ARTIFICIAL INTELLIGENCE TOOLS IN MATHEMATICS EDUCATION: A THEORETICAL INQUIRY INTO THEIR TRANSFORMATIVE POTENTIAL

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https://www.doi.org/10.34293/eduspectra.v7i2.05

Abstract
Artificial Intelligence (AI) is increasingly transforming education, particularly in mathematics, where AI offers tremendous promise to strengthen conceptual understanding, create customized learning experiences, and improve assessment. This paper offers a theoretical examination of AI tools in mathematics teaching and learning by focusing on five current platforms, Magic School AI, SchoolAI, Brisk Teaching, Auto Classmate, and Teach Easy, which represent a next generation of educator- and learner-centered AIs. These new kinds of technologies enable intelligent automation, adapatitve instruction, and real-time feedback for students and teachers. Using constructivist and cognitive learning theories, the researchers had examined how these kinds of tools may support learning, instructional design, and data-informed teaching pedagogy in mathematics classrooms. Additionally, the study addresses the challenges and ethical implications of expanding supportive technologies in education in order to provide insight into future-oriented educational practice.
Keywords*: Artificial Intelligence, Mathematics Education, Adaptive Learning, AI Tools, Digital Pedagogy, Constructivism, Educational Technology.*

1.   Introduction

The combination of AI and education is bringing about one of the biggest changes in pedagogy in recent times. As education changes toward using more data and personalized instruction worldwide, AI technologies are being used more in teaching and learning. As mathematics relies on order, sequential learning, and solving various problems, AI integration becomes highly possible within this subject (Holmes, Bialik, & Fadel, 2019; Luckin et al., 2016). AI technology provides new opportunities to manage challenges found in classrooms, for instance, low participation from students, students with a wide range of skills, limited access to quality teaching, and using the same teaching methods for everyone.

With AI in math education, students are offered adaptive content delivery, receive instant feedback, are regularly assessed, and benefit from tutoring by the software, so they learn more individually and interactively. With the support of these tools, educators can organize lessons, make tests, alter instruction for each student, and control behavior, and students receive quick feedback, take part in interactive problem-solving, and follow a learning practice designed for them (Chen, Chen, & Lin, 2020).

Internationally, Carnegie Learning, Squirrel AI, and Khan Academy have proved that using AI in education can greatly boost students' performance and interest in mathematics

(Zhou, Weng, & He, 2020). The National Education Policy (NEP) 2020 wasn't just another reason for Indian education to use AI; it suggested making technology a part of teaching in subjects like math and science (Ministry of Education, 2020). Indian government-run initiatives such as PM eVIDYA and DIKSHA prove that the country is dedicated to ensuring everyone has a chance at quality education by offering it online.

In this changing situation, Magic School AI, School AI, Brisk Teaching, Auto Classmate, and Teach Easy are some new AI tools made for teachers and learners to help them in the classroom. They are perfect examples of how AI is applied daily to teaching by helping with lesson and worksheet generation, giving students adaptive questions, giving personal feedback, and having digital helpers in the classroom. In the past, AI tools were made for a specific topic and were hard to use, but these platforms focus on being accessible and matching what teachers already teach in classrooms.

This paper looks into the impact of these five AI tools on teaching mathematics. It studies their main opportunities for learning, their relation to theories in this field, and how they could change math instruction from a traditional rote approach to one that involves deeper thinking and puts learners first. By viewing the subject from the perspectives of the world and Indian education, this paper adds to the existing work on using AI for lessons in mathematics and select options for smartly and equally integrating it into schools.

2.   Theoretical Foundations: AI and Learning Sciences

The integration of Artificial Intelligence (AI) in education draws upon multiple theoretical paradigms within the learning sciences, particularly constructivism, cognitive development theory, and instructional design models. These frameworks provide the conceptual foundation for understanding how AI can enhance teaching and learning processes, especially in a subject like mathematics that demands both conceptual understanding and procedural fluency.

Constructivist learning theory is the foundation of AI's use in education and believes that students create their own understanding of knowledge through experiments, thought, and communication (Piaget, 1972; Vygotsky, 1978). The theory states that learning happens actively, where students give meaning to the things they learn. Using AI, students benefit from constructivist theories as they advance through lessons based on their replies, can explore new topics quickly, get prompt guidance, and resolve problems themselves. In mathematics education, AI makes it possible to design lessons that stay in the Zone of Proximal Development, as described by Vygotsky. AI tools work as digital guides in this area, giving learners personalized help.

When it comes to education, cognitive learning theory greatly helps analyze the impact of AI. The theory is concerned with how people learn to store and access information. Mastering a new mathematical concept often puts a lot of pressure on students' thinking, since it combines their past experiences, working memory, and abstract ideas (Sweller, 1988). AI can help people by arranging data one step at a time, automating

simple tasks, and supplying relevant and quick feedback. Because of these mechanisms, students are able to put more energy into learning things that are relevant to them. As an example, a tool that helps deal with complicated tasks one step at a time aids the learning process.

AI-supported instructional design also benefits from the use of Bloom's taxonomy of educational objectives (changed by Anderson & Krathwohl in 2001). AI in programs such as MagicSchool AI and TeachEasy has the expertise to make materials and assessments that fit with all types of thinking abilities starting from recall to more complex tasks. This way of structuring content creation allows teachers to plan problems that challenge students' thinking skills in math, which matches the goals of competency-based education.

In addition, being mindful of your mental processes is significant for doing well in mathematics. AI tools help students improve their ability to think and plan their problem-solving by suggesting they consider what they did wrong and what changes they could make. Using tools such as SchoolAI, which have real-time student interaction, students can receive supporting feedback and prompts that help them control their learning, making them more skilled in math.

The role of AI in education is also consistent with socio-cultural theory, which suggests that tools and artifacts play a key role in people's actions. AI in mathematics classrooms acts both as a tool for sharing content and as something that influences how students interact with others. It allows students to connect, focuses their activities, and gives them useful intellectual resources.

Essentially, using AI in teaching math is built on sound educational methods, not only on new technology. It combines some of the leading learning ideas, like constructivism, cognitive processing, metacognition, and instructional scaffolding. Overall, these theories prove that AI can be a smart companion in learning math, meeting personal requirements, encouraging better understanding, and raising the bar for teaching.

3.   Mathematics Education in the Age of Artificial Intelligence

Mathematics is commonly known as the logic language and is essential for helping people develop in problem-solving, critical thinking, and analytical reasoning. Still, traditional math education often deals with problems including memorizing answers, low levels of involvement, and the fact that quality instruction is not equally available (Boaler, 2016). With AI, students get new ways to address these problems thanks to personal learning paths, prompt feedback, and intelligent teaching methods.

AI platforms in the classroom are designed to update the learning content according to each student's unique needs. Adjusting to students' needs in the classroom supports their understanding, corrects any misunderstanding during lessons, and promotes learning by themselves, all of which are vital for doing well in math (Pane et al., 2014). AI tools also make it possible for teachers to give different students the help they require in mathematics.

4.   AI Tools in Mathematics Instruction: An Analytical Overview

As educational technology develops quickly, different AI tools are now available to help teachers plan, deliver lessons, evaluate students, and oversee the classroom. They aim to resolve serious issues in the teaching of math such as differentiating lessons, giving real-time feedback, showing concepts through graphics, and motivating students. Modern AI tools differ from older educational technology in that they act within the learning process to react to students' minds, past scores, and methods of learning. Five AI tools, such as MagicSchool AI, SchoolAI, Brisk Teaching, AutoClassmate, and TeachEasy, are analyzed for their theoretical and practical aspects, especially in relation to mathematics education.

4.1   MagicSchool AI: Automating Instructional Design and Differentiation

MagicSchool AI is a platform specially built for teachers, using AI and language processing to help them plan lessons, create various assignments, develop tests, make rubrics, manage parent relations, and other tasks. In its math teaching function, MagicSchool AI supports instructors by making lesson plans that are designed to follow curriculum and well-known taxonomies such as Bloom's taxonomy (being discussed in Anderson & Krathwohl in 2001). They can be adapted for various grades, topics, and the expertise teachers want students to achieve, which promotes both inclusion and different learning experiences.

Teachers can use MagicSchool AI to make several copies of an algebra lesson to fit students at different stages of learning. Using this tool to generate activities that focus on tasks in real life supports deeper levels of thinking. As tasks that take a lot of time are automated by MagicSchool AI, teachers can spend more time on important activities with students.

4.2   SchoolAI: Real-Time Learner Support and Intelligent Feedback

SchoolAI comes with a unique assistance system powered by AI with "student sidekicks" that can interact directly with students. These companions offer words of assistance by providing hints, reasons, and encouragement while students work on problem-solving tasks. Using this method in math teaching helps with correcting errors, repeating helpful methods, and sustaining students' attention.

The dashboard provides detailed information about each student's performance, which helps find trends in errors and sends alerts for needed actions. According to theory, SchoolAI is consistent with Vygotsky's ZPD because it helps students work on problems they cannot do independently. Intelligent systems used with teachers by SchoolAI allow the classroom to respond better and interact more fully with everyone's needs.

4.3   Brisk Teaching: Dynamic Content Transformation and Differentiated Assessment

Brisk Teaching is created to allow rapid development of materials for teaching. The platform enables teachers to add prompts or upload materials and right away get

educational items such as simplified questions, quizzes, assignments, and summaries. In math classes, Brisk Teaching helps you make practice exercises, instructional diagrams, and assessments that match each group's needs.

The flexibility of the tool allows teachers to set up tasks that fit the needs of all kinds of learners, beginning with basic needs and going to challenging tasks. Brisk Teaching makes it easier to use Universal Design for Learning (UDL), as it allows material to be expressed in various ways and students to communicate in several ways. Since it is adaptable, it supports effective teaching in mathematics classes that include people with different learning pace and needs.

4.4   AutoClassmate: Streamlining Content Creation and Enhancing Conceptual Understanding

AutoClassmate helps in creating classroom resources, making summaries, starting analogy explanations, making formative questions, and revision guides. The strength of a well-written textbook is in explaining complicated concepts using comparison and examples that students can understand. When subjects like abstract reasoning in math cause students trouble, these steps are most helpful.

As a case in point, while covering linear equations, AutoClassmate uses analogy prompts to link math concepts to real-life examples, which supports students to develop a schema and learn more easily. With the tool, it's easy to produce both review sheets and flashcards, helping students use an effective technique for remembering information for a long time.

4.5   TeachEasy: Structuring Pedagogy through Cognitive-Aligned Content

TeachEasy comes with materials that meet educational requirements and can help teachers develop unique lesson plans, worksheets, tests, and grading guidelines. It follows ideas from Bloom's taxonomy and outcome-based education to make sure the curriculum is well-matched. In the classroom, TeachEasy lets teachers set up tasks that go from just remembering facts to using and examining them.

The tool makes it easier to assess students by including example templates and checklists for giving feedback and prompting them to reflect. Because the system is very easy to use, it helps educators who lack technology skills to start using AI sooner in their routines. With TeachEasy, teachers do not need to spend as much time planning and can ensure that activities are aimed at particular learning objectives and indicate what students are expected to learn.

5.   Pedagogical Implications in Mathematics Education

The integration of AI tools in mathematics education offers a broad spectrum of pedagogical benefits that extend beyond mere technological convenience. These tools are deeply interwoven with instructional design, learner engagement, and assessment

practices, reshaping how mathematics is taught and experienced. The following implications highlight how the affordances of AI technologies align with contemporary educational goals.

5.1   Differentiation and Equity

AI-based personalization may effectively help students learn better by meeting the multiple learning needs present in any classroom. Brisk Teaching and TeachEasy tools assist in making different question sets, helpful feedback, and appropriate activities that students need to learn math. When content is adjusted to each person's learning profile, these tools ensure that both fast and slow learners are provided with what they need (Luckin et al., 2016). Having these adaptive skills fits with the UDL, which highlights the use of numerous ways to show what someone knows, take part, and express themselves (Meyer, Rose, & Gordon, 2014).

5.2   Formative Assessment and Feedback

It is very important to use formative assessment when deciding on teaching and checking student progress. Tools such as SchoolAI and TeachEasy make it possible to collect information on how students perform and provide instant comments. Teachers can use these platforms to spot mistakes students make and act right away. Because of AI, students receive immediate feedback and grow more aware of their learning, helping improve things further (Black & Wiliam, 2009; Kay, Leung, & Tangney, 2019).

5.3   Efficiency in Instructional Planning

Making lesson plans and creating resources regularly takes up a lot of teachers' time and leaves them less able to focus on unique and personalized learning. MagicSchool AI and AutoClassmate greatly reduce the time spent planning routinely because they produce lesson plans, worksheets, quizzes, and rubrics on their own. This makes it available for teachers to focus their time and brains on unique class activities, managing students, and different learning methods. When teachers have a lot of work to do, this level of efficiency is particularly helpful in big and resource-limited classrooms (Holmes et al., 2019).

5.4   Enhanced Student Engagement

Math anxiety, feeling that one is not part of the lesson, and the unimportance of the content continue to be big problems for students. These AI tools help make mathematics discussion more engaging by letting students learn in interactive, game-like ways and with lessons suited to each student's needs. School AI allows students to interact in real time and handle problems on their own, while Brisk Teaching lets them use a variety of formats to learn.

5.5   Data-Informed Instructional Decision-Making

Since AI platforms rely heavily on data, teachers can see comprehensive reports on how well their students are performing and which behaviors they show. Data gathered on learners by SchoolAI can be turned into dashboards and used to prompt the right interventions. Using these analytics, teachers are able to spot learners who are having difficulties, try new ways to teach, and use individualized help, all of which is supportive of data-driven approaches in education (Ifenthaler & Yau, 2020). The continuous data provided by AI help educators to keep assessment development at the front of their minds.

6.   Challenges and Ethical Considerations

While AI offers considerable pedagogical advantages, its integration in mathematics education is not without limitations. Sustainable and equitable implementation demands critical reflection on infrastructural, pedagogical, and ethical challenges.

6.1   Infrastructure Gaps and Digital Divides

Although there are many educational technologies now, inadequate infrastructure in certain schools makes it hard for them to use AI. There are still big differences in internet availability, access to gadgets, and technical support in different schools and colleges. Such gaps have the potential to extend current inquirities, and children belonging to marginalized backgrounds may not take advantage of AI technology in education. It is important to invest in modern technology and make sure policies are welcoming to all by closing digital divides.

6.2   Teacher Training and Professional Readiness

Besides gaining familiarity with the tools, an educator should know how to interpret data, adjust assignments, and handle future challenges with responsibility. Various educators in traditional systems might not have received the necessary instruction to include AI into what they do (Joshi & Mehta, 2022). If teachers are not trained well in AI, they could rely only on its basics and this might negatively affect teaching and student performance. Practicing teaching skills in AI-related courses helps teachers make sure AI is an addition, not a substitution, for their lessons' outcomes.

6.3   Algorithmic Transparency and Fairness

Many times, AI systems function in a way that we cannot clearly understand how the decision-making works. Since it is difficult to understand how decisions are made by algorithms, there are issues with fairness, bias, and responsibility for using them (Williamson & Eynon, 2020). As an example, AI trained with limited data could accidentally favor some students over others who have different types of education or culture. AI models that people can easily understand are needed to promote fairness and gain trust in the decisions made in education.

6.4   Student Data Privacy and Ethical Use

To use AI in education, educators are required to collect and study large amounts of student data, for example, their grades, how they behave in class, and occasionally their biometric information. With no proper data governance frameworks, there becomes a bigger chance for data to be used for misguidance, spying, or breaches. To be used ethically, AI should have clear rules that guarantee that users know what will happen with their data, that data is not collected in over-excessive ways, it is stored securely, and people can choose whether or not to take part (UNESCO, 2021). Students and educators ought to learn about data rights and digital citizenship so they can take part appropriately in learning with AI.

7.   Conclusion

Nowadays, AI is no longer an upcoming trend but has already made a difference in math education. MagicSchool AI, SchoolAI, Brisk Teaching, AutoClassmate, and TeachEasy prove how AI can assist with planning classes, offer individualized help, give instant feedback, and ensure fairness. Making use of AI technologies in lessons supported by education theories can help make mathematics a source of excitement and achievement for students. We should focus in the future on models of AI integration that are adoptable, right, and involve all groups, giving importance to both human decisions and technology.

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