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A.I INTEGRATION FOR IMPROVING SELF EFFICACY OF SECONDARY SCHOOL MATHEMATICS TEACHERS

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Abstract:

Mathematics education plays a vital role in students' cognitive development throughout schooling, with teachers at its core. Yet mathematics teachers often struggle to address students' learning difficulties, rigid curricula, examination patterns, and evolving teaching methodologies. To fully engage and enrich every child, they leave no stone unturned, increasingly leveraging technologies to bridge these gaps. The advent of the internet and artificial intelligence (AI) has made it easier for teachers to plan lessons, assign and monitor homework, create questionnaires and workbooks, and provide timely feedback—boosting their self-efficacy and fostering professional development. Few studies have explored this intersection, leaving ample scope for further research. This paper examines AI integration strategies for mathematics teachers, their implications for enhancing teacher self-efficacy, and applications in the Indian context.

Key words: Mathematics, Self-Efficacy, AI, Teachers

1. Introduction:

Mathematics is one of three core subjects taught in all Indian secondary schools. It builds foundational skills essential for students' cognitive growth, career readiness, and real-world problem-solving, while playing a critical role during adolescence in developing logical reasoning and rational thinking. Mathematics forms an integral part of STEM (Science, Technology, Engineering, and Mathematics), blending seamlessly with the other disciplines. It equips students to manage realistic situations, from financial literacy to technology-driven careers.

At secondary schools, mathematics teachers play a pivotal role in guiding students to master numeracy, problem-solving, and analytical skills essential for STEM fields and everyday life. They develop and deliver engaging lessons on topics like algebra, geometry, trigonometry, and statistics, using proven methods such as visualization aids. They also assess student progress through tests, homework, assignments, and impart timely feedback. In India, teachers align instruction with CBSE, ICSE, or state curricula to foster deep understanding amid challenges like math anxiety and disinterest.

Teaching mathematics is challenging because it demands discipline and builds on students' prior knowledge. Teachers often experience stress, leading to fatigue and disinterest. Yet, at the secondary stage, the primary goals are to instill number sense and logical thinking in students, placing teachers in a critical role. As a core conceptual subject, mathematics adds extra responsibility. Teachers must balance explicit instruction with problem-solving and collaborative methods to develop logical thinking, critical skills, and readiness for diverse careers.

2. Theoretical framework

Mathematics education has long been identified as a core of cognitive development, yet many secondary school teachers grapple with self-efficacy—**the belief in their ability to teach effectively.** In an age where Artificial Intelligence is redesigning industries, its integration into classrooms offers a rare opportunity: empowering teachers with tools that augment confidence, adaptability, and instructional effectiveness.

2.1 Self Efficacy

"Self-efficacy is the belief in one's capabilities to organize and execute the sources of action required to manage the prospective situations."

- Bandura, 1986.

Rotter and Bandura were the pioneers in developing the concept of self-efficacy. Self-efficacy is the ability to perform activities. It is considered as the premature cognitive determinant of whether an individual will attempt a given behavior. Self-Efficacy can be considered as a self-tool in determining behaviors relating to self-regulation, goal achievement, task completion, achievement strivings, coping strategies, and career competencies. In entirety, it can be deemed as the 'belief system' one has in his or her life or profession. Self-efficacy can thus be considered as the motivational factor to impulse oneself into the accomplishment.

In 1986, Bandura, in his Social-Cognitive theory, emphasized the significant role of self-efficacy in human cognition, motivation, and behavior. He was of the firm opinion that our beliefs in our abilities powerfully affect our behavior, motivation and our success or failure. Continuing further, Bandura states these four ways of achieving Self Efficacy:

1. **Mastery Experiences** - Successfully performing a task builds strong belief in an individual. At the same time, repeated failures make it weak.
2. **Vicarious Experiences** - Seeing people much like themselves can increase one's ability to perform and complete the task.
3. **Social persuasion (verbal):** Getting positive feedback, encouragement and affirmation from others can really increase one's self-efficacy.
4. **Physiological and emotional states:** Emotions like stress, fatigue and excitement provide information about the person.

2.2 Artificial Intelligence

"Artificial intelligence is the new electricity." — Andrew NG

According to Google Cloud, "Artificial intelligence (AI) is a set of technologies that empowers computers to learn, reason, and perform a variety of advanced tasks in ways that used to require human intelligence, such as understanding language, analyzing data, and even providing helpful suggestions. It's a transformational technology that can bring meaningful and positive change to people and societies and the world."

AI involves many diverse disciplines like computer science, data analytics, statistics, hardware engineering, software engineering, linguistics, neuroscience, philosophy, and psychology.

Artificial intelligence fundamentally relies on data, algorithms, and computational power. Artificial intelligence tools can replace any kind of human work and education is not an exception. Intelligent tutoring systems and adaptive platforms of AI can personalize math instruction to the large extent, addressing teacher readiness and boosting self-efficacy of mathematics teachers.

2.3 Mathematics teaching and AI integration

"The only way to learn mathematics is to do mathematics."

- Paul Halmos

Effective mathematics teaching engages students through active methods and real-world connections. Research-backed strategies like Discovery learning, Visual learning, Problem-solving, Embedded learning and Hybrid learning build up deep understanding in the students. The mathematics education at secondary level faces few challenges like Abstract concepts, Inadequate teaching methods, Teacher stress and burnout since secondary school students also struggle with:

- Poor prior knowledge in algebra, geometry, and arithmetic to some extent
- Trigonometry and Statistics to a larger extent.

For a mathematics teacher, inappropriate teaching methods, inability to use visuals in the classroom are yet few vulnerable areas. Insufficient resources, inadequate teacher training, non-support from the parents are few stressors among all educators. Added to this is the large classroom size and anxiety.

To address these challenges, AI integration presents five key areas of opportunity for enhancing teacher self-efficacy:

2.3.1 Lesson planning: Teachers used customized math lessons which makes them free time and proving teaching techniques. Magic School AI, Math GPT.ai, Khan Migo from Khan Academy can be helpful in this regard. These AI tools help in developing adaptive lesson planning that are aligned with curriculum, thus reducing stress and building confidence in teachers. The efficiency of lesson planning can be increased by generating emails to parents with syllabus updates, this helps a teacher to reduce administrative burnout that often erodes their emotional resilience and teaching confidence. The AI tools can automate feedback and prompt whether the teacher is in the right path, lecturing too much or asking the relevant questions or is able to ask open-ended questions.

Mustafa Erol Merve Canbeldek Erol, Ahmet Erol and Feride Gök Çolak in their research(2025), **Exploring the Relationship between Teachers' AI Attitudes, AI Self-Efficacy, and AI Technological Pedagogical Content Knowledge conducted a study on** 524 teachers working in preschool and primary schools teachers. Pearson correlation analysis and Structural Equation Modelling (SEM) were used for data analysis. It stated that teachers' AI self-efficacy is significantly and positively associated with AI attitudes AI-TPACK played a mediating role in the relationship between attitudes toward AI and AI self-efficacy.

AI analytics from platforms such as 'intelligent tutoring systems' pose instant insights on student data, increasing efficacy in engagement and assessment. Middle school math teachers in AI-PD programs reported student performance gains (0.18 SD), highlighting their instructional self-belief. Moral use avoids hazards, focusing on augmentation-like co-designing culturally relevant plans like, Kannada contexts.

2.3.2 Content Creation. Often teachers are forced to create content based on the mathematics curriculum. It is time-consuming if a teacher needs to generate four or five versions of the same problem before applying it to the class. AI tools like *Edu-Aid, CuriePod* can instantly generate multiple versions of a mathematics problem. It does levels. This enables teacher mastery and increase engagement.

2.3.3 Automated feedback*:* Students progress and adaptive feedback can be set. These in turn help the students to celebrate small wins. These incremental wins help them enhance their self-beliefs. ChatGPT usage at high schools is linked to higher vicarious experiences score indirectly via cognitive scaffolding. Those who belong to Lost in Class's category can be benefited at most. AI should be properly integrated with 'human-mode' exercises to avoid over-reliance (tools like Tutor Co-Pilot, suggest strategies to teachers while they are tutoring).

Adaptive platforms like ALEKS, MATHIA provide dashboards that state the exact stage at which the student's 'logic chain' is breaking. This enables the teacher not only to guess but to intervene data precisely and aid to suggest authoritative solutions. During 'live problem-solving' sessions, teachers can get the help of 'hint sequences' that few AIs provide, thereby rescuing the stuck children.

AI incidentally increases mathematics students' self-efficacy through teacher empowerment, personalized learning paths that foster mastery experiences and greater engagement, creating a virtuous cycle aligned with Bandura's theory. For instance, when AI elevates teacher efficacy—as in NCERT programs—educators deliver more convinced, adaptive instruction, showing success for students. This intervention effect is evident in studies where AI tools like ChatGPT correlate with student math self-efficacy (r=0.542), through improved cognitive engagement. The micro-goals and adaptive feedback (e.g., intelligent tutors), set by AI prompts incremental wins that enhance self-belief without direct confidence prompts. The use of ChatGPT at high schools linked to higher "vicarious experiences" scores (M=3.99), indirectly via cognitive framework in algebra/geometry. In India, CBSE AI curricula from Class 3-12 support self-paced mathematics, reducing disparities in secondary efficacy.

2.3.4 Professional Development*:* Tailored training modules enable every teacher to engage in mathematics pedagogy and adaptive assessments. Pre-service mathematics teachers when imparted GPT skills reported $F=8.589$, $P<0.05$ efficacy. Virtual mentors provide suggestions on classroom management and pedagogy, reinforcing their confidence. On the other hand, AI can identify gaps in teacher knowledge and recommend targeted training modules, enabling skill enhancement.

Jijian Lu Et al in their study "Supporting Teachers' Professional Development with Generative AI: The Effects on Higher Order Thinking and Self-Efficacy", (2026) on 215 preservice mathematics, science and computer teachers from a university in China, found that teachers who used generative AI for teachers' professional development, were considerably higher than those of the control group, both in teacher self-efficacy ($F = 8.589$, $p = 0.0084 < 0.05$) and higher order thinking ($F = 7.217$, $p = 0.008 < 0.05$). It proved that generative AI can be effective in supporting teachers' professional development.

2.3.5 Peer Collaboration and Non-judgmental Personalized Support: AI facilitates virtual communities for sharing mathematics resources and vicarious experiences via success stories. Personalized learning paths and enhanced engagements certainly improve confidence in children at the same time improve self-efficacy of a teacher. Improving homework using Tutor Chat Boards. Tutor Chat bots, gamified quizzes indirectly strengthen persistence and resilience. It offers tailored assistance, creates a safe space for open communication, self-reflection, genuine growth without any personal bias, criticism, or conditions. This, in turn, reduce stigma and encourage trust on the part of students.

Allan Mesa Canonigo conducted a study "Levering AI to Enhance Students' Conceptual Understanding and Confidence in Mathematics", (2024). The goal of this study was to investigate the effects of AI tools, such as GeoGebra and ChatGPT on students' conceptual understanding and self-efficacy in a mathematics classroom setting that focused on collaborative learning, teacher-student discussions and problem-solving. The major findings was that a noteworthy enhancement in students' conceptual understanding and self-efficacy belief when AI tools are incorporated into mathematics education.

Tools like MagicSchool.ai or MathGPT.ai generate 'specially made' mathematics lessons, quizzes and Socratic prompts, freeing time and confirming teaching efficiency of teachers to build confidence in the students.

AI chatbots like ChatGPT or Khan Academy provide round the clock doubt clarification without peer judgment, cutting fear of mistakes (44% student agreement) and building safe trial-and-error habits. Secondary students evaluated AI high for entertaining mathematics learning, correlating with lower anxiety and advanced engagement.

3. The way forward:

With the above concerns, a tentative framework for mathematics teachers, for the smooth functioning and rational amalgamation of AI can be considered as stated below:

Step 1:Awareness: Build AI awareness among educators and stakeholders. Let everyone know the implications of AI and its potentials in the education field.

Step 2:Training: Imparting relevant training to all the stakeholders not only teachers.

Step 3: Integration: Integrate AI into lesson plans using AI generators. Develop lesson.

plans that use differentiated content. Use it in the real classrooms to know the possible outcomes.

Step 4: Tracking: Track students' progress in the class using differentiated tools. Khan Academy has its own tracking tool.

Step 5: Engage: Enhance student engagement by using AI activities, games, simulations, quizzes etc.

Step 6: Feedback: Programmed learning enhances regular feedback, and it acts as a positive enforcer.

Step 7: Equity access: Ensure equal roles for all the students and responsibilities of all the stake holders.

Step 8: Reflect: Provide AI-based professional development. Encourage to reflect their experiences and learnings in journals, which get circulated internally among all the teachers.

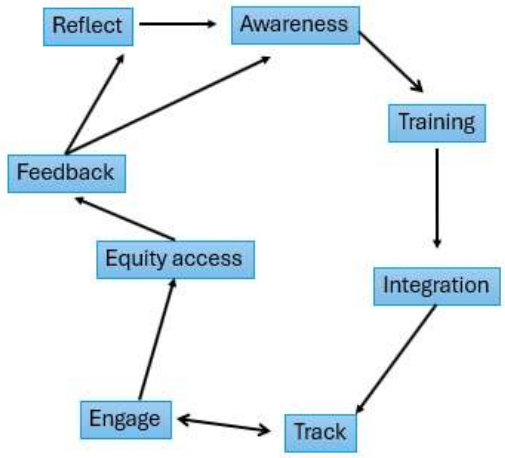

Fig 1: AI framework

Pre-2020 focused on student tools; post-NEP 2020 in India emphasizes teacher PD, with CBSE targeting 1 crore educators. Key: AI shifts teachers from content delivery to facilitation, boosting self-efficacy but risking over-reliance. For instance, to elevate teacher efficacy NCERT currently planning programs more persuaded, adaptive instruction, modeling success for students. In India, IITM Pravartak's **"AI for Educators"** course builds AI literacy for competence and student-centered mathematics learning, reducing stress thru efficient plans.

4. Challenges, Considerations, and mitigation strategies:

1. **Overdependence or reliance on AI** can kill creativity and outrun human touch, losing emotional gradients.
2. **Age** - All the teachers are not tech-savvy. Seniors tend to withdraw from the scene.
3. **Equity issues**: AI tools may vary across schools and regions. It may potentially widen the gap, cause disruptions, and havoc among the stakeholders.
4. **Incessant Internet**: For AI tools to work efficiently, the internet training centers like CIET, BRC should equip with lot of AI stuff, internet facilities, and train teachers on the long run.
5. **Lack of infrastructure**: With the lack of infrastructure, the training does not get completed to the core.

5. Conclusion:

The following table synthesizes how AI applications address each of Bandura's four efficacy sources.

Table 1- Bandura's sources of Self-Efficacy with AI integration

Efficacy Source	AI Application	Resulting Teacher Mindset
Mastery	AI-driven differentiation and instant data dashboards.	"I can reach every student of my class, regardless of their level."
Vicarious	AI simulations of "best practice" teaching scenarios.	"I've seen how this strategy works; Even I am confident of doing it"
Persuasion	AI coaching and real-time instructional prompts.	"I have a co-pilot who supports my decisions in the moment."
Emotional	Automating grading and complex visualization.	"I am less stressed I can focus more on the joy of mathematics."

For the teachers who wish to contribute at length to the mathematics class, AI can really be a 'Technical trailblazer' and overcome digital divide thus enhancing their self-efficacy. This ensures that teachers are in pace with technology and pedagogy, so that they impart right, requisite, and robust education to children making India future ready and *Atma Nirbhar.* AI can work as a 'magical staff' and 'magical stuff' guiding teachers and students through the labyrinth of numbers.

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