

Leveraging on Artificial Intelligence (AI) to Make Learning More Inclusive for Students with Learning Disabilities in Mathematics Education

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Abstract: The paper investigated how leveraging Artificial Intelligence (AI) can support more inclusive mathematics education for students with learning disabilities, a critical concern within broader science education. Learning disabilities such as dyslexia, attention-deficit/hyperactivity disorder (ADHD), and dyscalculia frequently impede students' access to and success in mathematics classrooms due to challenges in processing, retention, and engagement with abstract concepts. Drawing on current research and classroom practice, this study examines two central AI applications: adaptive learning systems that modify instructional content in real time based on student performance, and personalized support tools that deliver differentiated feedback aligned with individual cognitive and learning profiles. The discussion is organized under the following subheadings: The Transformative Role of AI in Inclusive Mathematics Education; Understanding Learning Disabilities and the Imperative for Inclusion; Leveraging AI for Adaptive Mathematics Instruction; Personalized Support and Feedback in AI-Mediated Learning; Longitudinal Monitoring through Learning Analytics; Ethical and Practical Considerations; and Envisioning the Future of Inclusive AI in Science and Mathematics Education. The paper argues that, when implemented thoughtfully and ethically, AI offers significant promise in dismantling structural barriers, fostering learner autonomy, and promoting equitable participation in mathematics education—advancing the goals of inclusive science education.

Key words: Artificial Intelligence (AI), Learning Disabilities, Mathematics Education, Adaptive Learning, Personalized Support and Inclusive Education.

I. Introduction

Many students experience occasional difficulties with certain subjects, but when persistent struggles occur despite consistent effort—especially in areas like mathematics—it may indicate a learning disorder. These disorders can affect a student's ability to process and retain information, impacting skills such as reading (dyslexia), writing (dysgraphia), attention, comprehension, memory, mathematical reasoning (dyscalculia), or motor coordination (Gupta, 2024). Such challenges often leave students feeling frustrated or discouraged, particularly when they are unable to succeed in mathematics despite their efforts. This can lead to emotional or behavioral responses such as withdrawal, acting out, or feelings of helplessness, and may co-occur with conditions like attention-deficit/hyperactivity disorder (ADHD). For example, in a middle school mathematics classroom, a student with dyscalculia may consistently struggle with basic arithmetic and number sense, despite participating in class and completing homework. The teacher, using an AI-powered adaptive learning platform, assigns the student personalized practice problems tailored to their specific difficulties. The system provides immediate, step-by-step feedback and adjusts the complexity of tasks based on the student's responses. Over time, the student shows increased confidence and progress, while the teacher receives real-time analytics to further guide instruction. This illustrates how leveraging AI can make mathematics education more inclusive by responding to individual learning needs in ways traditional instruction often cannot.

This study seeks to explore the ways in which AI can address the challenges faced by students with learning disabilities in mathematics classrooms, ensuring that every student, regardless of ability, can have equal access to quality mathematics education. By examining the intersection of AI and inclusive mathematics education, this paper aims to contribute valuable insights into how technology can bridge the gap between diverse learning needs and academic success.

The Transformative Role of AI in Inclusive Mathematics Education

Artificial intelligence (Ai) being intelligence of a machine has different definitions from different authors. It refers to simulation of human intelligence in machines that are programmed to tasks such as learning, reasoning and problem solving (Russell & Norvig, 2021). According to Haenlein & Kaplan (2019), Ai is also defined as the intelligence of a machine or computer that enables it to imitate or mimic human capabilities or intelligence such as learning, reasoning and problem solving, linguistic interaction or creativity. Artificial Intelligence (AI) from the authors' view, refers to computer-based systems and algorithms that can simulate decision-making and learning behaviors to adapt educational content and delivery in real time, tailored to the cognitive and

behavioral patterns of individual learners. It is rapidly transforming the field of education, offering novel ways to address longstanding challenges in student learning, especially for those with learning disabilities.

In mathematics education—a subject often marked by high abstraction and sequential reasoning, students with learning disabilities frequently encounter barriers to comprehension and retention of Mathematics concepts. The integration of AI-powered tools into mathematics instruction offers the potential to create more adaptive, personalized, and inclusive environments that cater to the diverse needs of learners. AI's role in reshaping education is not just limited to automating tasks or improving efficiency, but also in its capacity to personalize learning pathways, making mathematics education more equitable for all students (Holmes, Bialik, & Fadel, 2021).

Understanding Learning Disabilities in the Mathematics classroom and the Need for Inclusion

Learning disabilities are neurologically based processing problems that interfere with learning basic skills such as reading, writing, or mathematics. Operationally, learning disabilities are enduring, neurologically-rooted barriers to conventional learning that interfere with the reception, processing, or expression of information. These are identified not by a clinical label alone but by observable inconsistencies between a learner's potential and their performance in typical instructional settings. Learning disabilities, including dyslexia, dyscalculia, Attention Deficit/Hyperactivity Disorder (ADHD), and other cognitive challenges, often place students at a disadvantage in traditional educational settings. These disabilities can manifest in various ways, affecting the way students receive, process, and express information, often leading to disengagement, frustration, and a decline in self-esteem. For these students, conventional educational models, which tend to follow a one-size-fits-all approach, can exacerbate their challenges. In mathematics, this can translate to difficulties in understanding number sense, following multi-step procedures, or applying abstract concepts. However, AI offers a transformative solution by tailoring learning experiences to the individual needs of students, thereby fostering a more inclusive and supportive mathematics learning environment (National Center for Learning Disabilities, 2020).

UNDERSTANDING LEARNING DISABILITIES IN THE MATHEMATICS CLASSROOM

DYSCALCULIA



difficulty with
math reasoning
and calculations

DYSLEXIA



reading problems
that affect math
word problems

ADHD



attention
challenges
during problem
solving

DYSGRAPHIA



difficulty with
writing affecting
math notation

They can also affect higher-level skills such as organization, time planning, abstract reasoning, long- or short-term memory, and attention (National Center for Learning Disabilities, 2020). Students with learning disabilities often face marginalization in conventional classrooms, which are designed for neurotypical learners. Inclusive education promotes the idea that all students, regardless of their abilities or disabilities, should learn together in the same environment. The importance of inclusion lies in recognizing diversity in learning needs and ensuring equal access to education. Traditional instructional methods often fail to

accommodate the unique needs of students with learning disabilities, leading to lower academic outcomes and diminished self-esteem. In mathematics education, this is particularly critical given the cumulative and hierarchical nature of the subject. AI offers tools that can transform this narrative by personalizing education and offering support that adapts to individual learners (Shute & Rahimi, 2021). Learning disabilities such as dyscalculia, ADHD, and working memory deficits often impact students' ability to understand abstract mathematical concepts, follow multi-step procedures, or retain mathematical facts (Geary, 2011). For example, a student with dyscalculia may struggle with number sense and operations, making even basic arithmetic tasks overwhelming. Traditional math instruction, with its emphasis on timed tests and procedural fluency, can marginalize such learners. Curriculum Link: The Common Core State Standards for Mathematics (CCSSM) emphasize "mathematical practices" like making sense of problems and persevering in solving them (MP1). These practices require differentiated support for students with learning differences to fully engage.

How AI Enables Adaptive Learning in mathematics education

Adaptive Learning is defined operationally as the process by which digital systems analyze continuous student input and automatically restructure instructional content, difficulty level, and learning pathways to maintain optimal engagement and comprehension for each learner, especially those with learning differences. Adaptive learning technologies use AI algorithms to analyze student data and adjust instructional content accordingly. These systems respond in real-time to a learner's inputs, offering customized resources that suit the student's pace and style of learning. For example, a student struggling with algebra might be given additional practice problems, step-by-step tutorials, or alternative explanations based on their progress and performance. Platforms like DreamBox Learning, MATHia, and ALEKS have shown promise in personalizing instruction for students with varying abilities. Adaptive mathematics platforms like DreamBox Learning, MATHia, and ALEKS adjust the difficulty, sequence, and type of problems based on the learner's responses in real time. For example, if a student consistently makes errors in fraction comparisons, the system may switch to visual fraction bars or manipulatives to reinforce understanding before moving on. These systems reduce cognitive overload by presenting content that is neither too easy nor too difficult, helping maintain engagement and motivation (Woolf, Arroyo, & Kulik, 2013).

For students with dyslexia or ADHD, adaptive learning can include text-to-speech features, interactive visuals, and segmented lessons that cater to their specific needs. In mathematics classrooms, adaptive learning supports equity by providing all students with a personalized learning path, regardless of their starting point. It moves away from the one-size-fits-all approach and acknowledges that learners progress at different rates and in different ways (Shute & Rahimi, 2021). Classroom Example: In a class working on fraction equivalence, a student with ADHD receives scaffolded tasks with frequent breaks and interactive visuals, keeping them engaged while staying aligned with learning goals. This aligns with standards from the National Council of Teachers of Mathematics (NCTM) which emphasize fostering problem-solving and mathematical confidence (NCTM, 2020).

Visual Aid: Adaptive dashboards showing concept mastery maps, color-coded to indicate where students need support.

Curriculum Link: CCSSM 5.NF.1 requires students to add and subtract fractions with unlike denominators. AI tools help to build foundational fraction sense before procedural fluency.

Personalized Support and Feedback in Mathematics Instruction

In this context, Personalized Support refers to the AI-driven provision of immediate, differentiated instructional feedback, resources, and learning strategies, aligned with an individual's unique needs, preferences, and challenges, enabling sustained independent progress. AI provides personalized support by continuously assessing student inputs and delivering feedback that is immediate and specific. This real-time feedback loop is crucial for students with learning disabilities, who may require more frequent guidance to stay on track. Tools like Grammarly, AI tutoring systems like Socratic by Google or Photomath offer step-by-step feedback based on a student's input, making learning more interactive. For students with learning disabilities, this immediate feedback loop is critical. Also, AI-powered writing assistants, and intelligent tutoring systems offer feedback on grammar, syntax, and logic, helping students develop their skills independently. In mathematics, systems like ALEKS provide feedback on each step of a problem, ensuring that students understand the process, not just the final answer (Baker & Siemens, 2014).

Personalized support also includes recommending resources tailored to the student's learning profile. For example, a student with auditory processing issues might benefit from visual aids and written instructions, while a student with dyslexia might require simplified text or audiobooks. AI ensures these preferences are respected and incorporated into the mathematics learning experience. Classroom Example: During a unit on solving linear equations, a student with dyslexia uses an AI-powered math assistant that reads problems aloud and offers simplified explanations.

Visual Aid: An AI tool interface showing incorrect steps and hints (e.g., "Remember: when solving for x, isolate the variable.").

Curriculum Link: CCSSM 8.EE.7 focuses on solving linear equations. Personalized AI tools allow practice that meets students where they are, regardless of reading level.

Long-Term Monitoring and Learning Analytics in Mathematics Education

AI-driven learning analytics involve collecting and analyzing data over time to identify patterns in student behavior and performance. These insights can inform educators about which strategies are effective and where additional support is needed

(Baker & Siemens, 2014). Learning analytics can help identify students at risk of falling behind and suggest timely interventions. For example, if a mathematics student consistently struggles with a specific mathematics concept, the system can alert the teacher and recommend supplementary materials or alternative instructional approaches. In mathematics, this could include targeted scaffolding for concepts like fractions, equations, or problem-solving strategies. AI systems equally track growth over time through embedded assessments, not just end-of-unit tests. Teachers receive alerts when students consistently struggle with a standard. AI tools also support the development and refinement of Individualized Education Programs (IEPs) by providing accurate, data-driven assessments of student progress. This reduces reliance on periodic testing and allows for continuous, dynamic evaluation. Classroom Example: A teacher uses analytics from MATHia to identify students who haven't mastered proportional reasoning. She forms a small group for targeted review.

Visual Aid: A heat map showing class performance on ratio and proportion tasks.

Curriculum Link: CCSSM 7.RP focuses on analyzing proportional relationships. AI-powered data informs differentiated instruction.

Challenges and Ethical Considerations in Mathematics EdTech

While the potential of AI in inclusive mathematics education is immense, several challenges must be addressed. One major concern is the digital divide: not all students have equal access to devices, internet connectivity, or digital literacy. This can exacerbate existing inequalities rather than resolve them (Holmes, Bialik, & Fadel, 2021). Bias in AI algorithms is another critical issue. If the data used to train AI systems lacks diversity, the outcomes may not serve all learners equitably. For instance, an AI system trained predominantly on neurotypical student data may fail to recognize the needs of students with learning disabilities. Also, an AI tool trained on general population data might not recognize how a student with autism interprets mathematics symbols or instructions. Data privacy and security are also paramount. The collection of detailed personal learning data raises concerns about consent, data misuse, and long-term impacts on students' educational records. Transparent policies and ethical guidelines are essential to protect students and ensure that AI tools are used responsibly. Classroom Example: A rural school with limited bandwidth can't fully use adaptive tools, disadvantaging students further. Solution Suggestion: Offline versions of adaptive tools or hybrid instruction combining AI feedback with teacher insights. Ethical Note: Transparency in how AI scores and assigns mathematics content must be provided to educators and families.

Envisioning the Future: AI and Inclusive Mathematics Classrooms

Inclusive Education, as used in this study, is not limited to physical integration but is operationalized as the intentional design of digital and pedagogical experiences—enabled by AI—that accommodate and empower all learners, regardless of cognitive, linguistic, or psychological differences. In the future, AI should not replace mathematics teachers but amplify their ability to support every learner. Training teachers to interpret AI analytics, co-designing curriculum with special educators, and emphasizing human-AI collaboration are key. The future of AI in mathematics education should be centered on collaboration between technology and human educators. AI can manage tasks like personalized content delivery and progress tracking, while teachers provide emotional support, creativity, and human connection (Holmes, Bialik, & Fadel, 2021).

Teacher training will be essential in this future, as educators must understand how to effectively integrate AI tools into their instruction. Policymakers and school administrators must also invest in infrastructure and create equitable access to these technologies. Ultimately, AI should be viewed not as a replacement for traditional education but as an enhancement that makes mathematics learning more inclusive, especially for those who have historically been marginalized. When implemented ethically and thoughtfully, AI can ensure that every student has the opportunity to reach their full potential. Vision Example: A classroom where AI handles real-time data, while the teacher focuses on building mathematical reasoning through group discussions and manipulatives.

Visual Aid: Side-by-side snapshot: AI suggesting regrouping practice while teacher leads a number talk.

Curriculum Link: CCSSM Mathematical Practice Standards encourage reasoning and argument, which require both human interaction and digital scaffolding.

AI-Powered Dashboard for Monitoring Student Progress

Sections:

Student List: Names or IDs with flags (e.g., “At Risk,” “On Track”)

Skill Breakdown: Progress bars for key math skills (e.g., fractions, equations, number sense)

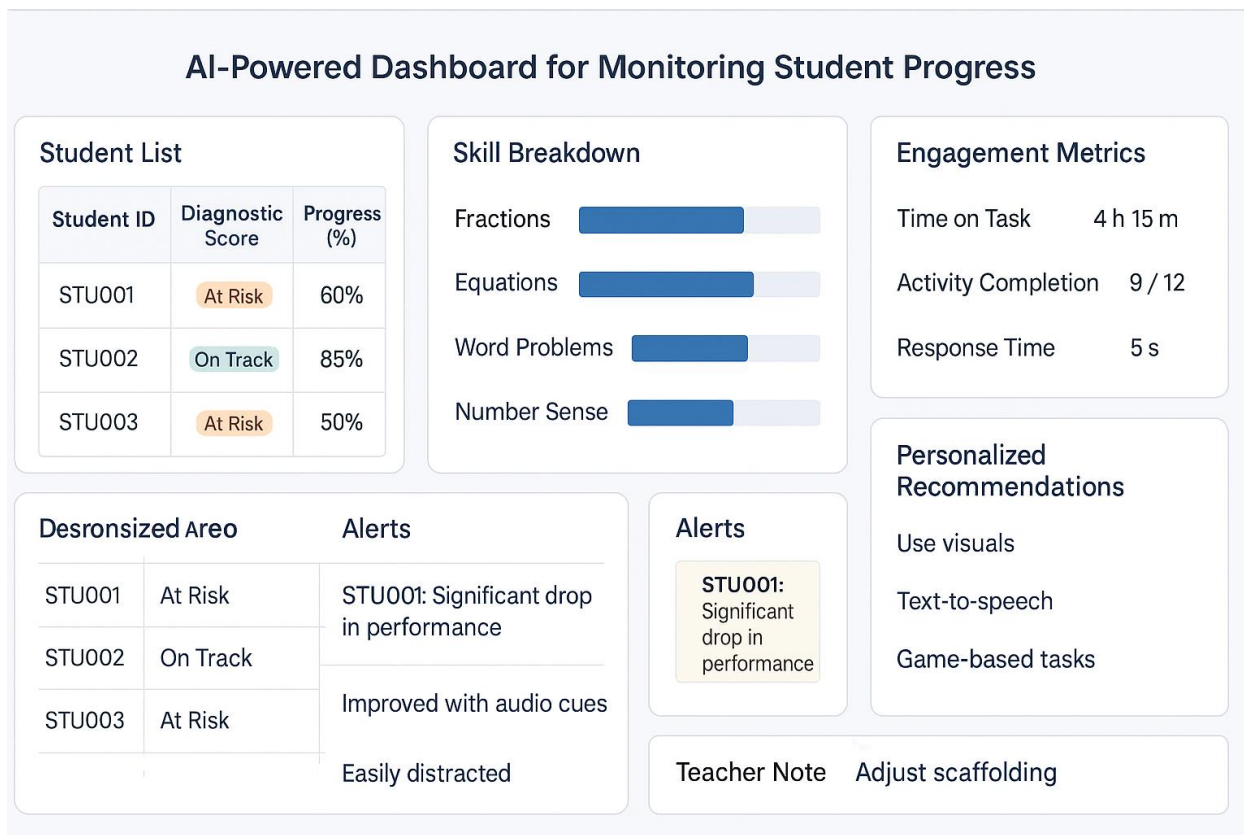
Personalized Recommendations: Suggested interventions or learning activities

Engagement Metrics: Time on task, activity completion rates, response time

Alerts: For students with significant drop in performance or signs of disengagement

Sample Data Table: AI Performance Analytics

Student ID	Diagnostic Score	Progress (%)	Key Struggle Area	AI Suggestion	Teacher Note
STU001	45%	60%	Fractions	Use visuals	Needs more scaffolding
STU002	72%	85%	Word Problems	Text-to-speech	Improved with audio cues
STU003	30%	50%	Number Sense	Game-based tasks	Easily distracted



III. Methodology

This study adopts a qualitative descriptive research design presents an informed opinion on the role of Artificial Intelligence (AI) in promoting inclusive mathematics education for students with learning disabilities. The perspective offered is grounded in practical experiences from inclusive classrooms, current educational technologies, and curriculum-aligned practices in mathematics instruction. Insights were drawn from:

Classroom observations in inclusive primary and secondary mathematics environments.

Informal conversations with educators who implement AI-supported tools (such as DreamBox, MATHia, and ALEKS).

Review of instructional materials aligned with national and state mathematics curriculum standards (e.g., NCTM, Common Core).

Review of scholarly literature on adaptive learning, personalized feedback, and inclusive pedagogies.

Rather than testing a hypothesis or collecting formal data, this paper synthesizes expert perspectives and existing educational practices to argue for how AI can bridge the gap between diverse learner needs and equitable mathematics achievement.

IV. Conclusion

Artificial Intelligence holds great promise for making mathematics education more inclusive for students with learning disabilities. By enabling adaptive learning, providing personalized support, facilitating long-term monitoring, and enhancing instructional strategies, AI can bridge many of the gaps left by traditional educational models. However, to fully realize this potential, challenges related to access, bias, and ethics must be proactively addressed. With the right investments in policy, training, and technology, AI can be a powerful ally in creating a more equitable and supportive learning environment for all students.

References

1. Baker, R. S., & Siemens, G. (2014). Educational data mining and learning analytics. *Cambridge Handbook of the Learning Sciences*, 2, 253–274.
2. Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. Jossey-Bass.
3. Common Core State Standards Initiative. (2010). Common Core State Standards for Mathematics. <https://www.corestandards.org/Math/>
4. Geary, D. C. (2011). *Cognitive predictors of achievement growth in mathematics: A five-year longitudinal study*. *Developmental Psychology*, 47(6), 1539–1552. <https://doi.org/10.1037/a0025510>
5. Haenlein, M., & Kaplan, A. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California Management Review*, 61(4), 5–14.
6. Heffernan, N. T., & Heffernan, C. L. (2014). The ASSISTments ecosystem: Building a platform that brings scientists and teachers together for minimally invasive research on human learning and teaching. *International Journal of Artificial Intelligence in Education*, 24(4), 470–497. <https://doi.org/10.1007/s40593-014-0024-x>
7. Holmes, W., Bialik, M., & Fadel, C. (2021). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. *Center for Curriculum Redesign*.
8. National Center for Learning Disabilities. (2020). The State of Learning Disabilities: Understanding the 1 in 5. Retrieved from <https://www.nclld.org>
9. National Council of Teachers of Mathematics. (2020). *Catalyzing change in early childhood and elementary mathematics: Initiating critical conversations*. Reston, VA: National Council of Teachers of Mathematics.
10. Pape, S. J., Lubinski, C. A., & Shin, H. (2017). Mathematics education for students with learning disabilities. In J. Cai (Ed.), *Compendium for research in mathematics education* (pp. 293–318). NCTM.
11. Russell, S. J., & Norvig, P. (2021). *Artificial Intelligence: A modern approach* (4th ed.). Pearson.
12. Shute, V. J., & Rahimi, S. (2021). Review of the literature on the potential of adaptive learning systems to personalize learning. *Educational Psychologist*, 56(4), 203–218.
13. Woolf, B. P., Arroyo, I., & Kulik, J. A. (2013). AI in education. In *The Cambridge Handbook of Artificial Intelligence* (pp. 644–669). Cambridge University Press.