Journal of Applied Research in Science and Humanities

Handling Learning Mathematics challenges using (Ai)

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Abstract

This study explores the use of Artificial Intelligence (AI) to address common challenges in learning mathematics, such as difficulties in comprehension, lack of engagement, and the absence of personalized learning experiences. With the growing need for innovative educational solutions, AI-powered tools such as adaptive learning systems, virtual tutors and machine learning platforms offer promising ways to support students and educators. The study analyzes key obstacles in mathematics education and evaluates existing AI-driven approaches. It also proposes a framework that leverages machine learning algorithms to diagnose student difficulties and provide tailored solutions. Findings indicate that AI enhances understanding, increases engagement, and delivers real-time feedback, thereby improving overall learning outcomes. Additionally, the research suggests that AI tools effectively complement traditional teaching methods, particularly in resource-limited settings.

The study concludes that integrating AI into mathematics education holds significant potential for improving learning efficiency and accessibility. However, further development is required to ensure accuracy, inclusivity, and adaptability to diverse student needs. This approach paves the way for a more interactive and effective future in mathematics education.

Key Words: **Artificial Intelligence**, **Smart Education**, **Adaptive Learning**, **Educational Technology**, **Automated Assessment**.

INTRODUCTION:

This study explores how artificial intelligence (AI) can be used to facilitate mathematics learning and improve student's experiences in overcoming challenges in this subject. By analyzing common problems students face in understanding math, the study aims to provide intelligent solutions based on AI technologies such as machine learning and interactive tutoring systems. These solutions can simplify mathematical concepts and make them more accessible.

In a rapidly evolving world, mathematics remains one of the most crucial academic disciplines due to it's vital role in daily life and various scientific fields such as engineering, medicine, economics, and even the arts. It enhances logical thinking, sharpens problem-solving skills, and serves as the foundation for countless technological advancements. Yet, many students struggle to grasp mathematical concepts which negatively impacts their academic performance and self-confidence.

As a student, I have personally faced numerous challenges in learning mathematics, including difficulties in understanding abstract concepts such as algebra and trigonometry, a lack of individualized attention in overcrowded classrooms, and anxiety that often accompanies solving math problems. Additionally, the limited availability of suitable learning resources tailored to different learning styles makes it harder for some students to keep up with the curriculum. Despite significant technological progress, there remains a substantial gap in supporting students who struggle with mathematics, as traditional teaching methods may not always ensure full comprehension of the materials.

Despite technological advancements, there remains a significant gap in supporting students who face difficulties in learning mathematics. Traditional teaching methods may not be sufficient to ensure that all students fully comprehend the material thus leading to poor academic outcomes. This study investigates how AI can provide customized and innovative solutions to enhance the learning experience.

This study highlights the potential of AI as an effective tool to help students overcome challenges in learning mathematics. By implementing intelligent and interactive learning systems, students can improve their understanding, build confidence, and enhance their academic performance.

Theoretical Framework:

Definition of Artificial Intelligence (AI) Artificial Intelligence is a branch of computer science that focuses on designing systems capable of performing tasks that typically require human intelligence, such as understanding, learning, and decision-making. This field aims to develop software and devices that can simulate certain cognitive functions such as logical thinking and data analysis. AI has become an integral part of our daily lives across various sectors, including education, healthcare, and industry.

Types of Artificial Intelligence (AI)

1. Narrow AI (Weak AI): This type focuses on performing a specific task, such as voice assistants or translation programs.
2. General AI: A theoretical type that is believed to be able to perform any intellectual task that humans can do.
3. Super AI: A potential future stage where AI surpasses human intelligence.
4. **Reactive Machines**: **These respond to** situations directly without retaining memories.
5. **Limited Memory Systems**: **These rely on** previous data to make better decisions over time.

Aspects of Artificial Intelligence in Education- Intelligent Tutoring Systems (ITS)

These offer personalized feedback and guidance:
- Automated Assessment Tools: These grade assignments provide immediate feedback.
- Adaptive Learning Platforms: These adjust content based on student performance.
- Chatbots and Virtual Assistants: These offer round the clock academic support.
- Predictive Analytics: These identify at risk students and suggest interventions.
- Content Creation and Recommendation: These generate tailored educational materials.
- Language Translation and Accessibility: These enhance learning for diverse students.

Importance of AI in Education

AI plays a critical role in personalizing education, automating routine tasks, and making learning more accessible and efficient. It enables data driven teaching and supports students with special needs through customized tools.

''AI technologies can help educators identify learning difficulties early and personalize interventions to improve student outcomes''. Holmes, Bialik, & Fadel (2019).

Advantages of AI in Education

- Personalized learning Reduced teacher workload Broader access to education data driven insights into student performance.

''The integration of AI in classrooms enhances not only administrative efficiency but also supports innovative teaching practices''.
Chen (2021)
–Broader access to education.
-Data-driven insights into student performance.

Disadvantages of AI in Education

- Decreased human interaction.
- High implementation cost.
- Data privacy concerns.
- Risk of dependency on technology.

Previous Studies:

Smith (2020): Found that AI increased engagement in high school students.
Chen (2021): Showed AI helped students with learning difficulties.
Ali & Hassan (2022): Reported positive impacts of AI in Egyptian virtual classrooms.

Methods of Research and the tools used:

This study employs a descriptive analytical methodology to examine the effect of AI tools on student understanding and engagement in mathematics lessons. The study focuses on comparing traditional teaching methods with

AI-supported methods, specifically for two lessons: one on Geometry (Transformation Geometry) and another on Algebra (Linear Equations and Functions), targeting first-year preparatory students.

Data collection tools included:

- Quizzes (via Quizizz and Kahoot!) to assess student performance.

-Surveys to gather feedback from students about their experience.

-Interactive lesson tools such as GeoGebra and Canva to present lessons visually.

- Eduaide AI for lesson preparation and structuring.

Findings and Recommendations

1. Key Conclusions

After investigating the role of AI tools in teaching mathematics, the study revealed significant insights:

-Improved student performance: The use of AI tools such as GeoGebra, Canva, and Quizizz led to a marked improvement in student scores and engagement in both the Geometry and Algebra lessons. This indicates that AI-supported teaching methods can effectively enhance comprehension and reduce distractions.

-High student engagement: Tools such as Kahoot! and Quizizz were particularly successful in making the learning process more interactive and engaging for students, fostering greater participation.

- Challenges with technology adoption: While students benefit from the integration of AI tools, some challenges were observed in terms of familiarity with the technology and its initial setup in the classroom.

2. Recommendations

-Professional development for educators: To fully benefit from AI tools, continuous training for educators is essential. This would allow teachers to effectively integrate AI into their teaching practices, enhancing student engagement and learning outcomes.

-Expand access to AI tools: Schools should invest in providing necessary infrastructure (e.g., computers, internet access) to ensure that AI tools can be used effectively in classrooms.

-Support for student preparedness: Educating students on the use of AI-driven platforms at an early stage can ensure they are comfortable with these tools, enabling better learning experiences.

3. Strategic Focus

Prioritize the integration of AI tools in mathematics curricula to enhance learning outcomes and promote technological literacy. This should align with national goals for digital transformation in education, addressing infrastructure challenges and creating a culture of innovation in school.

Result of Research:

Traditional Teaching Methods in Mathematics: A Lesson about: **Geometric Transformations**: **Reflection**

Traditional education relies on conventional pedagogical approaches, where knowledge transmission is central to the learning process. In this model, the teacher serves as the primary source of information, while students passively receive knowledge through lectures and direct instruction a method often referred to as rote learning. Here, the teacher dominates the classroom dynamics, with minimal emphasis on student inquiry or independent research.

To illustrate this approach, **we conducted a lesson on geometric reflection using traditional teaching methods**, **structured as follows**:

1. Introduction

The lesson began with a simple discussion to connect the topic to student's daily lives. Examples included:

- ''What happens to our image when we look in a mirror?''.
- ''Have you ever observed light reflecting off water?''.

This study aims to differentiate between rotation and reflection using relatable scenarios.

2. Concept Explanation

- Reflection is defined as a geometric transformation that produces a mirror image of a shape across a line (the axis of reflection).
- Visual examples were drawn on the board, such as reflecting a triangle vertically or horizontally.

3. Properties of Reflection

The key characteristics are explained as follows:

- The original figure and its reflection are congruent.
- The reflected image is reversed, mimicking a mirror.
- Practical demonstrations included plotting point reflections across the x-axis and y-axis.

4. Application & Practice

- Students observed diverse shapes and practiced determining their reflections across the x- axes and y-axes.
- Guided examples were solved collaboratively.

5. Recap & Assessment

- The lesson concludes with a summary through Q&A.
- A competitive group activity tasked students with reflecting on complex figures (e.g., letters and numbers).
- A short quiz verified comprehension.

5. Conclusion

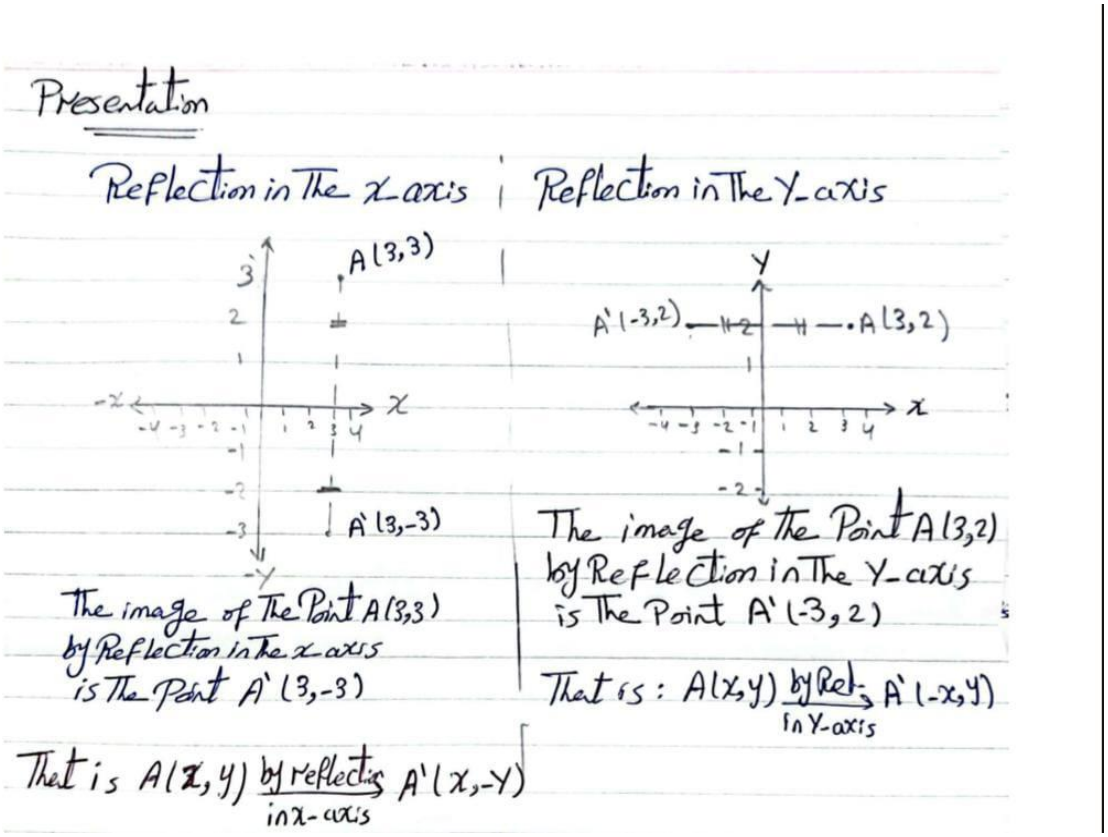
This teacher-centered method emphasizes knowledge delivery over active exploration. While it ensures structured content coverage, it may also limit critical thinking. Modern pedagogies often advocate blended approaches to foster deeper engagement.

Traditional method :

PIC 1

Traditional teaching TRY

To demonstrate the structure and content of the traditional teaching approach, we prepared a standard lesson plan and a corresponding written assessment using conventional methods without the use of AI. Below is a sample of the materials used during the traditional instruction.



Here are some questions about the Traditional quiz:

6. Which of the following is the image of the point (a, b) by reflection in the y-axis?

   a) (a, -b) b) (-a , b) c) (-a , -b) d). (b , - a)

7. What is the image of the point (-a ,b) by reflection in the X-axis followed by reflection in the y-axis?

   a) (a, b) b) (a , -b) c) (- a, - b) d). (b , a)

8. The image of the point (3,0) is the same point by reflection in the .....-axis.

The full traditional lesson plan can be accessed here:
https://drive.google.com/drive/folders/12c3bGoEKFlmzxB0DtV_J0zdH5ZbNj2Nh

AI-Powered Lesson: Teaching Geometric Translations: Reflection

Step 1: Interactive Introduction to AI

- AI Chatbot Engagement:

Use conversational AI (e.g., ChatGPT or DeepSeek) to spark curiosity with prompts such as:

-''What's the difference between rotation and reflection? Give real-life examples''.

- ''How does a mirror flip our image? Can you draw it?''.

- Multimedia Support:

Show a short Khan Academy animation demonstrating light shapes reflection.

Step 2: Generative AI for Concept Explanation

- AI-Guided Definition:

Tools such as Gemini or DeepSeek explain reflection concisely:

''Reflection is a geometric transformation that flips a shape over a line (axis), preserving its size and shape.''

- Visual Demonstration.

GeoGebra AI: dynamically plots shapes (e.g., triangles, squares) and computes their reflections across adjustable axes.

Step 3: Hands-On Practice with AI

- Adaptive Exercises:

Platforms such as Cognii or Sora generate personalized problems:

- ''Find the reflection of point (3, -2) over the y-axis''.

- ''What are the coordinates of a square after reflection over the x-axis?''.

- Instant Feedback:

AI analyzes errors and provides tailored hints (e.g., "Remember to invert the x-coordinate for y-axis reflection").

Step 4: Real-Time Assessment & Feedback

- AI-Powered quizzes

Tools such as Quizizz AI or Kahoot! create adaptive tests that include multilevel questions such as multiple-choice questions (MCQs) and shape-drawing tasks as well as performance analytics to track student progress.

-AI generates reports highlighting strengths and weaknesses (e.g., ''90% mastered point reflections, but 40% struggled with complex shapes'').

Step 5: Collaborative Learning via AI

- Team Challenges:

Classcraft's AI designs group tasks such as:

"Reflect the letter 'A' over a 45° slanted axis. Determine its new coordinates."

- Gamification:

Live leaderboard display rankings as students solve AI-generated problems.

Step 6: Personalized Learning & Improvement

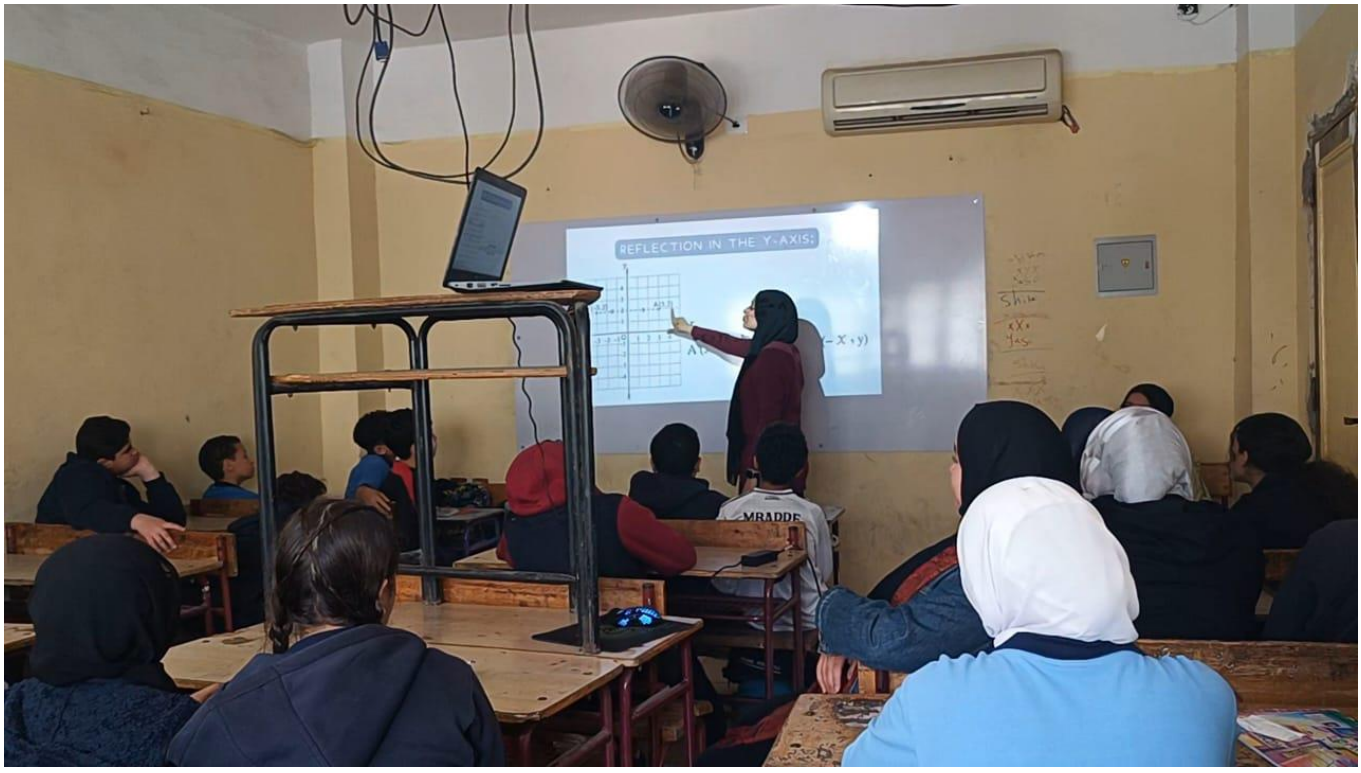
- Customized Recommendations:

AI suggests resources (e.g., YouTube tutorials) based on individual progress.

- Content Creation:

Students use Canva AI or Bing Image Creator to design posters summarizing reflection properties.

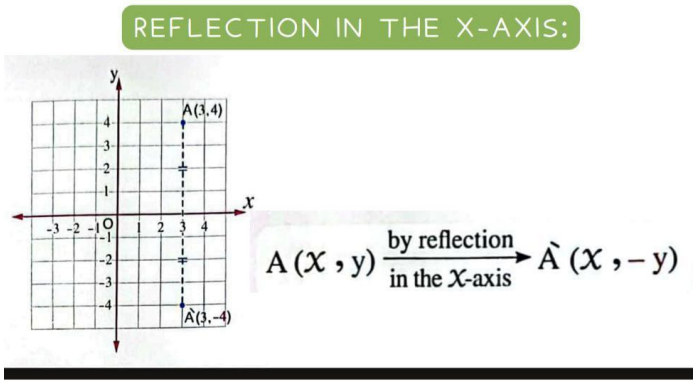
AI – driven teaching:

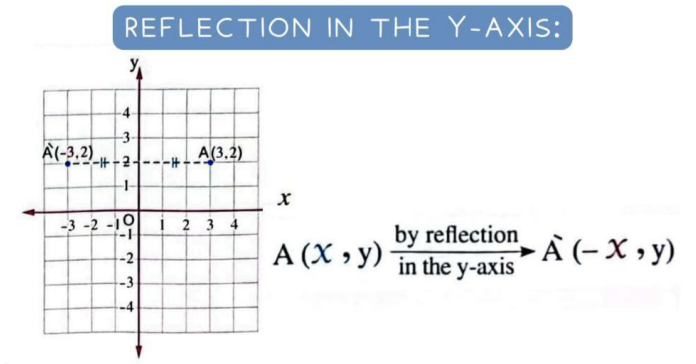


Pic 2

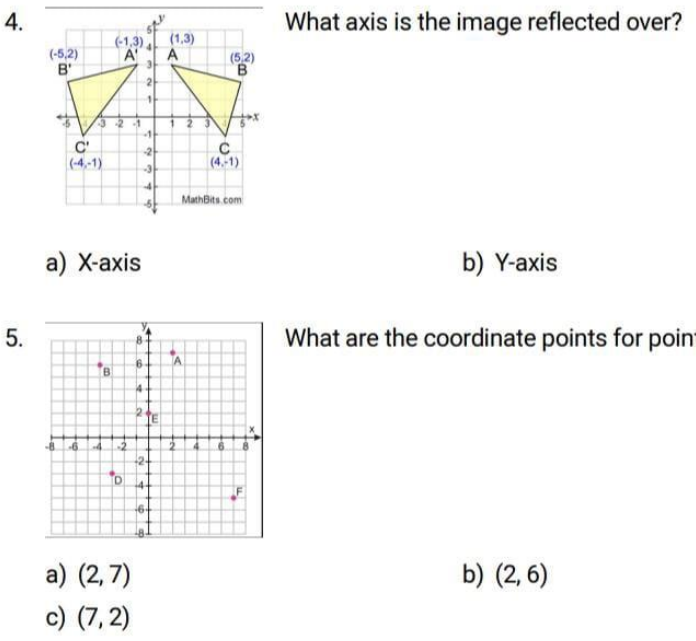
AI AI–Powered teaching method

To evaluate the effectiveness of AI-based teaching compared to traditional instruction, I prepared two lesson plans and assessments: one using conventional methods and the other integrating AI tools. Below are samples of the materials used for each method.





Here are some questions about AI-Generated teaching methods



The full lesson materials (presentation and quizzes) can be accessed here: https://drive.google.com/drive/folders/12eJJArtfr0-eSk-H8bBLNtRTj3T8JBob

Advantages of AI Over Traditional Teaching

1. Interactivity: Dynamic visualizations replace static whiteboard drawings.
2. Immediate Feedback: Corrections in real-time vs. delayed teacher grading.
3. Personalization: Exercises adapted to each student's level.
4. Engagement: Game-like elements boost motivation.

After conducting the experiment and analyzing the collected data, the results of this study clearly supported the initial hypothesis that using AI tools in teaching mathematics could improve students' understanding and reduce distractions in the classroom.

The key findings of this study were as follows:

- **Significant improvement in student performance**:
  -All students who participated in the study showed higher scores in the AI-based teaching session compared to the traditional one. For instance, Sama Amr's score improved from 1/10 to 9/10, while Jana Ahmed increased from 3/10 to a full score of 7/10.

- **Engagement and comprehension enhancement**:
  -Based on classroom observations, students were more engaged and responsive during the AI-supported session, particularly when interactive elements such as games and visual aids were used (e.g., GeoGebra and Canva).

- **Reduction in distraction levels**:
  -The integration of multimedia and interactive tools appeared to reduce behavioral distractions and helped students stay focused throughout the lesson.

- **Suitability of AI tools in mathematics education**:
  -The tools used, such as Canva, GeoGebra, and Quizizz, proved to be suitable and effective in clarifying abstract mathematical concepts, especially in geometry.

Here are the population data charts:

Chart 1 :

This chart illustrates the distribution of student's grades after applying the traditional teaching method. It highlights the variation in student's performance, reflecting the impact of relying solely on conventional educational approaches without the integration of modern technologies. The data analysis shows a noticeable disparity in student's results, which may indicate gaps in understanding or differences in content comprehension levels.

Chart 2:

This chart displays the distribution of the same student's grades after applying a teaching method based on artificial intelligence. It reveals a significant improvement in the performance of most students compared to Chart 1. This suggests that using AI as a supportive educational tool can enhance student's understanding and reduce the achievement gap among them.

Chart 1
Line chart of Student's Grades Before Applying AI–Based Instruction

Chart 2
Line chart of Student's Grades After Applying AI–Based Instruction

Chart 3&4:

This chart compares the difference between the mean and the median of student's grades before and after implementing AI-based instruction. The comparison highlights how the use of AI has shifted the central tendency measures, indicating not only an increase in the overall average (mean) but also a more balanced distribution (as shown by the median). This reflects a positive impact on both the general performance and the consistency of student's outcomes.

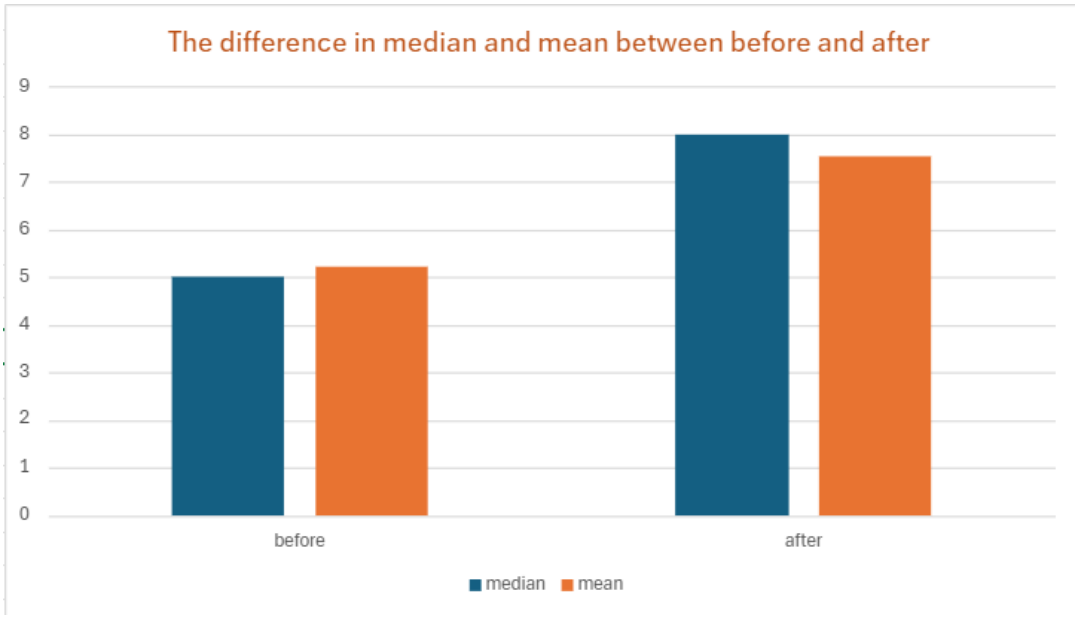


Chart 3 (As bar chart)

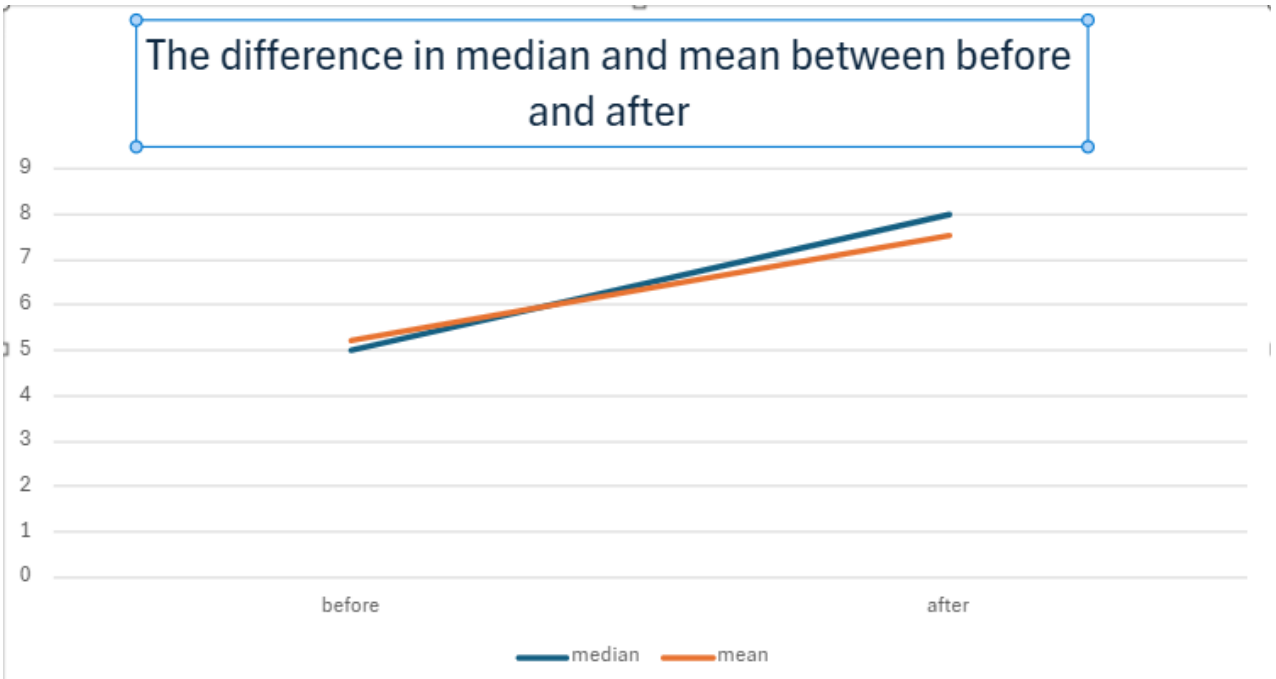


Chart 4 (As line chart)

➢ **The following table presents the sample data used in this study. It includes each student's grade before and after applying AI–based instruction. This data serves as the foundation for the subsequent analysis and visualizations.**

students	before	after
Yasen Mohamed	8	10
Sama Amr	1	9
Sajda Sameh	3	8
Tomas Soliman	3	8
Ireni Yousef	5	8
Jana Ahmed	3	7
meadian	3	8
mean	3.833333333	8.333333

Data 1

➢ **To better understand individual progress, the following bar chart presents the grade differences for each student.**

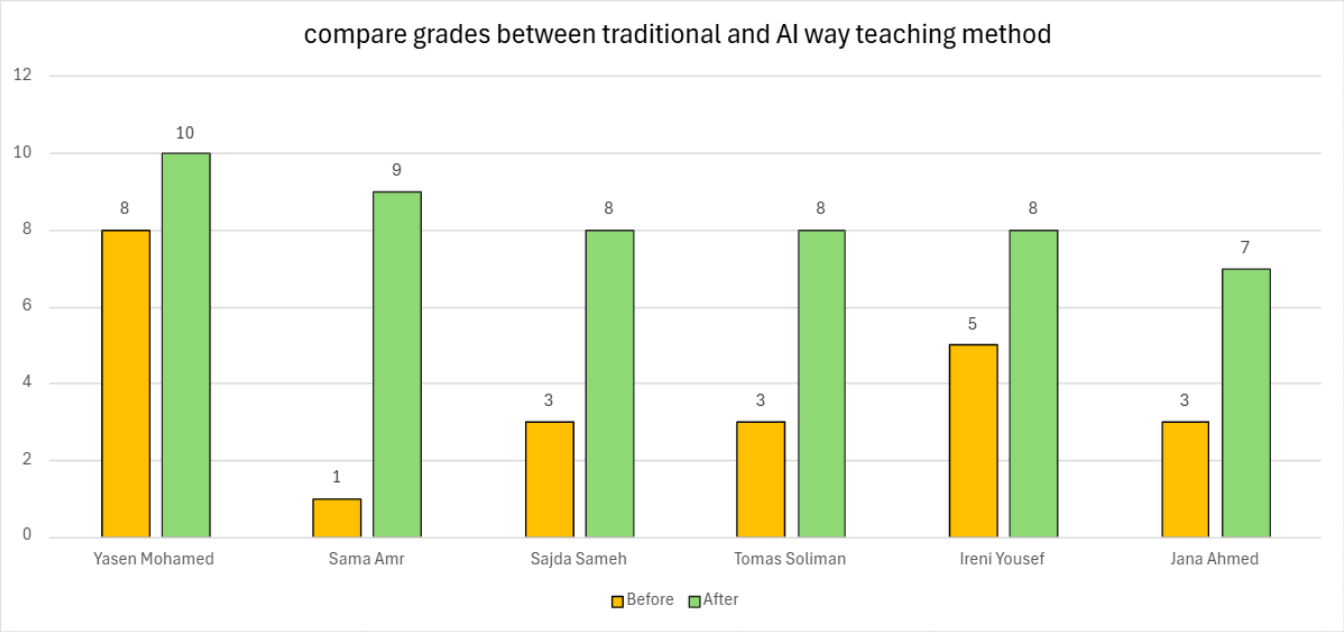


Chart 5

This bar chart shows the difference in each student's grade before and after the use of AI. Most students showed noticeable improvement.

- **In order to evaluate the overall impact of the AI-based instruction, the following chart compares the mean and median grades before and after implementation. This helps to highlight not only the improvement in average performance but also the consistency among students.**

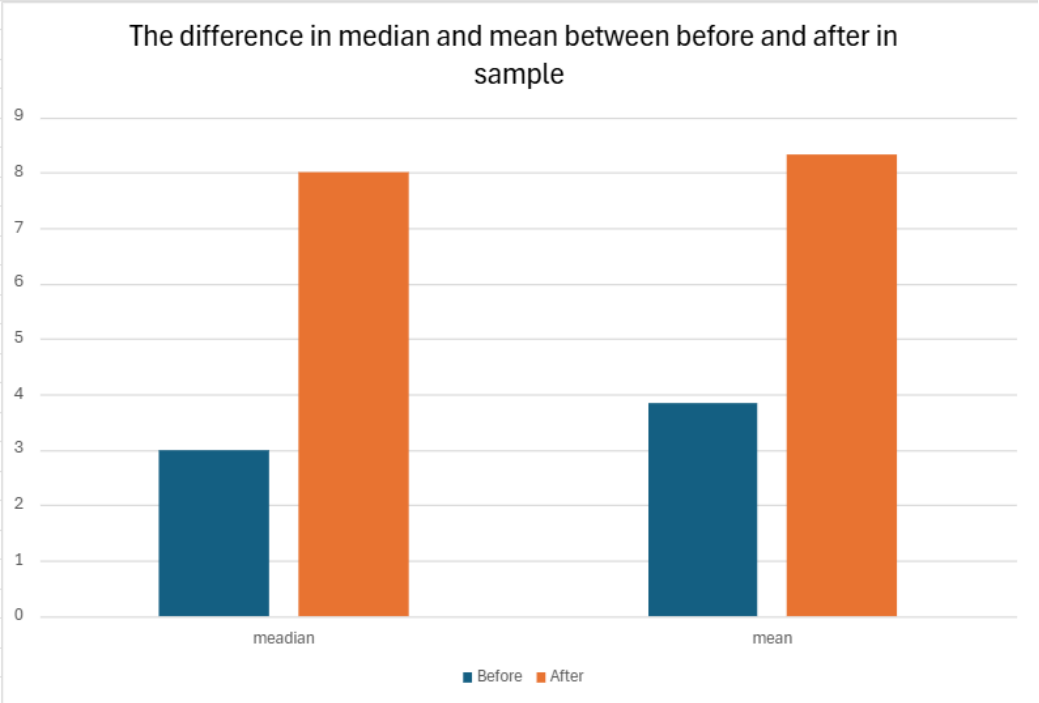


Chart 6

A noticeable increase in both the mean and median reflects the effectiveness of the AI-enhanced teaching method.

Algebra Lesson: Linear Equations and Solving First-Degree Equations

The results of the experiment in teaching linear equations using AI tools clearly show significant improvement in student's performance in terms of understanding and engagement. This improvement was observed through a comparison of the results between the traditional class and the one where interactive digital tools were used.

Key findings from the experiment:

1. Increased Understanding of Concepts:

At the beginning of the traditional lesson, some students struggled to grasp the concept of linear equations and how to represent them. However, with the introduction of visual and interactive tools such as GeoGebra and Canva, students were able to visualize the relationship between variables more practically, which led to a noticeable improvement in their understanding of the material.

2. Support of Graphical Representation in Clarifying Solutions:

Tools such as GeoGebra helped in illustrating how linear equations are graphed, and allowed students to see the effects of changing coefficients directly on the graph. This enhanced their understanding of the concept of solution and linked it to a clear graphical representation.

3. Increased Enthusiasm and Active Participation:

Through the use of Kahoot! for end-of-lesson quizzes, students showed active engagement, as they competed to answer questions more quickly and accurately, bringing a more interactive atmosphere to the classroom.

4. Improved Application Skills:

Students demonstrated better ability to apply mathematical rules to solve equations after watching step-by-step examples presented visually on Canva. The solutions were presented in an organized manner, supported by colors and symbols, making the steps easier to follow.

5. Positive Impact on Academic Results:

All students who participated in the experiment achieved higher scores in the second evaluation after using digital tools, indicating that AI-supported tools were not only motivating but also effective in improving academic performance.

The objective of the Experiment:

The objective of this experiment was to teach first-year preparatory students the concept of linear equations and how to solve them. The aim was to evaluate whether using AI tools, such as GeoGebra, Canva, and Quizizz, enhances student understanding and reduces distractions in the classroom.

Tools Used:

GeoGebra: This tool was used to visually represent linear equations and graph solutions. Students could interact with the equations by changing values and see the results in real time.

Canva: Visual aids were created using Canva, including slides that illustrated step-by-step solutions to linear equations, making the content more engaging.

Kahoot!: A set of interactive quizzes was prepared on Quizizz to assess student understanding of solving linear equations in a fun, engaging way.

Desmos: This tool was also used to graph linear equations and visually demonstrate how the line changes as the equation is modified.

Procedure:

1. Traditional Method: The lesson was first taught using traditional methods—writing equations on the board and solving them step by step without any technological aid. At the end of this session, a 10-question quiz was administered, and the student's scores were collected and corrected manually.

2. AI-Supported Method: The same lesson was then taught using AI-supported tools. The teacher used GeoGebra to visually represent the solutions of linear equations, and Canva was used to prepare slides that showed detailed step-by-step solutions. The lesson was further enhanced using Kahoot!, where students took an interactive quiz at the end. Their scores were recorded and compared to the traditional teaching session.

Data Collected:

The following data reflects the student's performance in both the traditional and AI-supported lessons:

algebra lesson		
students	grades before	grades after
Ahmed Mostafa	4	9
Mariem Mohamed	2	8
Ahmed Hosam	3	7
Sara Ali	5	9
Yousef Hassan	1	6

Data 2

Results of Research:

The results of this experiment show a clear improvement in student's performance after using AI tools. The average score increase was significant, with most students showing considerable improvement (e.g., Ahmed Mustafa's score increased from 4 to 9). These results suggest that the use of visual and interactive tools such as GeoGebra and Canva, along with interactive quizzes from Kahoot!, had a positive impact on student learning.

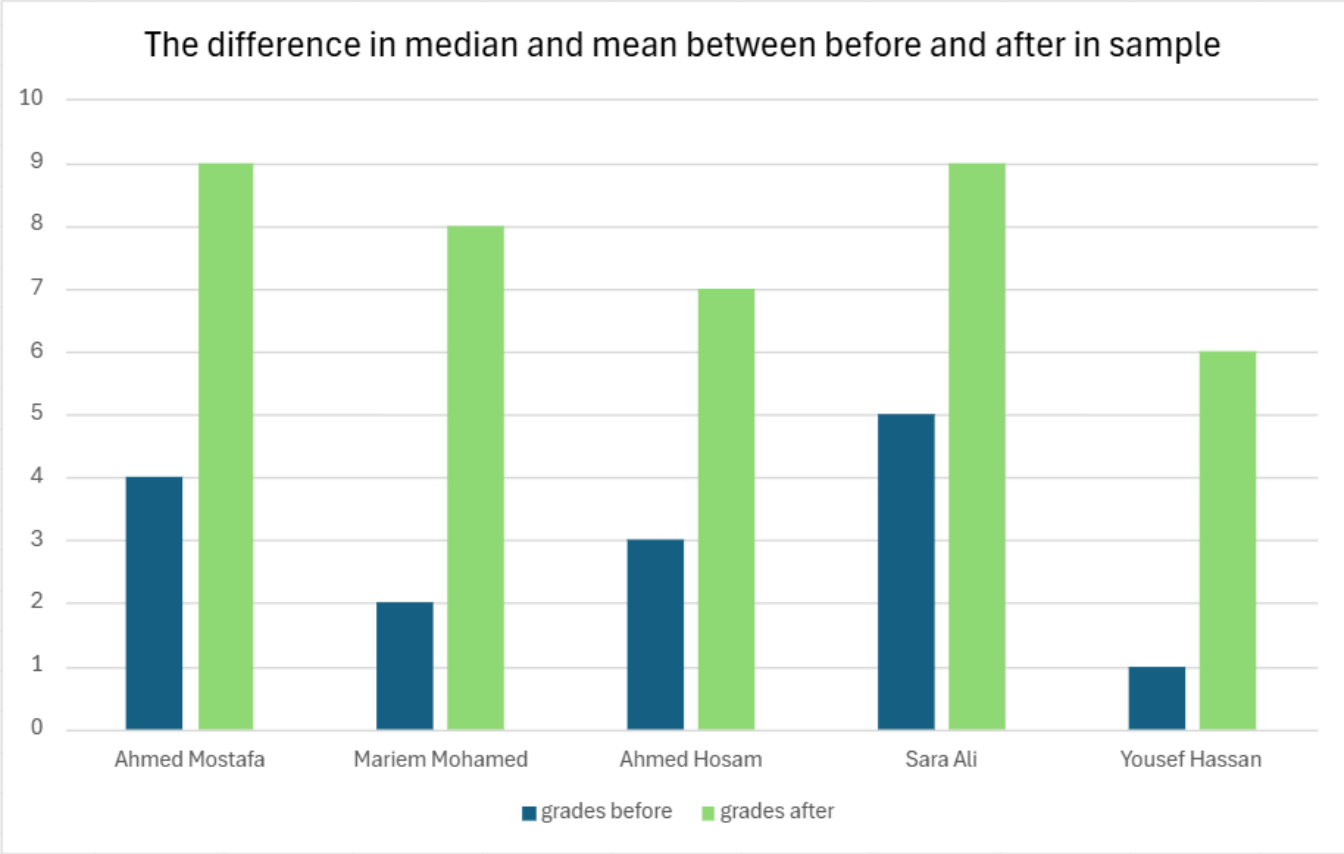


Chart 7

This bar chart shows the difference in each student's grade before and after the use of AI. Most students showed noticeable improvement.

These results confirm the hypothesis of the study and demonstrate that AI tools can play a vital role in overcoming common challenges in learning mathematics.

Interpretation of Results

The results of this study strongly support the research hypothesis, which proposed that the use of AI tools in teaching mathematics enhances student understanding and reduces classroom distractions. The improvement in student performance after the application of AI-supported methods suggests a strong positive correlation between the use of technological tools and improved learning outcomes.

Geometry Lesson (Transformation)

In the Geometry lesson, the integration of AI tools significantly contributed to student engagement and comprehension. The use of GeoGebra allowed students to visualize geometric transformations in real-time, which facilitated a deeper understanding of abstract concepts. This visual approach helped students grasp the relationship between figures and their transformations, which is often challenging in traditional teaching methods.

Additionally, Canva was used to organize and present the lesson content in a simplified manner, making the information more accessible. The Quizizz quizzes provided a fun and interactive way for students to test their knowledge, offering immediate feedback and fostering an engaging learning environment. These tools together catered to various learning styles visual (GeoGebra), auditory (teacher explanations with Canva slides), and kinesthetics (interactive quizzes with Quizizz).

The noticeable improvement in scores from the pre-test to the post-test (e.g., Sama Amr from 1 to 9, and Sajada Samah from 3 to 8) reflects not just academic progress but also increased student motivation, attention, and overall interaction with the content. These results align with existing educational theories that emphasize the importance of active learning and student engagement in enhancing comprehension and retention.

Algebra Lesson (Linear Equations and Functions)

In the Algebra lesson, the use of AI tools allowed students to better understand and visualize complex algebraic concepts, such as linear equations and their graphical representations. The interactive nature of these tools enabled students to explore mathematical relationships and functions dynamically, reinforcing their learning experience. The Kahoot! quizzes provided immediate assessment, keeping students engaged and allowing them to track their progress in real time.

Similar to the Geometry lesson, the combination of visual, auditory, and kinesthetic methods through these AI tools addressed different learning styles, ensuring a more inclusive learning environment. The positive change in scores from the pre-test to the post-test across the group reflects the effectiveness of the AI-supported methods in enhancing student learning and engagement.

Conclusion

This study concluded that the use of artificial intelligence tools in teaching mathematics can have a positive impact on student understanding, engagement, and academic performance. By using tools such as GeoGebra, Canva, and Kahoot!, students showed a noticeable improvement in their performance and increased interaction with the subject matter.

The results also demonstrated that integrating AI into teaching helps meet various learning needs, whether visual, auditory making education more inclusive and accessible to all students.
Furthermore, the use of these tools was not limited to theoretical lessons but extended to interactive assessments that allowed students to engage immediately with what they had learned, enhancing the evaluation process.
Although advanced statistical tests were not conducted in the study, the comparison between traditional teaching methods and AI-supported methods showed clear improvement in student's scores, indicating the effectiveness of these tools in improving academic performance in mathematics.
In light of these results, it can be said that integrating AI into teaching is not merely an additional educational tool, but a significant step toward advancing traditional teaching methods and creating an interactive and progressive learning environment. These tools contribute to bridging educational gaps, especially in subjects such as mathematics where students often face difficulties.
This study suggests that the integration of AI in education is a fruitful step toward improving academic understanding, reducing distractions, and enhancing interaction with the subject, ultimately helping to develop traditional teaching methods and provide an inclusive and effective learning environment.

Acknowledgment

We would such as to express our sincere thanks and appreciation to Dr/ Mahmoud Hamed from the Department of Mathematics, Faculty of Education, Ain Shams University, for his unwavering support, valuable guidance, and constant encouragement throughout this study. His advice and dedication played a crucial role in the successful completion of this project.
We are also deeply grateful to our field training supervisor, Dr/ Amira Hassan, for her continuous support and effort in overcoming the challenges we faced during our time at the school. Her help was instrumental in ensuring the smooth execution of the project.
Additionally, we extend our heartfelt thanks to the Faculty of Education, Ain Shams University, for providing the academic resources and an enriching environment necessary for conducting this study.

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