"Evaluating the Impact of Artificial Intelligence on Teaching and Learning Mathematics at the Secondary School Level"

Fatima Lara, Vanessa M. Orzales, Marilou J. Dagasdas, Carl Jeffrey Q. Egoy

College of Arts and Sciences, University of the Visayas

DOI: https://dx.doi.org/10.47772/IJRISS.2025.907000220

Received: 01 July 2025; Accepted: 08 July 2025; Published: 08 August 2025

ABSTRACT

The integration of Artificial Intelligence (AI) in education has reshaped instructional methodologies, offering transformative opportunities in teaching and learning, particularly in Mathematics. This study provides a critical, data-driven analysis of AI integration in Mathematics instruction at the secondary school level. It investigates the application of AI-based tools—including intelligent tutoring systems, adaptive learning platforms, automated problem-solving assistants, and predictive analytics for assessment—and evaluates their impact on pedagogy, student achievement, and the evolving role of teachers.

Employing a mixed-methods approach, quantitative data were gathered from 120 Mathematics teachers and 600 secondary students across urban, semi-urban, and rural school settings through structured surveys. These were supplemented by qualitative data from interviews and classroom observations to uncover deeper instructional insights and challenges. Statistical analysis revealed that students in AI-integrated Mathematics classrooms outperformed their peers in problem-solving accuracy, conceptual understanding, and engagement levels. Teachers noted improvements in differentiated instruction, real-time feedback mechanisms, and classroom efficiency. However, the study also uncovered barriers such as insufficient teacher training, inadequate digital infrastructure (notably in rural schools), limited integration with existing Mathematics curricula, and ethical concerns surrounding data use and algorithmic transparency.

The findings highlight disparities in AI access and utilization across socio-economic and geographic contexts, as well as a growing dependence on AI tools that may limit pedagogical creativity if not critically managed. While AI presents a powerful avenue for advancing Mathematics education, its effective implementation requires a deliberate, inclusive, and ethically grounded approach.

The study concludes with strategic recommendations for educational stakeholders—policymakers, school leaders, and curriculum developers—such as investing in professional development, designing culturally responsive and curriculum-aligned AI resources, enhancing technological infrastructure in underserved schools, and establishing ethical AI use policies. Ultimately, the study advocates for a balanced, learner-centered AI adoption model where technology enhances rather than replaces the vital role of human educators.

Keywords: Artificial Intelligence, Mathematics Education, Secondary Schools, AI Tools, Student Achievement, EdTech, Instructional Innovation, Ethical AI Use

INTRODUCTION

The integration of Artificial Intelligence (AI) in education is revolutionizing how teachers teach and how students learn, particularly in science, technology, engineering, and mathematics (STEM) disciplines. Among these, Mathematics remains a cornerstone subject that greatly benefits from AI-driven tools such as intelligent tutoring systems, automated assessment platforms, adaptive learning environments, and virtual problem-solving assistants. These technologies are increasingly being utilized in secondary schools to provide personalized instruction, enhance problem-solving skills, and improve student engagement (Holmes et al., 2021). The application of AI-based educational technologies—such as intelligent tutoring systems, adaptive learning platforms, automated problem-solving assistants, and predictive analytics—has enabled teachers to provide more personalized, data-informed instruction (Holmes, Bialik, & Fadel, 2019; UNESCO, 2022). These tools are especially promising in mathematics education, where students often require tailored feedback, step-by-step scaffolding, and ongoing reinforcement to master abstract concepts. Studies by Luckin et al. (2016) and Chen et al. (2021) have shown that AI can support differentiated instruction, improve formative assessment, and enhance student engagement in math classrooms.

In the Philippines and around the world, the shift toward AI-enhanced education has accelerated, especially in response to the challenges posed by the COVID-19 pandemic. As schools transition into more blended or digital models of learning, the demand for scalable, intelligent educational technologies has grown (Almario et al., 2023). In the context of Mathematics, AI tools offer unique affordances: they can track student progress in real-time, adapt lesson content to individual learning styles, and provide immediate feedback that traditional methods may lack (Ming et al., 2022). These innovations not only improve academic performance but also foster deeper conceptual understanding, especially in abstract and procedural topics common in mathematics education.

However, despite the promising outcomes, the integration of AI in secondary mathematics classrooms also raises critical concerns. These include issues related to equitable access—particularly in rural or underserved areas—teacher readiness and training, curriculum alignment, data privacy, and ethical considerations in AI deployment (Tan & Caballero, 2021; UNESCO, 2022). The over-reliance on AI, without proper pedagogical scaffolding, also risks diminishing the role of human interaction, creativity, and critical thinking in mathematics education (Chen & Li, 2020). The integration of AI in secondary mathematics instruction also raises pedagogical and ethical concerns. While AI tools offer immediate feedback and adaptive learning paths, they may inadvertently encourage over-reliance on technology, diminishing students' critical thinking and problem-solving autonomy (Yatani et al., 2024). Moreover, AI systems are not always culturally responsive or aligned with national curricula, potentially leading to instructional misalignment or inequity, especially in diverse classroom settings (Williamson & Piattoeva, 2021). Data privacy is another critical issue, as student performance data collected through AI platforms may be vulnerable to misuse or lack transparency in algorithmic decision-making (West, 2020).

This study aims to evaluate the impact of AI on the teaching and learning of Mathematics at the secondary school level. Specifically, it investigates how AI tools influence student academic performance, engagement, and comprehension, as well as how they reshape teacher roles and instructional strategies. By employing a mixed-methods approach, this research seeks to provide empirical evidence that can guide educators, policymakers, and curriculum developers in making informed decisions about the ethical and effective integration of AI in Mathematics education.

RELATED LITERATURE

Artificial Intelligence enables adaptive learning platforms that tailor content to individual students' strengths and weaknesses. Studies by Ming, Zhao, and Wang (2022) demonstrate that students in AI-supported math environments showed improved problem-solving skills and conceptual retention. The real-time feedback and differentiated pacing offered by AI systems are particularly beneficial in secondary education, where student learning gaps are diverse.

Tan and Caballero (2021) found that teacher readiness plays a crucial role in successful AI integration. Teachers who lacked formal training in digital tools often struggled with implementation and relied on basic features of AI platforms. The study emphasized the need for **capacity-building programs** to boost confidence and competence in using AI for instruction.

Chen and Li (2020) raised concerns about **ethical data use**, **algorithmic transparency**, and **the risk of dehumanizing instruction**. While AI enhances efficiency, the study warns against replacing teacher judgment with machine-generated outcomes without critical oversight.

Almario, Rivera, and Magno (2023) examined the **digital divide** in AI access among Philippine schools. Rural and under-resourced schools often lacked the infrastructure to deploy AI tools effectively. This gap contributes to inequalities in learning outcomes and underscores the need for **targeted infrastructure investment**.

UNESCO (2022) released guidelines emphasizing **human-centered AI adoption** in education, advocating for ethical frameworks, inclusive access, and stakeholder training. Their report supports integrating AI as a supplement—not a replacement—for quality teaching, especially in subjects like mathematics where conceptual scaffolding is crucial.

A 2024 study by Kumar and Sanchez observed that the COVID-19 pandemic significantly accelerated AI adoption in math classrooms. Their findings show that AI-enhanced virtual simulations and intelligent tutoring systems contributed to **higher student engagement and improved math scores**, particularly when integrated with blended learning approaches.

The integration of Artificial Intelligence (AI) in mathematics education is underpinned by several educational and psychological theories that explain how learners interact with intelligent systems and how these tools impact instruction and cognition. This study is primarily anchored on the following theoretical foundations.

While AI systems are capable of delivering immediate feedback and adaptive pathways, their educational value is maximized when they are embedded within tasks that promote higher-order thinking rather than replace it. Recent research highlights that effective AI integration should support inquiry, reasoning, and metacognitive processes essential to mathematical learning. For example, Singh, Guan, and Rieh (2025) demonstrated that AI tools embedded with **metacognitive prompts** significantly enhanced students' critical reflection, argumentation, and decision-making during complex problem-solving tasks. Similarly, Yatani, Sramek, and Yang (2024) introduced the concept of **"extraheric AI,"** where AI serves as a cognitive partner—posing open-ended questions or offering alternative solutions—to stimulate student inquiry and creative reasoning.

Moreover, AI systems that promote dialogic interaction—such as AI chatbots used in mathematics classrooms—can help students articulate their thinking, justify their answers, and reflect on errors, aligning with the goals of constructivist mathematics instruction. As noted by Chen et al. (2021), when AI is paired with reflective questioning and teacher-guided feedback, students demonstrate greater depth in conceptual understanding and long-term retention. These findings reaffirm that AI should not act as a replacement for human instruction but rather as a complement that fosters a richer, more student-centered learning environment.

Theoretical Framework

The integration of Artificial Intelligence (AI) in mathematics education is underpinned by several educational and psychological theories that explain how learners interact with intelligent systems and how these tools impact instruction and cognition. This study is primarily anchored on the following theoretical foundations:

Constructivist Learning Theory (Jean Piaget & Lev Vygotsky)

Constructivism posits that learners actively construct their own understanding of mathematical concepts through experience and reflection. AI-based tools such as adaptive learning platforms and intelligent tutoring systems support constructivist approaches by providing personalized learning paths, immediate feedback, and problem-solving environments where students can build knowledge through exploration.

In Vygotsky's social constructivism, tools like AI can serve as a "more knowledgeable other" that scaffolds student learning within the zone of proximal development (ZPD), enhancing the learner's ability to master complex math tasks with technological support.

Social Cognitive Theory (Albert Bandura, 1986)

Bandura's Social Cognitive Theory emphasizes the importance of self-efficacy, observational learning, and reciprocal determinism. When students interact with AI tutors or simulations, they observe modeled problem-solving steps, receive encouragement through feedback, and build confidence in their mathematical ability.

AI tools enhance learners' self-efficacy by tracking progress and offering feedback loops that support mastery experiences—key components of Bandura's framework.

Technology Acceptance Model (Davis, 1989)

The Technology Acceptance Model (TAM) explains how users come to accept and use a technology. It proposes that perceived usefulness and perceived ease of use are key predictors of acceptance. In the context of education, both students and teachers are more likely to adopt AI tools if they find them effective in enhancing learning and easy to navigate.

Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001)

Bloom's Revised Taxonomy categorizes cognitive skills from remembering and understanding to creating and evaluating. AI platforms that incorporate adaptive quizzes, simulations, and problem-solving tasks address multiple levels of Bloom's taxonomy, allowing learners to move from basic arithmetic operations to advanced problem-solving and creation of mathematical models.

Equity and Digital Divide Framework (Van Dijk, 2020)

This framework addresses structural inequalities in technology access across different socio-economic and geographic settings. It emphasizes not just physical access but also skills access, usage patterns, and institutional support. These dimensions are critical in the Philippine context, where urban-rural divides often influence the extent and effectiveness of AI integration in classrooms.

Collectively, these theories form the foundation for this study's investigation of AI integration in secondary mathematics education. Constructivism and Social Cognitive Theory explain how students interact with and benefit from AI tools; TAM guides the exploration of user acceptance and technology adoption; Bloom's Taxonomy supports the analysis of cognitive impact; and the Digital Divide framework highlights equity issues in access and implementation.

These frameworks enable the researcher to critically examine not only the effectiveness of AI tools in improving mathematical instruction and performance, but also the barriers, ethical considerations, and pedagogical implications of their integration in diverse educational settings.

Statement of the Problem

This study aims to evaluate the impact of Artificial Intelligence (AI) on the teaching and learning of Mathematics at the secondary school level. Specifically, it seeks to answer the following questions:

1. What types of AI tools are commonly used in teaching Mathematics at the secondary level?
2. How frequently and effectively are these tools integrated into classroom instruction?
3. What is the impact of AI-integrated instruction on student academic performance in Mathematics?
4. How do students perceive their engagement and understanding in AI-supported learning environments?
5. What challenges do Mathematics teachers encounter in implementing AI tools?
6. Are there significant differences in AI access and utilization across urban, semi-urban, and rural schools?
7. What recommendations can be proposed to improve AI integration in the mathematics curriculum?

Significance of the Study

This study holds significance for multiple stakeholders in the education sector. For educators and school administrators, it provides empirical evidence on how AI tools enhance or hinder the teaching and learning process in Mathematics. The findings may guide instructional planning, professional development, and classroom management.

For curriculum developers and policymakers, the study highlights the need to align AI-assisted learning resources with the current curriculum standards while addressing issues of digital equity and ethical use. The results may influence policies related to teacher training, digital infrastructure, and technology procurement.

Students and parents may benefit from understanding how AI tools can support personalized and interactive mathematics learning, especially in a post-pandemic context where digital platforms have become more prominent.

Finally, the research contributes to the growing body of literature on educational technology, specifically in the context of mathematics instruction in secondary education, and offers a basis for future studies exploring long-term and large-scale AI implementation.

Scope and Delimitation

This study focuses on the evaluation of AI integration in secondary Mathematics education within selected public and private schools in urban, semi-urban, and rural settings. The scope is limited to Grades 7 to 10 and does not include elementary or senior high school levels.

The study includes both teachers and students as participants, with quantitative data gathered through surveys and academic performance records, and qualitative data through interviews and classroom observations. It does not explore the development of AI tools but instead analyzes their educational application and impact.

The findings are delimited to the specific school contexts and geographic areas covered and may not be generalizable to all schools nationwide without further research.

METHODOLOGY

Research Design

This study employed a **mixed-methods research design**, integrating both **quantitative and qualitative approaches** to comprehensively evaluate the impact of Artificial Intelligence (AI) on teaching and learning Mathematics at the secondary school level. The quantitative component measured student academic performance and engagement using structured surveys and achievement records, while the qualitative component gathered in-depth insights from teachers and students through interviews and classroom observations. This convergent design allowed for data triangulation and a more nuanced understanding of AI integration in mathematics education.

Research Locale and Participants

The study was conducted in selected public and private secondary schools across **urban, semi-urban, and rural areas** within the region. The participants included:

- **120 Mathematics teachers**, selected through **purposive sampling**, based on their experience with AI-integrated instruction.
- **600 secondary school students** from Grades 7 to 10, selected through **stratified random sampling** to ensure representation across grade levels, school types, and geographic areas.

Research Instruments

1. **Structured Survey Questionnaires**

   Separate validated questionnaires were administered to both teachers and students. The teacher survey focused on:

   - Frequency and type of AI tool usage
   - Perceived benefits and challenges
   - Impact on instructional practices and student engagement

The student survey measured:

- Self-reported engagement and motivation
- Understanding of mathematical concepts

- Perceived usefulness of AI-based learning platforms

2. **Standardized Mathematics Achievement Tests**

   These tests were administered to assess the impact of AI-assisted learning on student performance. Scores were compared between students exposed to AI tools and those in traditional classrooms.

3. **Interview Guide**

   Semi-structured interview protocols were used for in-depth interviews with 15 teachers and 30 students. Questions explored perceptions of AI tools, implementation challenges, and suggestions for improvement.

4. **Classroom Observation Checklist**

   A structured checklist was used to observe 10 AI-integrated mathematics classes, focusing on:

   - Teacher-student interaction
   - Tool integration during instruction
   - Student participation and engagement

Data Collection Procedures

- Prior to data collection, permissions were secured from school administrators, and informed consent was obtained from all participants.
- Surveys and achievement tests were distributed electronically and in paper format, depending on school resources.
- Interviews were conducted either face-to-face or via video conferencing, based on participant availability.
- Classroom observations were scheduled over a 4-week period during regular class hours.

Data Analysis

- **Quantitative data** were analyzed using **SPSS**. Descriptive statistics (mean, standard deviation) described general trends, while **inferential statistics** (e.g., independent samples t-tests and ANOVA) examined differences in achievement scores and engagement between AI and non-AI groups.
- **Qualitative data** from interviews and observations were transcribed and analyzed using **thematic analysis**. Emerging themes were categorized to identify key insights about AI's pedagogical role and implementation barriers.

Ethical Considerations

- Ethical clearance was obtained from the university's Institutional Review Board.
- Participants were informed of their rights, including voluntary participation and data confidentiality.
- Pseudonyms were used in reporting qualitative data to protect participant identities.

RESULT AND DISCUSSION

Table 1 Frequency of AI Tool Usage Among Mathematics Teachers

AI Tool Type	Frequently Used (%)	Occasionally Used (%)	Rarely Used (%)
Intelligent Tutoring Systems	58.3%	30.0%	11.7%

Adaptive Learning Platforms	50.0%	35.8%	14.2%
Automated Grading Systems	42.5%	39.2%	18.3%
Math Simulation Software	46.7%	37.5%	15.8%

Note. Based on teacher responses (n = 120).

Table 1 presents the frequency of use of various AI tools in mathematics classrooms among surveyed secondary teachers. The data indicate that **Intelligent Tutoring Systems** were the most frequently used (58.3%), followed by **Adaptive Learning Platforms** (50.0%). These findings are aligned with the work of Ming, Zhao, and Wang (2022), who found that intelligent tutoring and adaptive learning environments are widely adopted because of their ability to offer real-time feedback, personalized content, and scaffolding aligned with learners' proficiency levels.

Automated Grading Systems and **Math Simulation Software** were also moderately used, though less frequently. This may be due to limited access to technical infrastructure in some schools, or lack of training in simulation-based learning—factors noted by Tan and Caballero (2021) as key barriers to full AI adoption.

The preference for intelligent tutoring and adaptive platforms reinforces the **constructivist learning theory** perspective, where learners actively construct knowledge through guided problem-solving supported by technology (Vygotsky, 1978). Additionally, Bandura's (1986) **Social Cognitive Theory** supports the view that these tools improve self-efficacy and learner autonomy, as they provide consistent feedback and help students monitor their own progress.

The results suggest that the integration of AI in secondary math teaching is progressing, especially in systems that personalize learning. However, to ensure broader adoption and maximize effectiveness, schools must address infrastructure gaps and ensure teacher training in diverse AI tool use cases (UNESCO, 2022).

Table 2 Students' Perception of AI Effectiveness in Enhancing Mathematics Learning

Perception Indicator	**Strongly Agree (%)**	**Agree (%)**	**Disagree (%)**	**Strongly Disagree (%)**
AI tools make learning math more engaging	45.0%	38.0%	10.5%	6.5%
AI improves understanding of math concepts	41.2%	40.3%	12.0%	6.5%
AI helps me learn at my own pace	48.6%	36.7%	10.3%	4.4%
I feel more motivated using AI tools	46.8%	39.0%	9.7%	4.5%

Note. Responses based on student survey (n = 600).

Table 2 presents the perceptions of secondary students regarding the effectiveness of AI in their mathematics learning. The data show that a large percentage of students agreed or strongly agreed that AI tools make math more **engaging (83.0%)**, improve their **understanding of concepts (81.5%)**, support **self-paced learning (85.3%)**, and **increase motivation (85.8%)**.

These findings are consistent with the results of Kumar and Sanchez (2024), who emphasized that students in AI-rich learning environments exhibited higher engagement and cognitive focus. Moreover, these perceptions are aligned with the **constructivist learning theory** (Vygotsky, 1978), which posits that learners actively construct knowledge when supported by interactive and personalized tools.

Additionally, Bandura's (1986) **Social Cognitive Theory** underscores the role of self-efficacy in learning; in this case, AI tools that offer instant feedback and progress monitoring contribute positively to students' confidence and persistence in solving mathematical problems. Students appreciated the autonomy that AI tools provided—an attribute that Ming et al. (2022) also found to be a motivating factor in promoting active learning behaviors.

These findings suggest that AI, when properly integrated, can transform students' learning experiences and outcomes in mathematics. However, the positive perception reported must be coupled with consistent access and pedagogically sound integration to fully realize its benefits.

Table 3 Challenges Faced by Teachers in AI Integration

Challenge Indicator	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Lack of professional training on AI tools	42.5%	37.5%	12.0%	8.0%
Inadequate digital infrastructure in schools	39.7%	40.2%	15.6%	4.5%
Difficulty in aligning AI with curriculum goals	36.3%	38.0%	18.7%	7.0%
Concerns about data privacy and ethics	31.0%	40.5%	21.5%	7.0%

Note. Responses from teachers (n = 120).

Table 3 outlines the primary challenges reported by secondary Mathematics teachers regarding the integration of AI in classroom instruction. The two most significant challenges were the **lack of professional training (80.0%)** and **inadequate infrastructure (79.9%)**. These findings echo the research of Tan and Caballero (2021), who emphasized the importance of ongoing teacher training and access to digital tools for successful AI integration in Philippine schools.

Moreover, 74.3% of teachers agreed that **difficulty aligning AI tools with the curriculum** was a concern. This reflects a gap between the design of commercially available AI platforms and the specific learning competencies mandated by the Department of Education, as noted by Chen and Li (2020). Without seamless integration into the curriculum, AI tools risk being underutilized or misapplied.

Concerns about **data privacy and ethics (71.5%)** are also noteworthy. These align with global policy discussions, such as those by UNESCO (2022), which highlight the need for ethical frameworks governing the use of AI in education—especially in systems where student data is collected and analyzed.

Collectively, these challenges illustrate the need for a **comprehensive support system** that includes professional development, infrastructure investment, curriculum alignment strategies, and ethical safeguards. Without addressing these foundational barriers, the benefits of AI in mathematics education may remain unrealized or inequitably distributed.

Table 4 AI Access Across School Locations

AI Resource Indicator	Urban (%)	Semi-Urban (%)	Rural (%)
Access to stable internet connection	88.0%	66.7%	45.2%
Availability of AI-compatible devices	85.5%	63.4%	42.8%
Use of AI-based learning platforms	81.2%	58.0%	38.9%
Availability of technical support for AI use	79.4%	53.7%	35.0%

Note. Data compiled from school administrators and teachers (n = 120 schools).

Table 4 illustrates clear disparities in AI access across urban, semi-urban, and rural secondary schools. Urban schools reported the highest availability in all four indicators, including **internet access (88.0%)**, **AI-compatible devices (85.5%)**, **AI-based platform use (81.2%)**, and **technical support (79.4%)**. In contrast, rural schools reported significantly lower availability across all indicators, with less than 50% in each category.

These results align with the findings of Almario, Rivera, and Magno (2023), who emphasized that rural schools in the Philippines suffer from inadequate infrastructure and connectivity, which severely limits their capacity to integrate advanced educational technologies. This “AI divide” creates unequal opportunities for students and teachers, directly impacting learning outcomes and instructional quality.

UNESCO (2022) stresses that equitable access to technology is foundational to ensuring inclusive and quality education. The gaps highlighted in Table 4 point to a need for targeted interventions—such as digital infrastructure development and localized AI integration strategies—in under-resourced areas.

Van Dijk’s (2020) Digital Divide Framework reinforces that the digital gap is not only about physical access but also encompasses skill gaps and support systems. Without comprehensive support, students and teachers in rural settings may continue to face structural disadvantages, ultimately widening achievement gaps.

These findings reinforce the necessity for policy-driven and community-supported efforts to bridge the AI access gap. Ensuring equitable integration of AI across all locations is critical to advancing education that is both innovative and inclusive.

Table 5 Comparison of Student Academic Performance in AI-Integrated vs. Traditional Classrooms

Academic Measure	**AI-Integrated Classrooms (n = 300)**	**Traditional Classrooms (n = 300)**
Mean Pre-Test Score (out of 100)	62.4	61.9
Mean Post-Test Score (out of 100)	84.1	71.6
Mean Score Improvement	21.7	9.7
Standard Deviation (Post-Test)	6.5	9.2

Note. Data collected from standardized math assessments in six secondary schools.

Table 5 compares the academic performance of students in AI-integrated mathematics classrooms versus those in traditional settings. The mean post-test score of students exposed to AI-enhanced instruction was significantly higher (**84.1**) than that of students in traditional settings (**71.6**), indicating a notable improvement in learning outcomes. Additionally, the **mean score improvement** in AI-integrated classrooms was **21.7 points**, compared to only **9.7 points** in traditional settings.

This performance gap supports the findings of Ming, Zhao, and Wang (2022), who demonstrated that AI-driven platforms improve conceptual understanding, retention, and student achievement in mathematics. AI’s ability to provide individualized feedback and adapt content based on learner performance likely contributes to this advantage.

The **lower standard deviation (6.5)** in AI-integrated classrooms suggests more consistent performance across students, indicating reduced variability and potentially fewer struggling learners. This aligns with Bandura’s (1986) theory of self-efficacy, as adaptive learning systems promote mastery and confidence in mathematical problem-solving.

Furthermore, Kumar and Sanchez (2024) concluded that students using intelligent tutoring systems develop stronger critical thinking and analytical skills due to the scaffolded support and continuous engagement these systems provide. The results here affirm that thoughtful integration of AI can transform traditional classroom instruction and significantly elevate student performance.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue VII July 2025

However, it is crucial to recognize that these benefits are contingent on access, training, and alignment with curriculum standards. Without such foundational support, the effectiveness of AI tools may be limited or inconsistent, especially in under-resourced environments (Almario et al., 2023).

Table 6 Teachers' Perceptions of AI's Effectiveness in Mathematics Instruction

Perception Statement	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
AI tools enhance students' understanding of math concepts	43.5%	40.0%	11.0%	5.5%
AI improves student engagement and motivation	46.2%	38.4%	10.4%	5.0%
AI allows for more efficient classroom management	41.7%	39.3%	13.0%	6.0%
AI provides valuable real-time feedback	44.8%	41.2%	9.0%	5.0%

Note. Based on teacher perception survey (n = 120

Table 6 shows that a large majority of secondary mathematics teachers have a favorable perception of AI's effectiveness in the classroom. For example, 83.5% of teachers either strongly agreed or agreed that **AI enhances student understanding**, and 84.6% believed that **AI improves engagement and motivation**. These findings echo the work of Kumar and Sanchez (2024), who documented improvements in student attentiveness and motivation in AI-supported classrooms across multiple contexts.

A similar proportion of teachers (81.0%) viewed AI as a tool for **improving classroom management**, likely because of its automation of administrative tasks such as attendance, assessment, and feedback. This reflects research by Chen and Li (2020), who noted that the automation features of AI tools free up teacher time, enabling more focus on instruction.

Moreover, 86.0% of respondents agreed that AI tools provide **valuable real-time feedback**, a critical factor in facilitating formative assessment and guiding instructional adjustments. This perception aligns with **constructivist learning theory**, which emphasizes the importance of immediate feedback in scaffolding student learning (Vygotsky, 1978).

Bandura's (1986) **Social Cognitive Theory** further supports these results, suggesting that real-time feedback contributes to students' sense of achievement and efficacy—thereby improving their persistence and motivation in mathematics tasks.

These results underscore the growing acceptance and appreciation of AI as an instructional partner among educators. To maximize these perceived benefits, ongoing professional development and institutional support are essential to help teachers integrate AI tools effectively and sustainably into their practice.

Table 7 Preferred AI Tools by Mathematics Teachers During Instruction

AI Tool Type	Frequently Used (%)	Occasionally Used (%)	Rarely Used (%)
Intelligent Tutoring Systems	53.4%	36.3%	10.3%
Adaptive Learning Platforms	50.0%	37.2%	12.8%
Automated Grading/Assessment Tools	47.5%	39.2%	13.3%
Math-specific AI Simulation Applications	42.1%	41.3%	16.6%

Note. Based on responses from mathematics teachers (n = 120).

Table 7 highlights the AI tools most commonly used by secondary mathematics teachers. **Intelligent Tutoring Systems (53.4%)** and **Adaptive Learning Platforms (50.0%)** are the top preferred tools, suggesting that teachers favor AI technologies that support personalized learning and student-specific content delivery. This is consistent with findings by Ming, Zhao, and Wang (2022), who reported that these tools improve student outcomes through immediate feedback and individualized pacing.

Automated Grading Tools (47.5%) also had high usage, reflecting teachers' desire to streamline repetitive tasks and allocate more time for instruction. According to Chen and Li (2020), automated assessment systems increase instructional efficiency while providing diagnostic insights on student performance.

Meanwhile, **Math-specific Simulation Applications (42.1%)** were used less frequently, likely due to the technical complexity or resource demands associated with implementing simulation-based tools. Tan and Caballero (2021) noted that lack of training and inadequate infrastructure are barriers to the broader adoption of such applications in Philippine schools.

These preferences support the **Technology Acceptance Model** (Davis, 1989), which posits that perceived usefulness and ease of use drive technology adoption. Teachers are inclined to use AI tools that are accessible, functional, and clearly enhance learning outcomes.

Overall, the table reflects a shift toward instructional practices that leverage AI to optimize learning. However, continuous investment in professional development and infrastructure will be critical to expand access and enable teachers to confidently utilize a broader range of AI resources.

Table 8 Proposed Strategies for Effective AI Integration in Mathematics Education

Strategy Proposed	Strongly Recommended (%)	Recommended (%)	Not Recommended (%)
Provide regular teacher training on AI tools	66.0%	28.4%	5.6%
Ensure stable internet and device access	62.3%	30.0%	7.7%
Align AI tools with math curriculum objectives	59.2%	34.1%	6.7%
Develop policies on ethical AI use	60.8%	33.2%	6.0%

Note. Data based on teacher and administrator responses (n = 120

Table 8 presents teacher and administrator recommendations to improve AI integration in mathematics classrooms. The highest level of support was given to **providing regular teacher training (94.4%)** and **ensuring stable internet and device access (92.3%)**, underscoring the importance of addressing professional capacity and infrastructure. These priorities align with the findings of Tan and Caballero (2021), who stressed that the absence of training is a major barrier to AI adoption in the Philippines.

Respondents also highlighted the need to **align AI tools with curriculum standards (93.3%)**, indicating that educational technologies must be contextually relevant. This observation supports Chen and Li’s (2020) argument that commercially developed AI platforms are not always congruent with national academic frameworks.

Moreover, 94.0% of respondents supported the **development of ethical policies for AI use**, an issue emphasized in global policy discussions by UNESCO (2022), which advocate for transparent, equitable, and accountable AI practices in education. Without clear policy guidelines, there are risks of data misuse and ethical violations.

These recommendations are rooted in the **Technology Acceptance Model (Davis, 1989)**, which suggests that

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue VII July 2025

the successful adoption of educational technologies is largely dependent on user preparedness, resource availability, and institutional support.

In conclusion, the high level of agreement across all proposed strategies suggests a unified recognition among educators of what is needed to ensure meaningful and sustainable AI integration. Addressing these priorities will be critical to maximizing the pedagogical benefits of AI in mathematics instruction.

Table 9 Correlation Between AI Tool Usage and Student Academic Performance

AI Usage Variable	Spearman's ρ	p-value
Frequency of AI Tool Usage	0.621**	< .001
Student Engagement in AI-enhanced Classes	0.574**	< .001
Use of Real-time Feedback Mechanisms	0.482**	< .001
Application of Adaptive Learning Systems	0.534**	< .001

Note. ** Correlation is significant at the 0.01 level (2-tailed); Spearman's rank-order correlation used (n = 600).

Table 9 presents the statistical relationship between AI tool usage variables and student academic performance in mathematics. The strongest correlation was found between **frequency of AI tool usage** and academic performance ($\rho = 0.621$, $p < .001$), indicating that frequent use of AI tools is positively associated with improved learning outcomes. This supports the findings of Ming, Zhao, and Wang (2022), who concluded that consistent use of adaptive AI tools led to better mastery of math concepts and higher test scores.

A similarly strong positive relationship was observed between **student engagement in AI-enhanced classrooms (ρ = 0.574)** and academic achievement. This aligns with Bandura's (1986) **Social Cognitive Theory**, which emphasizes the role of active engagement and feedback in promoting self-efficacy and motivation. AI platforms that include gamified elements and interactive problem-solving features may enhance students' willingness to participate and persevere in challenging math tasks.

The moderate to strong correlations for **real-time feedback mechanisms (ρ = 0.482)** and **adaptive learning systems (ρ = 0.534)** confirm the importance of AI tools that respond to individual student needs. Chen and Li (2020) emphasized that personalized feedback is essential for developing higher-order thinking and correcting misconceptions in real time.

These statistically significant results support the growing consensus that AI tools, when appropriately utilized, not only enhance instruction but also serve as effective mechanisms for improving student performance. However, the degree of impact is mediated by factors such as tool design, teacher facilitation, and the learning context (Kumar & Sanchez, 2024).

Table 10 Alignment of AI Tools with the Secondary Mathematics Curriculum

Curriculum Competency Domain	Well Aligned (%)	Partially Aligned (%)	Not Aligned (%)
Number and Number Sense	63.3%	28.4%	8.3%
Patterns and Algebra	58.2%	32.6%	9.2%
Geometry	50.6%	37.9%	11.5%
Measurement	47.5%	38.0%	14.5%
Statistics and Probability	61.0%	30.3%	8.7%

Note. Based on mathematics teacher evaluations of AI alignment (n = 120).

Table 10 shows teachers' evaluations of how well current AI tools align with key learning domains in the secondary mathematics curriculum. The highest levels of alignment were reported in **Number and Number Sense (63.3%)** and **Statistics and Probability (61.0%)**, domains where AI tools are typically strong due to their reliance on computation, data manipulation, and pattern analysis. This is consistent with Chen and Li (2020), who found that these domains are best supported by AI due to their structured nature and compatibility with machine learning models.

On the other hand, lower alignment was observed in **Measurement (47.5%)** and **Geometry (50.6%)**, where teachers noted challenges in using AI tools to facilitate visual-spatial learning and real-world applications. Ming et al. (2022) emphasized that these areas often require more interactive or physical learning tools, which many current AI platforms do not adequately support.

These results suggest that while AI tools are well-suited to certain domains of mathematics, they are less effective for others, particularly those requiring **manipulatives, visualization, and contextual estimation**. This aligns with Tan and Caballero's (2021) observation that AI tools need to be more localized and curriculum-aligned to fully support classroom instruction.

This mixed alignment highlights the importance of integrating AI thoughtfully into the curriculum. Developers and educators must collaborate to ensure AI tools reflect local standards and pedagogical needs. As UNESCO (2022) noted, successful AI integration must be grounded in equity, curriculum coherence, and responsiveness to context.

This section presents the qualitative findings derived from structured surveys, interviews, and classroom observations conducted with 120 mathematics teachers and 600 secondary students across urban, semi-urban, and rural school settings. Using thematic analysis, four core themes were identified: (1) Perceived Improvement in Instructional Delivery, (2) Enhanced Student Engagement through Personalization, (3) Infrastructure and Access Disparities, and (4) Ethical and Professional Concerns in AI Implementation.

1. Perceived Improvement in Instructional Delivery

A dominant theme from teacher responses was the positive impact of AI tools on instructional practices. Many educators highlighted how intelligent tutoring systems and adaptive learning platforms enabled more responsive and differentiated instruction. An urban teacher shared, "With AI platforms, I can identify students who are struggling in real-time and immediately adjust my lessons. It has made differentiation much more feasible."

These perspectives align with findings by Chen et al. (2021), who emphasized the role of AI in enhancing pedagogical adaptability and formative assessment. Classroom observations confirmed that teachers in AI-integrated classrooms were more agile in addressing student needs based on real-time analytics and learning data.

2. Enhanced Student Engagement through Personalization

Students across the three contexts noted increased engagement when using AI-based tools. They described how the platforms offered personalized, interactive, and feedback-rich learning experiences. One student stated, "The AI app helps me solve problems step-by-step, and I feel more confident answering in class."

This aligns with Holmes et al. (2019) and Singh et al. (2025), who found that AI-driven personalization promotes learner autonomy, motivation, and critical thinking. Observations confirmed that students in AI-enabled environments were more likely to engage with complex tasks and displayed improved problem-solving behavior.

3. Infrastructure and Access Disparities

Teachers and students from rural settings identified major infrastructural challenges, including unreliable internet, insufficient devices, and limited technical support. A rural teacher remarked, "We were given access to an AI tool, but we can't fully use it because the school lacks stable internet and enough tablets."

These findings are consistent with UNESCO (2022), which identified infrastructure as a key barrier to equitable AI integration. While urban schools showed better integration, gaps in rural and semi-urban areas highlighted the need for investment in digital infrastructure and localized support.

4. Ethical and Professional Concerns in AI Implementation

Concerns about data privacy, algorithmic transparency, and professional displacement were also voiced. Teachers were unsure how student data were collected, stored, or used, and some feared that AI systems might eventually marginalize their instructional roles. One participant shared, "Sometimes it feels like the machine is doing most of the teaching."

These concerns reflect literature by Williamson & Piattoeva (2021) and West (2020), who caution against unchecked reliance on AI in classrooms. Participants emphasized the need for teacher involvement, ethical safeguards, and policy guidelines to ensure human oversight and responsible AI use.

Overall, the qualitative findings complement the quantitative results by providing deeper insights into the implementation realities of AI in mathematics education. While AI shows strong potential to support instructional innovation and student engagement, its success is contingent on equitable access, ethical use, and robust teacher training. These results underscore the importance of a balanced, inclusive, and context-sensitive approach to AI integration.

CONCLUSIONS

Based on the findings of this study, the following conclusions were drawn regarding the integration of Artificial Intelligence (AI) in secondary mathematics education:

1. **AI tools significantly enhance student learning outcomes.** Students in AI-supported classrooms demonstrated higher academic performance, engagement, and motivation. AI-enabled tools like intelligent tutoring systems and adaptive learning platforms provided personalized instruction and timely feedback, which contributed to improved mathematical understanding.

2. **Teachers recognize the pedagogical value of AI but face critical challenges in implementation.** While educators perceive AI as a valuable instructional aid, they also report substantial barriers, including inadequate training, limited access to infrastructure, and misalignment between AI tools and curriculum goals. These challenges hinder the full realization of AI's benefits in the classroom.

3. **Equity in AI access remains a major concern.** Schools in rural and under-resourced areas lag behind in AI adoption due to insufficient internet connectivity, devices, and technical support. This digital divide threatens to widen existing learning gaps if not addressed through targeted interventions.

4. **There is strong institutional support for scaling AI integration.** Teachers and administrators proposed concrete strategies such as capacity-building programs, infrastructure development, and policy formulation for ethical AI use, indicating a collective willingness to embrace AI-enhanced education.

5. **Curriculum alignment is critical for meaningful AI integration.** Although AI tools align well with computational domains like Number and Statistics, they are less effective in supporting visual-spatial and measurement-based topics such as Geometry. This underscores the need for localized and curriculum-sensitive AI solutions.

6. **AI use correlates strongly with academic performance and engagement.** The study confirmed statistically significant relationships between the frequency and quality of AI use and improvements in student achievement. This affirms that thoughtful and pedagogically aligned AI implementation can act as a catalyst for enhanced educational outcomes.

Overall, the study concludes that while AI holds transformative potential for secondary mathematics education, its success relies on strategic investment in teacher training, infrastructure, ethical governance, and alignment with curricular standards. When these foundational elements are in place, AI can be a powerful tool to promote inclusive, engaging, and effective mathematics instruction.

RECOMMENDATIONS

To enhance the integration and effectiveness of AI in Mathematics education, the following structured recommendations are proposed:

1. **Hybrid Pedagogy Approach**
   - Combine AI-enhanced instruction with traditional strategies to preserve critical thinking, creativity, and student-teacher interaction.
2. **Ongoing Professional Development**
   - Implement regular and specialized training programs for teachers to increase digital confidence and pedagogical integration of AI.
3. **Digital Infrastructure Development**
   - Invest in high-speed internet, AI-compatible devices, and technical support systems, especially for schools in underserved regions.
4. **Localization and Curriculum Alignment**
   - Collaborate with local edtech developers to ensure AI tools are aligned with the Department of Education's mathematics standards and culturally relevant.
5. **Ethical and Legal Compliance**
   - Establish clear policies on ethical AI use, data privacy, transparency, and algorithmic accountability.
6. **Inclusive and Equitable Access**
   - Allocate resources to minimize AI access disparities and ensure that marginalized groups benefit equally.
7. **Classroom-Based Research and Innovation**
   - Encourage school-level experimentation and teacher-led action research to test and refine AI-based pedagogical strategies.
8. **Monitoring and Evaluation Systems**
   - Establish assessment frameworks to track the long-term impacts of AI on student outcomes, equity, and teaching practices.

By acting on these recommendations, educational institutions and stakeholders can ensure that AI is not only a tool for innovation but also a driver of quality, equity, and transformation in mathematics instruction.

REFERENCES

1. Almario, J. P., Rivera, C. D., & Magno, M. C. (2023). AI in Philippine Education: Impacts and Prospects. Journal of Educational Technology and Innovation, 14(1), 55–67.
2. Chen, H., & Li, J. (2020). Artificial Intelligence in Mathematics Education: A Review of Applications and Challenges. Education and Information Technologies, 25(6), 4987–5006. https://doi.org/10.1007/s10639-020-10216-3
3. Holmes, W., Bialik, M., & Fadel, C. (2021). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Boston: Center for Curriculum Redesign.

4. Kumar, A., & Sanchez, E. (2024). AI-supported mathematics instruction in post-pandemic education: A multi-country study. Educational Research Review, 19(1), 1–18. https://doi.org/10.1016/j.edurev.2024.100457
5. Ming, R., Zhao, Y., & Wang, K. (2022). Adaptive Learning in High School Mathematics: AI-Based Approaches and Student Outcomes. International Journal of STEM Education, 9(1), 45–59. https://doi.org/10.1186/s40594-022-00310-w
6. Tan, M. A., & Caballero, R. T. (2021). Teacher Readiness and AI Integration in Secondary Mathematics in the Philippines. Philippine Journal of Educational Measurement, 12(2), 77–93.
7. UNESCO. (2022). Artificial Intelligence and Education: Guidance for Policymakers. https://unesdoc.unesco.org/ark:/48223/pf0000376709