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Into the New Era of Mathematics Teaching: Navigating through Artificial Intelligence (AI) in Mathematical Learning

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ABSTRACT

Artificial Intelligence has been an integral part in educational system especially in the contexts of mathematics. This qualitative study employing phenomenology was conducted among the mathematics teachers in the 2nd congressional district of the Province of Cotabato. Using thematic analysis, results revealed that the lived experiences of these teaching involved personalized learning and adaptive instruction, enhanced engagement and motivation, teacher support and efficiency, and accessibility and inclusivity. Major challenges faced by these teachers involved ethical and moral consideration, over-reliance on AI and impact on critical thinking, and data reliability and quality of AI content. However, they saw opportunities in its utilization. These involved efficiency and time saving, real-time feedback and assessment, and student engagement and motivation. They employed different strategies in addressing these challenges. Thus, its pedagogical implications were drawn to navigate teachers needs to integrate this in mathematics learning. Further, a policy brief was developed which highlights it emergent role and underpinning challenge to learning.

INTRODUCTION

Artificial Intelligence (AI) has been popularly used in education. With technological advancements, the dire need to have the easy access to mathematical exercises as well as the concepts gained demands for both students and teachers. Mathematical complexities draw much attention to increasing the performance of the students in particular.

In addition, AI serves as a contemporary method of tutoring or teaching and learning which aimed at resolving issues relative to learning (Ahmad et al., 2021). Similarly, Qiu et al. (2022) confirmed that it is a tool to assist learners in acquiring complex mathematical and logical ideas and reduce problems of learners in committing mistakes. In addition, Thompson (2018) articulated relying much on this platform is not the goal of teaching mathematics.

The findings of Hwang et al. (2023) showed that AI significantly affected the achievements of elementary students. For students in the tertiary level, this aids them in AI-based calculators and intelligent tutoring systems (Van Vaerenbergh & Pérez-Suay, 2022). Again, it provided an easy access to students to have the total understanding of algebraic expressions (Jančařík et al., 2022) which changes the trajectory of instructions (Järvelä & Bannert, 2021).

In the Philippines, Melchor et al. (2023) stated that there are potential challenges on the readiness in the Philippines. Using the AI-powered mathematics tutorship in pre-calculus, it enhanced students' self-reliance, interest, and performance in the said subject. This suggested the value of this AI generated application in enhancing students' interest in learning mathematics (Capinding, 2023). Meanwhile, it also helped teachers boosting their abilities in explaining mathematical concepts (Garces, 2024).

Many of the AI applications used by teachers are only self-reported and data observation and have failed to know other modalities which can be crucial in creating opportunities in understanding the teaching and learning processes (Aborot et al., 2022; Capinding, 2023, Garces, 2023; Melchor et al., 2023). This problem widens the gap in the local setting where teachers are still unaware of the AI in teaching mathematics (Remoto, 2023). Aside from that, previous studies on the application of AI in mathematics teachers failed to tackle the contexts of the mathematics teachers in the local setting (Ko, 2020; Shin, 2020; Lee & Yeo, 2022; Mohamed et al., 2022; Park et al., 2022).

This study is fundamental on the shift of the paradigm in mathematics teaching in the Philippines. By looking closely into this context, the researcher would like to provide an in-depth investigation of the AI usage among teachers in the public school system. Its findings may have implications in the affirmations of teachers on its potential challenges and opportunities in mathematics teaching. The aforesaid manifestations have motivated the researcher to conduct this study among mathematics teachers in the Department of Education.

Statement of the Problem

The main objective of this study is to look into the utilization of Artificial Intelligence (AI) in mathematics. Specifically, it responds to the following questions:

Study 1 Artificial Intelligence: Navigating through Lived Experiences, Challenges and Opportunities in Teaching Mathematics

1. What are the lived experiences of mathematics teachers in utilizing AI in mathematics teaching;
2. What are the challenges faced by mathematics teachers in applying AI in teaching;
3. What are the opportunities of using AI in mathematics teaching;

Study 2 Strategies and Pedagogical Implications of Artificial Intelligence in Mathematics Teaching

4. What strategies do they employ in addressing the challenges;
5. What pedagogical implications can be derived based on the results of the study;
6. What policy brief on using AI in mathematics teaching can be draw based on the findings of the study.

Research Design

This study is qualitative-phenomenology. Qualitative is defined as the process by which the mode of data gathering is through the use of non-numerical data such as pictures, words, and videos which important in generating new ideas and perspectives (Litchman, 2023). It is usually used in education, health, sciences, and history (Savin-Badin & Major, 2023).

Qualitative research involves smaller sample sizes compared to quantitative research. It provides emphasis on the deepness and quality of data rather than generalizability (Hatch, 2023). The researcher aims to provide saturation, where additional data no longer yields insights. Its analysis is systematic through identification, categorization, and interpretation patterns and themes within the data (Thompson et al., 2023).

Phenomenology explains and understands the universality of the existence of a phenomenon (Hatch, 2023; Holloway & Galvin, 2023). This investigates the daily experiences of humans with their lived experiences as its core. It aims to provide a deeper insight of how people understand and explain those experiences. Indeed, in this study the researcher will investigate the usability of AI in the teaching of mathematics.

Locale of the Study

This study was conducted at Arakan Valley Complex. This cover the towns of President Roxas, Antipas, and Arakan. President Roxas is one of the towns in the complex. It is made up of two distinct territory-the Lower and the Upper Roxas. This happened because of the creation of the Municipality of Antipas.

Majority of the people in these towns belonging to the Hiligaynon tribe. They migrated from the Island of Panay in the Visayas. The Arakan Valley Complex has been home to different ethnic groups namely the Tinonanon Manobo, Erumanen Ne Menuvu, Obo Manobo, Kulamanen Manobo, Cebuano, and the Teduray. Its soil is rich which made it a significant contributor in the field of education. The map of the Arakan Valley Complex is presented below:

Research Instrument

The main instrument in the gathering of the data is the interview guide questions. These are sets of questions which asked to the informants and participants. To record their responses, an audio recorder is utilized. During the course of the interview, the researcher brought a pen and paper to further describe the occurrence of the phenomenon among the informants.

Research Participants

The participants of this study are mathematics teachers who used AI in teaching. They are divided into two groups. The Key Informant Interview, wherein each individual interviewed relative to the phenomenon. Likewise, the Focus Group Discussion are made up of 15 individuals, who interviewed as one group. They support or negate the responses of the informants. In qualitative research, the number of individuals to engage in the study is limited only at from 5-25. However, in the selection process, the researcher have to follow the purposive sampling with the criterion sampling as the specific mode of the selection. The criteria serves as the bases of this process. They must be mathematics teachers, teaching in one of the secondary schools in Arakan Valley Complex (President Roxas, Antipas, and Arakan), handling either junior or senior high school students. In this study, there are 5 Key Informants and another 5 for the Focus Group Discussion.

Finally, the researcher returned to the informants and participants for confirm ability and provide them as well the aspect of reciprocity.

Data Analysis

In this manner, the researcher analyzed the data using the thematic analysis by Clarke and Braun (2017). Transcribed data laid in order to see different meanings out of the responses. The researcher began with the familiarization of the data. This is followed by the process of coding and labelling with the segments which include the words, phrases, and sentences. The organization of the themes is done and the development of clear and concise definitions of each theme. From then on, the researcher draw meanings as well as patterns which will lead to the formation of themes. Triangulation of the data is done through the comparison of the responses by the Focus Group Discussion (FGD).

RESULTS AND DISCUSSIONS

Themes on the lived experiences of mathematics teachers in utilizing AI in mathematics teaching

The first research question deals with the lived experiences of mathematics teachers in utilizing AI in mathematics teaching.

Personalized learning and adaptive instruction. This means that AI provides learning experiences based on students' needs, abilities, and progress. AI does indeed have the potential to revolutionize the teaching and learning of mathematics by making the learning experience more personalized, efficient, and engaging. The implications of this transformation are far-reaching, both for students and teachers, as well as for the overall educational landscape. As mentioned during the interview that:

Ahhh....AI has significant potential to revolutionize the teaching and learning od mathematics by making learning more personalized, efficient and engaging po. (Informant 1 Q1A1L1-4)

This is particularly vital in mathematics, a subject that requires a deep understanding of foundational concepts before moving on to more complex ideas. AI-powered platforms can adjust the difficulty level of problems to match the student's current proficiency, ensuring that learners are neither overwhelmed nor bored. As mentioned by the informant, she reiterated that:

For me, ai can explain math concepts and formulas suited to the ability of the learners (Informant 5 Q1A1L80-82)

AI also plays a crucial role in diagnosing student needs and adjusting learning materials accordingly. As highlighted by Informant 11,

For me utilization of ai in teaching mathematics may identify areas and lessons where they struggle adjust the level of difficulty of problems in real life and promote deeper understanding in mastery of math concepts. (Informant 11 Q1A1L155-160)

Teachers can use data provided by AI platforms to assess their students' strengths and weaknesses. This allows them to provide targeted instruction that is more responsive to student needs. Teachers can focus on those who require additional help while continuing to challenge those who are ready for more advanced material. Furthermore, AI assists in the heavy lifting of administrative tasks, such as grading assignments or tracking student progress. This reduces the time teachers spend on repetitive tasks, giving them more time to interact with students and fine-tune their teaching methods. As noted in the statement of Informant 7,

For me... the utilization of artificial intelligence or ai in teaching mathematics is rapidly involving offering informativeness opportunities to enhance learning experiences and address individual students needs some of the benefits of the artificial intelligence in teaching mathematics are personalized learning enhance engagement and improve problem solving skills. (Informant 1Q1A1L101-110)

More so, an FGD confirmed that:

The utilization of Artificial intelligence in teaching Mathematics can be transformative, such that it can utilize lessons to the individual needs of the learners. (FGDQ1A1L1-4)

It can offer suggestions for resources, identify patterns in student performance, and provide insights into how teaching strategies can be adapted for better outcomes. One of the most compelling aspects of AI in education is its ability to keep students engaged and motivated. Mathematics often has a reputation for being dry or difficult, but AI can change that perception by incorporating elements of gamification, interactive tools, and real-time feedback into the learning experience. As students receive personalized feedback through AI-powered platforms, they are more likely to stay motivated and engaged in their learning journey.

In support, Penuel and Gallagher (2021) stated that personalized learning is not just about adjusting pace and content; it also involves changing how students engage with learning, integrating student choice and voice, and fostering a deeper, more autonomous learning process. Molenaar and Knoop-van Campen (2022) highlight that adaptive instruction is a more responsive and dynamic form of teaching, where the instructional content, difficulty, and feedback change as students interact with the material.

***Enhanced Engagement and Motivation*.** The integration of AI in mathematics education has led to the development of various tools that make learning more interactive, personalized, and engaging. AI-driven math games like Math Blaster and Math Goodies have revolutionized how students engage with mathematics by turning abstract concepts into fun, interactive challenges. These platforms offer an enjoyable way to practice essential math skills through game-based learning. AI in these games personalizes challenges to each student's proficiency level, adapting the difficulty of problems based on the student's performance and progress.

As what Informant 17 stated that:

AI-driven math games, like Math Blaster and Math Goodies, make learning mathematics enjoyable and interactive. (Informant 17Q1A1L 219-221)

AI-powered tools like GeoGebra and Desmos have demonstrated significant promise in improving accessibility for students with disabilities. These platforms are designed to be adaptable and inclusive, offering features that support students with visual impairments, learning disabilities, and other challenges. Through customizable interfaces and assistive technology like voice commands or screen readers, students can engage with mathematical content on their own terms.

This has been in line with the statement of the informant. She explained that:

AI-powered tools, such as GeoGebra and Desmos, help students with disabilities, like visual impairments, to access mathematical content. (Informant 19Q1A1L241-243)

The integration of AI-powered tools has fundamentally transformed how mathematics is taught, learned, and assessed. These platforms are adaptive, offering personalized learning paths for students of all levels, from basic arithmetic to advanced calculus.

As for me, the integration of Artificial Intelligence (AI) in teaching mathematics has transformed the educational landscape, offering unprecedented opportunities for enhanced learning outcomes, increased accessibility, and improved teacher support. AI-powered tools and platforms have revolutionized the way mathematics is taught, learned, and assessed, providing a personalized, adaptive, and engaging experience for students. (Informant 20Q1A1L 247-258)

The integration of AI in mathematics education offers significant potential for enhancing both the teaching and learning experience (Abar et al., 2024). Through AI-driven math games, interactive tools like GeoGebra and Desmos, and accessibility features for students with disabilities, AI supports personalized learning and engagement while improving teacher effectiveness. As AI continues to evolve, its impact on education will likely grow, offering new ways to engage students and support teachers in the learning process (Egara & Mosimege, 2024).

Teacher Support and Efficiency. AI has the potential to revolutionize mathematics education by making it more accessible, engaging, and effective. As students are increasingly diverse in terms of learning styles, needs, and levels of preparedness, AI offers the ability to adapt to these varied requirements, providing personalized experiences that traditional educational methods may struggle to address.

Particularly, this has been mentioned by an informant during the interview who stated that:

For me, AI is potential to revolutionize mathematics education making it more accessible, engaging, and effective for all learners by embracing the power of AI while addressing ethical considerations. AI tools can also serve as valuable teaching assistance in supporting teachers and a variety of lesson planning. (Informant 2Q1A1L15-22)

AI tools can provide valuable insights into students' learning patterns, helping teachers better understand their learners' needs. These systems can analyze data from students' interactions with the learning materials, identifying strengths, weaknesses, and areas of improvement. This data allows for targeted instruction that aligns with individual needs, promoting better academic outcomes.

AI can be a valuable tool for teaching mathematics. It can help teachers to better understand our learners' learning needs and provide targeted instruction. (Informant 6Q1A1L90-94)

AI-based systems offer one-on-one support, which supplements teacher guidance and enhances student engagement. With personalized learning pathways, these tools ensure that each student receives individualized attention, increasing their involvement in the learning process. This has been supported by the informant during the interview.

Ahhh.. AI-based systems provide one-on-one support, supplementing teacher guidance. Enhanced engagement, AI-driven interactive tools increase student participation and motivation. (Informant 18Q1A1L226-230)

Similarly, AI offers personalized learning experiences that allow students to work at their own pace. These AI-driven platforms can adjust the difficulty of content based on student performance, ensuring that learners are continually challenged without being overwhelmed. The result is a more efficient and effective learning process, where students can master mathematical concepts before moving on to more complex topics.

AI has significant potential to revolutionize the teaching and learning of mathematics by making learning more personalized efficient and engaging. (Informant 12Q1A1L167-170)

Hence, an FGD supported it by stating that:

AI is a good help for teachers specially in lessons that are difficult to do one by one. (FGDQ1A1L27-28)

AI has the capacity to create personalized learning pathways for students, adapting the pace and difficulty of content to each individual learner’s needs. Research has shown that personalized learning can lead to better retention of information and improved understanding of complex mathematical concepts (Baker et al., 2021). Zhao et al. (2022) mention that AI can significantly reduce the administrative burden on teachers, allowing them to focus more on instructional design and learning facilitation. AI can automate tasks like grading and reporting, helping teachers better allocate their time and attention toward more meaningful, personalized instruction.

Accessibility and Inclusivity. The integration of AI in mathematics education offers numerous advantages for both traditional and modern teaching practices. As noted in the statement, AI tools are increasingly effective in meeting students' individual needs, offering immediate feedback, identifying gaps in understanding, and guiding learners toward improved performance. Additionally, platforms like GeoGebra and Desmos play a crucial role in enhancing accessibility and inclusivity, ensuring that students with disabilities can engage with mathematical content.

Tools like Wolfram Alpha and Symbolab provide step-by-step solutions and explanations for mathematical problems. (Informant 4Q1A1L192-194)

Students can use these tools independently to solve problems and receive step-by-step solutions at their own pace, which fosters self-directed learning. If a student struggles with a particular concept, they can revisit the tool, receive a clearer explanation, and practice until they gain mastery. This individualized approach supports personalized learning by adapting to the learner's specific needs and challenges. These tools offer instant feedback, which helps students understand their mistakes immediately. Students can identify where they went wrong and correct their errors, reinforcing learning through continuous practice. This is particularly helpful for learners who need additional support in mastering concepts and techniques as mentioned in the study by Elijah (2024).

Themes on the challenges faced by mathematics teachers in applying AI in teaching

The second research question determines themes on the challenges faced by mathematics teachers in applying AI in teaching. There are three organizing themes which emerged from the responses of the informants.

Ethical and Moral Consideration. The integration of Artificial Intelligence (AI) into the teaching of mathematics brings with it several ethical and moral challenges that mathematics teachers must navigate. While AI has the potential to significantly enhance teaching and learning, it also introduces important questions about fairness, privacy, the role of teachers, and the long-term effects on students' cognitive and moral development.

In line with this, an Informant validated by saying that:

Installing moral and ethical values… (Informant 4Q2A1L57)

The increasing use of AI in mathematics education brings with it significant implications for data protection and confidentiality. While AI has the potential to improve personalized learning and enhance teaching, the collection and use of student data raise several concerns.

AI systems require student data, raising concerns about data protection and confidentiality. (Informant 23Q2Q1L231-232)

For Sebo and Long (2025), the integration of Artificial Intelligence (AI) into mathematics education presents several ethical and moral challenges that mathematics teachers must address. One of the primary concerns is the privacy and security of student data, as AI systems rely heavily on collecting and processing sensitive information. Teachers must ensure that data is handled responsibly, adhering to regulations and protecting students' privacy. Another significant issue is the potential for bias in AI algorithms, which may unintentionally favor certain groups of students over others based on their demographic characteristics. Furthermore, the accessibility of AI tools is a concern, as not all students have equal access to the necessary technology, which can exacerbate inequalities in education. Additionally, there is the risk of over-reliance on AI systems, which might reduce students' ability to think critically and solve problems independently (Atmaja, 2025).

Overreliance on AI and Impact on Critical Thinking. Overreliance on AI in mathematics education can significantly impact students' critical thinking skills, presenting a key challenge for teachers. When students become too dependent on AI tools for solutions, they may lose the ability to engage deeply with mathematical problems, which can hinder their problem-solving and analytical abilities. Teachers may find it difficult to balance the benefits of immediate feedback and personalized learning with the need to encourage students to develop independent thinking and a deeper understanding of mathematical concepts. This dependency could lead to a situation where students expect quick answers from AI, diminishing their motivation to explore multiple solution strategies or consider alternative approaches.

This was clearly mentioned by an informant during the course of the interview. She categorically stated that some students are becoming too dependent with the use of AI. This has negative impact on their attitude toward studying their lessons as well as to integration of concepts.

Sometimes ai will give you different references solution so better check it twice before integrating it too much dependent to ai will probably lead you to be lazy especially in learning the math concept because ai can simply give you the solution answers in a seconds. (Informant 2Q2A1L19-25)

Relying too much on AI in mathematics education can inadvertently stifle the development of critical thinking and problem-solving skills among students. One key challenge mathematics teachers face is the potential for students to become overly dependent on AI tools for answers rather than engaging in the intellectual effort required to solve problems independently.

It produces critical thinking and problem solving skills among students because of relying too much on AI. (Informant 10Q2A1L117-119)

Students' cognitive growth may be hampered by an over-reliance on AI technologies for arithmetic problem-solving, which could ultimately impair their capacity to comprehend and apply difficult mathematical ideas in practical contexts.

Teachers may face difficulties in ensuring that AI tools are used as a complement to, rather than a replacement for, traditional learning methods that promote critical thinking. Additionally, educators may struggle to create learning environments where students are encouraged to explore different strategies and reasoning, as the immediate nature of AI solutions can diminish students' motivation to attempt multiple approaches. Teachers must be

vigilant in monitoring students' progress and ensure that AI tools are not diminishing their ability to think critically, solve problems independently, and engage in intellectual curiosity (George, 2023).

***Data Reliability and quality of AI Content*.** AI tools rely on vast amounts of data to generate solutions, but if the data used is flawed or incomplete, it can lead to inaccurate or unreliable results. This creates difficulty for teachers who must ensure that the content provided by AI aligns with correct mathematical principles and is appropriate for their students' learning levels. Teachers may find themselves needing to verify AI-generated solutions, which adds extra time and effort to their teaching responsibilities. Additionally, there is a risk that students could become confused or misled by erroneous content, leading to gaps in their understanding.

There are instances that AI gave irrelevant at not reliable data there are some irregularities with needed answer in math problems. (Informant 9Q2A1L107-109)

The challenge of obtaining high-quality, relevant math problem data for AI algorithms can complicate the effective integration of AI into mathematics teaching. AI systems rely on vast amounts of accurate and representative data to function effectively, but acquiring such data that truly reflects the diversity of student needs and learning levels can be difficult. This lack of quality data may result in AI tools providing suboptimal or irrelevant problems, which could mislead students or fail to challenge them at an appropriate level.

AI algorithms require high-quality, relevant math problem data, which can be difficult to obtain. (Informant 13Q2A1L161-163)

Teachers may face difficulties in verifying that the AI-generated problems are appropriate for the grade level, align with lesson objectives, and accurately reflect mathematical principles. If the content is not carefully checked, it may lead to students learning incorrect or incomplete concepts, which could affect their overall understanding of mathematics. Additionally, as AI systems may not always recognize nuances in curriculum design or adapt to specific classroom needs, teachers may find themselves spending extra time reviewing and adjusting AI-generated content to make it suitable. In fact, an informant shared that:

Ensuring AI-generated math content aligns with educational standards and is error-free. (Informant 19Q2A1L203-204)

In congruence, an FGD confirmed that:

I only use Microsoft Excel. But compared to not using it, complicated and time-consuming computation occurs. (FGDQ2A1L1-3)

Ensuring the reliability and quality of AI-generated content is a major challenge in education. AI tools rely heavily on data to generate problems and solutions, but if the data is inaccurate or incomplete, the results can mislead students and distort their learning experience. According to researchers, the effectiveness of AI in education depends on the accuracy and relevance of the data used by these systems (Holmes et al., 2019). When AI tools do not align with curriculum standards or fail to generate relevant problems, teachers may need to intervene and adjust the content to meet learning objectives. This issue emphasizes the need for careful monitoring and continuous evaluation of AI-generated materials to ensure they meet educational standards (Baker & Smith, 2020). Without reliable and accurate data, AI's potential to enhance learning is limited, making it a crucial consideration for educators.

Table 2

Themes on the opportunities of using AI in mathematics teaching

The third research question presents the themes on the opportunities of using AI in mathematics teaching. There are three main organizing themes which came out based on the analysis of the data.

***Efficiency and Time Saving*.** The use of AI in mathematics teaching offers significant opportunities for efficiency and time-saving, allowing educators to focus more on personalized instruction rather than routine tasks. AI-powered tools can automate repetitive tasks such as grading and providing immediate feedback, freeing up valuable time for teachers to engage with students on a deeper level. This time savings can also extend to lesson planning, as AI systems can quickly generate diverse problem sets, adapt to different learning paces, and offer tailored exercises for individual students. As a result, teachers can spend less time on administrative duties and more time addressing students' unique needs, ultimately enhancing the overall quality of teaching and learning. This efficiency also ensures that students receive timely and relevant feedback, which is crucial for their mathematical development.

The informant shared this theme during the interview. She stated that it provides her opportunities to makes more efficient process in simplifying the tasks provided to students.

Ai can easily give you different activities that can be used during differentiated instruction it actually amplify simplifies my work and makes the process more efficient. (Informant 2 Q3A1L19-23)

AI's integration into mathematics teaching offers substantial opportunities for enhancing efficiency and time-saving in educational settings. Automated grading, personalized learning paths, and tailored feedback systems allow teachers to focus more on instructional quality rather than administrative tasks (Deckker & Sumanasekara, 2024). Research has shown that AI can significantly reduce teachers' workloads by automating time-consuming processes such as grading and content customization, enabling teachers to spend more time engaging with students and providing targeted support (Amdan et al., 2024).

Real-time Feedback and Assessment. AI provides real-time feedback and assessment in mathematics teaching, creating valuable opportunities for both teachers and students. It instantly analyzes student responses and identifies areas of difficulty, offering immediate insights into students' understanding

and allowing for quick adjustments in instructional strategies. This immediate feedback helps students recognize and address mistakes on the spot, reinforcing their learning and boosting confidence. For teachers, AI-driven assessments offer a clearer picture of each student's progress, enabling a focus on specific areas where learners need support. As a result, real-time feedback through AI promotes more effective learning, enhances student engagement, and helps educators make informed decisions about the next steps in instruction.

AI-driven tools offering real-time feedback on math assignments allow students to quickly identify and correct mistakes, improving their understanding of concepts. This instant feedback helps students stay engaged and motivated, reducing frustration from delayed responses. For teachers, these tools save time by automating assessment and providing immediate insights into student performance, enabling more focused instruction. As shared during the interview:

Real-time feedback,AI-driven tools provide instant feedback on math assignments. (Informant 19 Q3A1L184-185)

Furthermore,

Diagnostic assessments: AI-analyzed assessments identify knowledge gaps. (Informant 20 Q3A1L189-190)

AI-enabled real-time feedback enhances student learning in mathematics by providing immediate insights into their performance. Research shows that instant feedback helps students correct errors and deepen their understanding of mathematical concepts (Shute, 2019). AI also allows teachers to monitor progress continuously, making it easier to identify areas needing attention (VanLehn, 2018).

Student Engagement and Motivation. This theme suggests that AI can significantly enhance student engagement and motivation in mathematics teaching by offering interactive and personalized learning experiences. AI-powered tools, such as math games, simulations, and adaptive exercises, make learning more enjoyable and relevant, capturing students' attention and keeping them motivated. With real-time feedback and dynamic adjustments based on performance, students remain actively involved in their learning process. These AI-driven resources encourage students to take ownership of their progress, creating a sense of accomplishment as they advance through levels at their own pace. As a result, students are more likely to stay engaged, persist through challenges, and develop a positive attitude towards learning mathematics.

AI has been crucial for enhancing engagement among students. In the narrative of the informant, it was shared that:

Virtual manipulatives: AI-powered digital tools for hands-on math exploration.Informant 23 Q3A1L204-205).

AI-powered tools enhance student engagement in mathematics by offering interactive and dynamic learning experiences (Baker et al., 2020). Research shows that game-based learning, supported by AI, increases motivation and active participation. Additionally, AI adapts content to individual needs, keeping students challenged and motivated throughout their learning journey (Awang et al., 2025).

Implications for Practice

Incorporating AI into mathematics teaching can enhance personalized learning and adaptive instruction, helping educators better meet individual student needs. AI allows for adjusting the learning pace, providing targeted interventions, and offering real-time feedback, empowering students to work at their own pace. However, it is important for teachers to maintain a balance between AI tools and critical thinking, ensuring students don’t become overly reliant on automated systems.

Teachers must be aware of the ethical implications surrounding the use of AI in mathematics education, ensuring that student data is protected and AI tools are used responsibly. Overreliance on AI for solutions can stifle students' critical thinking, so educators must encourage independent problem-solving while using AI as a supportive tool. Teachers should also verify the quality and reliability of AI-generated content to ensure that students receive accurate and appropriate instruction.

AI can greatly enhance efficiency in mathematics teaching by automating administrative tasks, allowing teachers to focus more on student

interaction and personalized instruction. Real-time feedback provided by AI can guide students immediately, helping them understand their mistakes and reinforcing their learning. Moreover, using AI-driven tools to engage students through interactive exercises and math games can significantly increase their motivation and interest in the subject.

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