's machine learning systems, AI has developed considerably. Large language models (LLMs) such as ChatGPT have attracted significant attention for their ability to simulate human-like interactions and produce personalised feedback. These tools show promise in education, especially in helping students who find conventional instruction difficult. However, the integration of AI remains inconsistent, particularly in meeting the needs of students with learning disabilities, thereby exposing a critical gap between technological potential and inclusive implementation (Bhushan et al., 2024; Moonpreneur, 2024).

Inclusive education is rooted in the principle that all learners, including those with special educational needs, deserve equal access to quality instruction. Traditional teaching practices have attempted to accommodate students with disabilities through differentiated instruction, the use of manipulatives, and ICT tools. Pedagogical models such as social pedagogy emphasise student-centered approaches, shared decision-making, and personalised learning goals that align with AI's adaptive capabilities (Lindner & Schwab, 2020; Sharp et al., 2020). AI-enabled platforms can enhance these approaches by tailoring instruction to individual learning profiles, automating feedback loops, and modifying content delivery in real-time to match student readiness and abilities. These advantages are especially critical for learners with dyscalculia, visual impairments, or cognitive processing challenges.

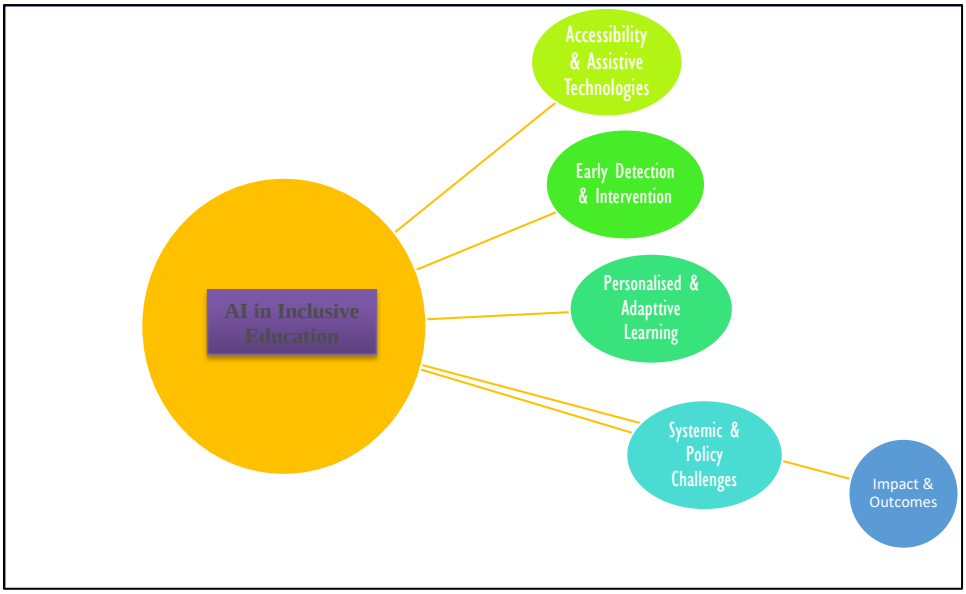
Recent research reveals that AI systems significantly improve accessibility in mathematics education. Tools such as screen readers, captioning systems, and tactile graphic generators enable students with disabilities to access learning content in multimodal ways. For example, real-time captioning assists students who are deaf, while visually impaired learners benefit from audio-enhanced materials enriched by AI-generated descriptions (Barker, 2023). Further, AI-powered tools like Photomath and Mathway offer real-time problem-solving guidance, which is especially valuable for students with dyscalculia or other math-related learning difficulties (Santos, 2024; Faller, 2023). These platforms not only foster academic independence but also reduce the anxiety associated with mathematics learning.

However, the adoption of AI tools remains in its early stages. A 2024 analysis by Korhonen found that 17% of students used AI to complete assignments, with a further 15% doing so despite institutional restrictions, highlighting both its popularity and regulatory tensions. Generative AI tools like Eduaide.AI and Mentimeter are also being explored for lesson planning and differentiation, allowing educators to tailor content to specific learning needs (Tlili et al., 2023). The potential of AI in instructional design is clear, yet its actual use in classrooms, particularly in special education, remains limited due to infrastructure and policy constraints (Education Sciences, 2023).

Another critical concern is the early identification and intervention for learning disabilities such as dyscalculia. Bhushan et al. (2024) and Lucariello (2024) advocate for AI-driven screening systems that use neural networks and reasoning algorithms to detect early signs of learning difficulties in children as young as six. These systems can recommend timely, individualised strategies to support both instruction and remediation. Educational institutions like Wareham Middle School and Arizona State University have adopted such AI tools with reported success in boosting student confidence and improving mathematics performance (Cipolla, 2023; Faller, 2023).

Despite the promise, significant challenges persist. Many AI systems are not fully accessible to students who rely on braille or other assistive technologies. During the COVID-19 pandemic, students with disabilities faced significant barriers to remote math education due to poorly optimised AI platforms that were not designed with inclusivity in mind (Barker, 2023; Moonpreneur, 2024). In addition, ethical concerns, ranging from data privacy and algorithmic bias to the absence of human oversight, remain unresolved and hinder large-scale adoption.

Nonetheless, the literature strongly supports AI's potential to create more inclusive, equitable, and engaging educational environments. For AI to fulfil its promise, educational stakeholders must invest in the development of ethically sound, accessible, and pedagogically effective AI tools. Policymakers and educators must work together to implement frameworks that ensure students with disabilities are not left behind in the digital transformation of education (Bhushan et al., 2024; Tlili et al., 2023; Education Sciences, 2023). Figure 1, depict the diagrammatic representation of AI in Inclusive Education Literature Map.



(Source; Author, 2025)

Figure 1 AI in Inclusive Education Literature Map

3. Methodological Approach

This study adopts a narrative literature review methodology to explore the use of Artificial Intelligence (AI) tools in mathematics education for students with learning disabilities (SLDs), particularly within the United States. The purpose is to synthesise existing knowledge, examine how AI technologies contribute to inclusive math instruction, and identify gaps and opportunities for improvement in practice and policy.

3.1. Data Sources and Search Strategy

A wide range of scholarly and grey literature was examined, including academic journal articles, government reports, NGO publications, news articles, and educational blogs. Key sources were sourced from databases and platforms such as Google Scholar, Science Direct, Emerald, ERIC, JSTOR, and official sites like the U.S. Department of Education. The literature review was confined to materials published between 2020 and 2025 to reflect the most recent advances in AI and special education.

3.2. Selection and Inclusion Criteria

The selection of materials followed a set of inclusion criteria that prioritised studies addressing AI applications in mathematics education, particularly those aimed at improving accessibility for students with disabilities. Special emphasis was placed on tools like Photomath, Mathway, Socratic, Century, Merrimeter, and the MACS Curriculum, which have been recognised for their inclusive features. Comparative studies from countries such as China were also examined to provide a broader international perspective.

3.3. Synthesis and Analysis

The study did not involve any primary data collection. Instead, it employed a qualitative synthesis approach to analyse patterns, themes, and expert insights from the existing literature. This allowed for a holistic understanding of how AI is currently being used in math education for students with learning disabilities, the challenges involved, and the implications for future educational policy and practice in inclusive education.

4. Findings and Discussion

Artificial Intelligence (AI) has gained recognition as a transformative tool in education, especially for mathematics instruction among individuals with disabilities. Its integration aims to address diverse learning needs through personalised teaching, enhanced accessibility, and early detection of learning difficulties (Moonpreneur, 2024). In the United States, where inclusive education is supported by legal and policy frameworks, AI technologies are increasingly being explored for their potential to foster academic independence among students who have traditionally faced

barriers in conventional settings (Wang et al., 2024). However, while the potential is substantial, practical implementation reveals an interaction of benefits, limitations, and ethical challenges (Opesemowo & Adewuyi, 2024; Gupta & Kaul, 2024). This study used a narrative literature review method to examine how AI tools are utilised in mathematics education for students with learning disabilities (SLDs), with particular focus on the U.S. context. Applications such as Photomath, Mathway, Socratic, Century, Merrimeter, and the MACS Curriculum demonstrate how AI can support personalised learning experiences (Imulla & Faisal Amjad, 2025). Comparative perspectives from countries like China further contextualise the adoption and effectiveness of these technologies globally (Xie, 2021; Santos, 2024), offering insights into both promising strategies and ongoing challenges.

4.1. The Case for AI Integration in Inclusive Mathematics Education

A significant body of literature advocates for the use of AI to enhance the learning experiences of students with disabilities. Bhushan et al. (2024) emphasize the use of AI-driven screening systems employing neural networks to detect early signs of mathematical learning difficulties such as dyscalculia. These tools, implemented in U.S. schools like Wareham Middle School and Arizona State University, have reportedly improved student confidence and mathematics performance. Similarly, Lopez and Rangappa (2024), Shivani et al. (2024) support the role of AI in early detection and intervention, especially through diagnostic tools such as VRAIlexia, DyslexiScan, and AI-based braille devices.

These findings are reinforced by Santos (2024) and Faller (2023), who highlight the usage of AI-powered math tools such as Photomath and Mathway in reducing math-related anxiety and promoting academic independence among students with dyscalculia and other disabilities. These tools provide real-time, step-by-step solutions and allow students to learn at their own pace, mirroring the personalized learning ideals rooted in social pedagogy, as discussed by Lindner and Schwab (2020) and Sharp et al. (2020).

Moreover, empirical studies from Toyokawa et al. (2023), Patiño-Toro et al. (2023), and Costa et al. (2023) demonstrate that AI-powered personalisation improves learning outcomes and engagement in mathematics. Platforms like DreamBox, InnerVoice, and Immersive Reader, analysed in Structural Learning (2025), cater to diverse needs by adapting content to individual abilities, enhancing both inclusivity and autonomy. These tools leverage AI's adaptive capabilities to respond to learner profiles, supporting students with cognitive, auditory, and visual impairments.

Despite the enthusiasm, several studies caution against assuming a seamless integration of AI into inclusive mathematics education. Moonpreneur (2024) and Osondu, Francois, and Strycker (2024) point out that AI integration remains uneven, especially for students with disabilities. Many AI systems are not fully optimized for assistive technologies like braille readers, while others lack accommodations for linguistic diversity or severe cognitive impairments (Barker, 2023; Opesemowo & Adewuyi, 2024; Imulla & Faisal Amjad, 2025). For instance, although screen readers and captioning tools have improved access, gaps remain in braille compatibility and content translation for students with needs.

Additionally, ethical and infrastructural challenges persist. Korhonen (2024) found that while 17% of students used AI for schoolwork, 15% did so despite institutional bans, raising concerns about unregulated AI use and the absence of clear policy guidance. Issues of algorithmic bias, data privacy, and limited teacher training are echoed by Jain, Jain, Daga, Roshni and Bhardwaj (2024) and Nuankaew, Nasa-Ngium, Wongpanya, and Nuankaew (2025), both of which emphasise the importance of developing context-specific, ethically sound AI tools that respect user agency and confidentiality.

Furthermore, during the COVID-19 pandemic, many students with disabilities were disproportionately affected due to the lack of inclusive design in remote learning platforms (Moonpreneur, 2024; Barker, 2023). This highlighted a broader contradiction: while AI has the potential to bridge learning gaps, it can also worsen inequalities if designed or implemented without inclusivity at the forefront.

There is broad agreement across the literature that AI enhances personalisation, supports early intervention, and increases learner engagement in mathematics education for students with disabilities (Bhushan et al., 2024; Santos, 2024; Toyokawa et al., 2023; Structural Learning, 2025). However, contradictions arise in the implementation feasibility. While some institutions report successful use (e.g., Faller, 2023), others highlight that widespread deployment is hindered by infrastructure gaps, limited educator preparedness, and policy vacuum (Education Sciences, 2023; Melo-López, Basantes-Andrade, Gudiño-Mejía, & Hernández-Martínez, 2025).

Another tension lies in the extent of AI's accessibility. On one hand, platforms offer multimodal content (audio, text, visual) that caters to various disabilities; on the other, they often fail to serve students with multiple or severe disabilities, particularly those requiring tactile feedback (Barker, 2023; Shivani et al., 2024). Moreover, while AI may

support differentiated instruction, it cannot replace the empathetic and intuitive human support essential for inclusive learning environments, a point often underplayed in highly technical reviews.

Table 1 Summary of findings

Author(s)	Year	Methodology Used	Findings	Conclusion and Recommendations
Bhushan et al.	2024	Literature review, case studies	AI-driven screening systems using neural networks can detect early signs of learning difficulties in children as young as six. Implementation in schools improved student confidence and math performance.	AI tools should be further developed for early intervention. Recommend investment in accessible, ethical AI systems for education.
Moonpreneur	2024	Review, sector analysis	AI integration in education is uneven, especially for students with disabilities. COVID-19 exposed gaps in AI platform accessibility.	Urges inclusive design and policy frameworks to ensure equitable AI adoption in education.
Lindner & Schwab	2020	Theoretical analysis	Social pedagogy aligns with AI's adaptive capabilities, supporting student-centred and personalised learning.	Recommend leveraging AI to enhance differentiated instruction and shared decision-making in classrooms.
Sharp et al.	2020	Theoretical analysis	Emphasises the importance of personalised learning and shared decision-making, which AI can support.	Suggests integrating AI to further student-centered approaches in inclusive education.
Barker	2023	Review, case examples	AI tools (screen readers, captioning, tactile graphics) improve accessibility for students with disabilities, but many platforms lack full accessibility (e.g., braille support).	Recommends universal design principles and ongoing evaluation of AI tools for accessibility.
Santos	2024	Review, tool analysis	AI-powered math tools (Photomath, Mathway) provide real-time guidance, supporting students with dyscalculia and math difficulties.	Encourages adoption of AI math tools to foster independence and reduce anxiety in learners with disabilities.
Faller	2023	Case study	Use of AI tools in schools led to improved math performance and student confidence.	Recommends broader implementation and research on AI's impact in special education.
Korhonen	2024	Survey analysis	17% of students used AI for assignments; 15% used it despite restrictions, indicating popularity and regulatory challenges.	Calls for clear policies and guidance on AI use in education.
Tlili et al.	2023	Review, tool evaluation	Generative AI tools (Eduaide.AI, Mentimeter) support lesson planning and differentiation for diverse learners.	Recommends further research and infrastructure investment for AI in special education.
Education Sciences	2023	Policy review	AI's classroom penetration is limited by infrastructure and policy constraints, especially in special education.	Advocates for policy reform and investment in AI infrastructure for inclusive education.

Toyokawa et al.; Patiño-Toro et al.	2023	Empirical studies, systematic review	AI enables personalisation and adaptation of learning environments, essential for inclusion.	Recommend scaling AI solutions for broader, equitable access.
Costa et al.; Bicknell et al.	2017-2023	Systematic review, case studies	AI tutors (e.g., Khanmigo, Duolingo) deliver personalized support and feedback, improving learning outcomes.	Suggest integrating AI tutors in inclusive education to support diverse needs.
Lopez & Rangappa	2024	Integrated literature review	AI tools (e.g., VRAIlexia, DyslexiScan) use VR and deep learning for early dyslexia detection and intervention.	Recommend further development and evaluation of AI-based diagnostic and intervention tools for learning disabilities.
Shivani et al.	2024	Systematic analysis	AI-powered braille devices, AR apps, and speech therapy tools enhance accessibility and independence for disabled students.	Suggests continued innovation and user-driven design for AI tools in special education.
Toyokawa et al.	2023	Empirical study	AI personalizes learning, adapts to individual needs, and supports inclusive education.	Recommends policy support and teacher training for effective AI integration.
Ayeni et al.,	2024	Empirical study, user data analysis	AI-powered adaptive learning systems increase engagement, understanding, and memory in students with disabilities.	Recommends inclusive AI design and multidisciplinary approaches for adaptive learning platforms.
Structural Learning	2025	Review, tool analysis	AI tools (InnerVoice, Immersive Reader, DYSOLVE, DreamBox, Seeing AI) support communication, literacy, and independence for students with diverse needs.	Recommends adoption of AI tools tailored to specific disabilities and ongoing evaluation of their impact.
NSF AI Institute for Exceptional Education	2025	Program development, case studies	AI-enabled early screening and intervention tools address shortages in speech-language services for children with disabilities.	Recommends scaling AI solutions for early intervention and individualised support in special education.
Melo-López et al.,	2025	Systematic review, bibliometric analysis	AI enhances accessibility and personalises learning for students with disabilities, but challenges include a lack of training, infrastructure, and ethical concerns.	Recommends policy development and ethical frameworks for sustainable AI use in inclusive education.
Lopez & Rangappa	2024	Conference proceedings, literature review	AI improves early detection and intervention for dyslexia, using VR and deep learning models.	Recommends further research and development of AI-based screening and intervention tools.
Melo-López et al.,	2025	Literature review	AI impacts inclusive education by improving accessibility, personalisation, and engagement.	Recommends ongoing research and policy support for AI in inclusive education.
Gupta & Kaul,	2024	Systematic review (India)	AI enhances personalised learning, assistive tech, and admin efficiency, but faces challenges (linguistic diversity, infrastructure).	Recommends context-specific AI solutions and robust policy frameworks.

Wang et al.,	2024	Systematic literature review	AI algorithms and robots support a wide array of teaching and learning activities, including for students with disabilities.	Recommends integrating AI into mainstream and special education for broader impact.
Lopez & Rangappa	2024	Literature review	AI tools (VRAIlexia, DyslexiScan) use VR and deep learning for early detection and intervention in dyslexia.	Recommends further research and addressing limitations in current AI tools.
Shilpi et al.	2024	Empirical study, ML model comparison	Machine learning models effectively detect learning disabilities (dyslexia, ADHD, dysgraphia) and inform tailored support.	Recommends adoption of ML for early detection and personalized interventions in education.

5. Conclusion and Recommendations

The consensus across the studies is unequivocal: AI holds significant potential to enhance inclusive mathematics education, but its success depends on thoughtful, ethical deployment. To realise this potential, substantial investment is required in AI infrastructure, comprehensive teacher training, and robust policy reform aimed at ensuring equitable access for all learners. Furthermore, the design and implementation of AI tools must prioritise user-centered approaches, incorporating continuous evaluation to adapt to diverse learner needs effectively. Achieving meaningful and sustainable innovation in this field demands interdisciplinary collaboration among educators, technologists, and disability advocates, fostering solutions that are not only technologically advanced but also pedagogically sound and socially responsible. Only through such coordinated efforts can AI truly transform mathematics education into an inclusive, accessible, and empowering experience for students with disabilities.

The study concludes that AI represents a promising frontier in making mathematics education more inclusive for students with disabilities in the United States. Its capacity for personalization, accessibility, and early diagnosis has already demonstrated positive outcomes in pilot settings. Yet, without a robust policy framework, ethical oversight, and inclusive design principles, its potential may remain unrealised or, worse, become a source of further marginalisation. As such, future efforts must prioritise equity, collaboration, and sustainability to ensure that AI-driven education supports, not supplants, human-centered, inclusive learning practices.

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