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Artificial Intelligence and Digital Tools in Mathematics Education: An Exploratory Review of GeoGebra, Gamma AI and Wolfram|Alpha

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Abstract — The rapid development of Artificial Intelligence (AI) and digital technologies is transforming the teaching and learning of mathematics. Traditional mathematics education has increasingly been supplemented by dynamic visualization software, computational systems, intelligent learning environments, and AI-supported content-generation tools. This paper explores the role and educational potential of three contemporary digital tools—GeoGebra, Wolfram|Alpha, and Gamma AI—in mathematics education. GeoGebra provides an interactive environment for geometry, algebra, calculus, statistics, graphing, and three-dimensional mathematics. Wolfram|Alpha offers computational capabilities that can support symbolic manipulation, mathematical calculations, graphing, and step-by-step exploration. Gamma AI, although not primarily a mathematical solver, can support mathematics education through AI-assisted presentation development, visualization, lesson organization, and educational content creation. The paper adopts an exploratory literature-review approach to examine the pedagogical applications, benefits, limitations, and responsible use of these technologies. Existing literature indicates that AI-supported mathematics education can provide personalized assistance, feedback, visualization, and new opportunities for mathematical exploration, while GeoGebra has demonstrated particular value in visualization and conceptual understanding (Yoon & Kwon, 2024; Muslim et al., 2023). At the same time, technological integration can create challenges related to teacher readiness, student overdependence, academic integrity, accessibility, and the development of genuine mathematical reasoning. The paper proposes an integrated AI-Digital Mathematics Learning Model in which the teacher remains the pedagogical decision-maker while digital tools function as visualization, computation, communication, and exploratory supports. The paper concludes that AI and digital tools should complement rather than replace mathematical thinking, teacher guidance, and student reasoning.

Keywords— Artificial Intelligence, Mathematics Education, Digital Tools, GeoGebra, Wolfram|Alpha, Gamma AI, Mathematical Modelling, Digital Learning, AI-Assisted Education

I. INTRODUCTION

Mathematics is fundamentally concerned with reasoning, abstraction, representation, problem solving, modelling, and logical communication. However, many mathematical concepts are difficult for learners because they involve abstract relationships that cannot always be easily visualized or connected to real-world situations. Digital technologies have created new possibilities for representing mathematical ideas dynamically and interactively.

Artificial Intelligence has expanded these possibilities by introducing systems capable of providing automated feedback, supporting personalized learning, generating educational content, assisting problem solving, and analyzing learner interactions. Recent reviews indicate that AI-based mathematics education research is expanding rapidly, with AI being used for student support, teaching assistance, assessment, and adaptive learning (Yoon & Kwon, 2024).

Digital mathematical tools such as GeoGebra have also changed the way mathematical concepts can be represented. GeoGebra allows learners to manipulate mathematical objects and immediately observe changes in corresponding representations. Research reviews have reported applications of GeoGebra across geometry, algebra, calculus, statistics, and other mathematical domains (Muslim et al., 2023; Pinto et al., 2025).

Alongside mathematical software, generative AI platforms such as Gamma AI have created new possibilities for preparing presentations, organizing lessons, generating visual material, and communicating mathematical ideas. Wolfram|Alpha provides another important category of digital technology: computational knowledge and symbolic mathematics. It is important to distinguish such computational systems from generative AI because they operate primarily through computational algorithms, symbolic methods, structured data, and natural-language interpretation.

Therefore, the current mathematics classroom is moving toward an ecosystem in which teachers and students can combine human reasoning with computational, visual, and generative technologies.

Need for the Study

The increasing availability of AI and digital mathematical tools creates both opportunities and challenges.

Students can obtain rapid computational assistance, visualize mathematical relationships, explore multiple representations, and receive immediate feedback. Teachers can create interactive activities, presentations, simulations, worksheets, and assessment resources more efficiently.

However, easy access to technological assistance can also create problems. Students may accept automatically generated answers without checking the reasoning behind them. Excessive dependence on computational tools may reduce opportunities for independent problem solving. Teachers also need sufficient technological and pedagogical knowledge to integrate these tools effectively.

Research on AI-based mathematics education emphasizes that the teacher's role is changing from being merely a recipient of technology to becoming a constructive partner with AI (Yoon & Kwon, 2024). Consequently, research into the appropriate integration of AI and digital tools in mathematics education is important.

Objectives of the Study

The major objectives of this paper are:

- To examine the role of Artificial Intelligence in mathematics education.
- To explore the educational applications of GeoGebra.
- To examine the mathematical applications of Wolfram|Alpha.
- To investigate the potential of Gamma AI for mathematics teaching and communication.
- To compare the educational functions of GeoGebra, Wolfram|Alpha, and Gamma AI.
- To identify the advantages and limitations of AI and digital mathematics tools.
- To propose an integrated model for using AI and digital technologies in mathematics education.
- To examine the role of teachers in AI-supported mathematics learning.
- To suggest principles for responsible and academically meaningful use of these technologies.

Research Questions

The study addresses the following questions:

- How can Artificial Intelligence support mathematics teaching and learning?
- How can GeoGebra enhance mathematical visualization and conceptual understanding?
- How can Wolfram|Alpha support mathematical computation and exploration?
- How can Gamma AI support mathematics teachers in creating educational content?
- What are the similarities and differences among these three tools?
- What challenges may arise from their use?
- How can teachers integrate these tools without weakening students' mathematical reasoning?

II. RESEARCH METHODOLOGY

This paper follows an exploratory literature-review approach. Relevant scholarly literature concerning Artificial Intelligence in mathematics education, GeoGebra, digital mathematical tools, and AI-supported education was examined.

The review considered research articles, systematic reviews, and authoritative information concerning the functionality of the selected digital tools. Particular attention was given to studies discussing mathematical learning, visualization, problem solving, teacher roles, conceptual understanding, and challenges associated with technology integration.

The study is conceptual and exploratory. It does not claim to report primary experimental data. Instead, it synthesizes existing research to develop a proposed framework for integrating AI and digital tools into mathematics education.

III. ARTIFICIAL INTELLIGENCE IN MATHEMATICS EDUCATION

Artificial Intelligence can be defined broadly as the use of computational systems capable of performing tasks associated with aspects of human intelligence, including pattern recognition, prediction, language processing, decision support, and adaptive interaction.

In mathematics education, AI can contribute to:

- personalized learning;
- automated feedback;
- intelligent tutoring;
- mathematical problem-solving assistance;
- assessment;

- learning analytics;
- content generation;
- mathematical modelling;
- instructional planning; and
- student support.

A systematic review by Yoon and Kwon (2024) examined 57 studies on AI-based mathematics teaching and learning and found that AI had been used for student teaching, teacher support, student support, and system-level support. Their findings also emphasize the changing role of teachers in AI-supported learning.

AI therefore should not be viewed simply as a machine that provides answers. Its educational value depends on how it is incorporated into meaningful mathematical activities.

Applications of AI in Mathematics
AI-Assisted Problem Solving
AI systems can help learners explore mathematical problems by providing explanations, alternative approaches, hints, or computational assistance.

For example, when studying a quadratic equation, an AI-supported system may help students investigate:
Mathematical Exploration

$$ax^2 + bx + c = 0$$
$$\text{Discriminant: } D = b^2 - 4ac$$

Students can explore the discriminant and understand how its value affects the nature of the roots. The important pedagogical objective is not merely obtaining the roots but understanding why the roots change when coefficients change.

Personalized Learning
AI can potentially adapt instructional material according to students' learning needs. A student experiencing difficulty with algebraic manipulation may receive additional practice, while another student may be provided with more challenging problems. Such adaptive approaches are consistent with the broader development of AI-supported mathematics education identified in recent literature (Yoon & Kwon, 2024).

Automated Feedback
Digital systems can provide immediate feedback about mathematical procedures. Immediate feedback may help students identify errors while they are still engaged with the problem. However, feedback should encourage students to understand the source of an error rather than simply replacing an incorrect answer with a correct one.

Mathematical Modelling
AI and digital tools can support mathematical modelling by allowing learners to:
- identify variables;
- collect or organize data;
- formulate mathematical relationships;
- visualize relationships;
- calculate parameters;
- test assumptions; and
- interpret results.

Digital tools therefore can help connect mathematical theory with real-world situations.

IV. GEOGEBRA AS A DIGITAL MATHEMATICS TOOL

GeoGebra is a dynamic mathematics environment that integrates geometry, algebra, graphing, spreadsheets, calculus, statistics, probability, and three-dimensional representations.

Research has identified GeoGebra as an important digital tool for mathematics education, particularly because of its dynamic and interactive representations (Muslim et al., 2023).

A systematic review of GeoGebra research found applications across geometry, algebra, statistics, probability, and other mathematical areas. The literature also indicates substantial use in secondary and higher education (Muslim et al., 2023).

More recent reviews continue to report positive effects of GeoGebra on conceptual understanding, visualization, problem solving, and student engagement, while also identifying teacher readiness and infrastructure as important implementation challenges (Izdahara & Irvan, 2025).

Major Features of GeoGebra
GeoGebra can be used for:
- 2D graphing;
- 3D graphing;
- geometry construction;
- algebraic manipulation;
- functions;
- calculus;
- statistics;
- probability;
- transformations;
- sliders;
- dynamic constructions;

- mathematical modelling;
- coordinate geometry; and
- interactive classroom activities.

Its major strength is the connection between multiple representations. For example, a learner can change an equation and observe its corresponding graphical representation. This supports the development of connections between symbolic and visual mathematical thinking.

GeoGebra and Geometry

Geometry is one of the areas in which GeoGebra has particularly strong educational potential. A teacher can construct triangles, circles, polygons, tangents, transformations, loci, vectors, coordinate systems, and three-dimensional objects.

Students can manipulate points and observe invariant relationships. For example, students investigating the angle-sum property of a triangle can dynamically change the triangle while observing that $A + B + C = 180°$. This can transform geometry from a static diagram into an exploratory environment.

A systematic review of GeoGebra research reported that geometry and analysis have been prominent application areas and that activity-based approaches are frequently used (Muslim et al., 2023).

GeoGebra and Functions

GeoGebra can be used to visualize functions such as $f(x) = x^2$, $f(x) = \sin x$, and $f(x) = e^x$. Students can change parameters and observe the resulting transformations.

Function Transformation Model

$$f(x) = a(x - h)^2 + k$$

- a: vertical stretching or reflection
- h: horizontal translation
- k: vertical translation

Such dynamic exploration can support conceptual understanding better than viewing a fixed graph alone.

GeoGebra and Three-Dimensional Mathematics

Three-dimensional mathematical concepts can be challenging because students have to mentally interpret spatial relationships. GeoGebra's 3D environment can support the visualization of planes, lines, vectors, spheres, cylinders, cones, intersections, surfaces, and coordinate systems. This can be especially useful in Class 11–12 mathematics and undergraduate mathematics.

Wolfram|Alpha in Mathematics

Wolfram|Alpha is a computational knowledge system that accepts natural-language or mathematical input and generates computational results. It supports mathematical areas including arithmetic, algebra, calculus, differential equations, statistics, probability, geometry, number theory, linear algebra, and mathematical graphing.

Wolfram|Alpha is particularly useful for checking calculations and exploring mathematical relationships. It should not, however, be described simply as a conventional generative AI system. Its functionality is strongly based on computational algorithms, symbolic mathematics, structured knowledge, and natural-language processing.

Wolfram|Alpha and Algebra

Students can investigate equations such as $2x + 5 = 17$ or $x^2 - 5x + 6 = 0$. For higher mathematics, it can support exploration of integrals, derivatives, and systems of equations.

The educational value is strongest when students first attempt a problem independently and then use computational technology to verify, compare, or investigate their reasoning.

Wolfram|Alpha and Calculus

Calculus is another area where computational systems can provide valuable support. For example, students can explore derivatives:

Calculus Verification

$$\frac{d}{dx}(x^3) = 3x^2$$
$$\int 3x^2\,dx = x^3 + C$$

Such tools can help students investigate relationships between functions, derivatives, and integrals. However, computational verification should not replace students' understanding of differentiation and integration rules.

Gamma AI in Mathematics Education

Gamma AI represents a different category of digital tool. Unlike GeoGebra and Wolfram|Alpha, Gamma is primarily an AI-assisted content creation and presentation platform rather than a mathematical computation system.

Gamma can assist users in creating presentations, educational documents, lesson structures, visual explanations, classroom presentations, concept summaries, project reports, and educational communication materials. For mathematics teachers, this can reduce the time required to convert mathematical content into visually organized teaching material.

Applications of Gamma AI for Mathematics Teachers

A mathematics teacher can use Gamma AI to develop a presentation on "Applications of Quadratic Equations in Real Life." A presentation structure could include:

- Introduction to quadratic equations.
- Standard form.
- Graphical representation.
- Nature of roots.
- Real-life examples.
- Worked examples.
- Student activity.
- Assessment questions.
- Reflection.
- Summary.

The teacher should verify mathematical accuracy before classroom use. Thus, Gamma AI is best considered a communication and content-development assistant, rather than a replacement for mathematical software.

V. COMPARATIVE ANALYSIS

Table 1 provides a comparative summary of the functional capabilities of GeoGebra, Wolfram|Alpha, and Gamma AI in mathematics education.

Feature	GeoGebra	Wolfram|Alpha	Gamma AI
Main purpose	Dynamic mathematics	Computational mathematics	AI-assisted content creation
Geometry	Excellent	Strong computational support	Presentation support
Algebra	Strong	Excellent	Explanatory support
Calculus	Strong	Excellent	Content presentation
3D mathematics	Excellent	Available computationally	Visual communication
Graphing	Excellent	Strong	Presentation-oriented
Mathematical computation	Strong	Very strong	Limited
Dynamic exploration	Excellent	Moderate	Limited
Presentation creation	Good	Limited	Excellent
Lesson-content generation	Moderate	Limited	Excellent
Teacher support	High	High	High
Student exploration	Very high	High	Moderate
Main strength	Visualization	Computation	Communication

Integrated Use of GeoGebra, Wolfram|Alpha and Gamma AI

The greatest educational potential may arise when the three tools are used together, such as during a instructional unit on "Quadratic Functions":

- Stage 1: Mathematical Exploration — The teacher introduces $y = ax^2 + bx + c$. Students use GeoGebra to investigate the effect of a, b, and c.
- Stage 2: Computational Verification — Students use Wolfram|Alpha to verify selected algebraic calculations and explore mathematical properties.
- Stage 3: Mathematical Communication — Students use Gamma AI to organize their observations into a presentation.
- Stage 4: Human Reasoning — Students explain what they observed, why the graph changed, what mathematical principle explains the change, and whether their computational results are reasonable.

This final stage is critical because the purpose of technology should be to strengthen mathematical thinking.

VI. PROPOSED AI-INTEGRATED MATHEMATICS LEARNING MODEL

This paper proposes a five-stage model:

- Stage 1: Understand — Students first study the mathematical concept without depending on technology.
- Stage 2: Explore — Students use GeoGebra or another visualization tool to investigate relationships.
- Stage 3: Compute — Students use computational tools such as Wolfram|Alpha to verify calculations or explore advanced cases.

- Stage 4: Communicate — Students use AI-assisted tools such as Gamma to organize and communicate mathematical findings.
- Stage 5: Reflect — Students explain and critically evaluate the results independently.

AI-Integrated Mathematics Learning Pipeline

Mathematical Concept ➔ Exploration➔Computation➔ Communication➔ Reflection

The teacher remains responsible for selecting tasks, checking accuracy, guiding discussion, and assessing mathematical understanding.

Applications in Secondary Mathematics

AI and digital tools can be integrated into topics across school levels:

- Class 9: Coordinate geometry, Polynomials, Linear equations, Statistics, Geometry
- Class 10: Real numbers, Quadratic equations, Trigonometry, Coordinate geometry, Surface areas and volumes, Statistics
- Class 11: Functions, Permutations and combinations, Conic sections, Limits, Probability
- Class 12: Matrices, Determinants, Continuity and differentiability, Integrals, Differential equations, Three-dimensional geometry, Linear programming

Applications in Higher Education

At university level, these tools can support mathematical modelling, numerical analysis, calculus, linear algebra, differential equations, statistics, optimization, research visualization, computational mathematics, and mathematical presentations.

For research scholars, computational tools can also help explore mathematical structures before formal analytical development.

Benefits of AI and Digital Tools

Visualization

Digital tools can transform abstract mathematical relationships into dynamic visual representations.

Immediate Feedback

Students can receive rapid information about their calculations or representations.

Student Engagement

Interactive activities can encourage experimentation and exploration.

Personalized Learning

AI systems can potentially provide different levels of support according to learners' needs.

Mathematical Modelling

Digital environments can connect mathematics with real-world situations.

Teacher Productivity

AI-supported content tools can help teachers prepare presentations, activity structures, and instructional materials.

Multiple Representations

Technology allows students to move between symbolic, graphical, numerical, and geometric representations.

Limitations and Challenges

Technology integration also introduces significant challenges:

Overdependence

Students may become dependent on technology for even simple mathematical calculations.

Reduced Mathematical Reasoning

If students focus only on obtaining answers, the development of mathematical reasoning may be weakened.

Incorrect AI Output

Generative AI systems can sometimes produce inaccurate calculations, explanations, or interpretations.

Teacher Readiness

Effective integration requires teachers to understand both mathematics and the pedagogical use of technology (Yoon & Kwon, 2024).

Digital Inequality

Not all students have equal access to devices, reliable internet connections, or appropriate software.

Academic Integrity

Students may submit AI-generated material without demonstrating their own understanding.

Privacy and Ethical Concerns
AI-based educational systems may involve the collection and processing of student information. Schools and institutions therefore need appropriate privacy and governance practices.

AI and Mathematical Thinking
An important question is whether technology improves mathematical thinking or merely improves answer production. Mathematical thinking involves reasoning, conjecturing, proving, generalizing, connecting concepts, interpreting results, identifying errors, and communicating arguments.

Therefore, technology should be designed into tasks that require students to think.

Task Design Shift
Traditional Task: 'Find the roots of this quadratic equation.'

Technology-Enhanced Task: 'Change the coefficients of the quadratic equation and investigate when the graph has two, one, or no real x-intercepts. Explain your findings mathematically.'
26. Role of the Mathematics Teacher

The teacher remains central to effective technology integration. The teacher should:

- select appropriate digital tools;
- design meaningful mathematical tasks;
- verify AI-generated information;
- encourage independent reasoning;
- teach students to question computational results;
- discuss ethical use of AI;
- assess mathematical understanding rather than only final answers;
- support students who have limited digital access; and
- maintain a balance between technology-assisted and technology-free mathematical activities.

The emerging literature suggests that teachers should increasingly function as constructive partners with AI rather than simply as users or recipients of technology (Yoon & Kwon, 2024).

Proposed Classroom Activity
Classroom Activity Profile
Topic: Quadratic Function | Formula: $y = ax^2 + bx + c$
Objective: Students will investigate the relationship between the coefficients of a quadratic function and its graph.

Activity Steps

- Step 1: Construct the function in GeoGebra.
- Step 2: Create sliders for a, b, and c.
- Step 3: Change one parameter at a time.
- Step 4: Observe changes in the graph.
- Step 5: Record observations.
- Step 6: Use computational software to verify selected calculations.
- Step 7: Prepare a short presentation explaining the findings.

Higher-Order Questions

- What happens when $a > 0$?
- What happens when $a < 0$?
- How does c affect the graph?
- What role does the discriminant play?
- Can you predict the graph before changing the parameters?
- Can you formulate a general rule?

This activity emphasizes exploration, prediction, reasoning, verification, and communication.

Responsible Use of AI in Mathematics Education
Responsible use requires students to understand that AI is a support system rather than an unquestionable authority. Students should attempt problems independently, verify generated results, understand mathematical procedures, acknowledge AI assistance when required, avoid submitting generated material as entirely their own work, compare AI explanations with mathematical principles, and develop the ability to identify errors.

Teachers should establish clear classroom policies regarding acceptable and unacceptable AI use.

Future Scope
Future research can investigate:

- the effect of AI-supported mathematics learning on achievement;
- the impact of GeoGebra on mathematical reasoning;
- AI-supported mathematical modelling;
- the use of generative AI in mathematics assessment;
- AI-assisted personalized mathematics learning;
- student attitudes toward AI mathematics tools;
- teacher readiness for AI integration;
- digital equity in mathematics education;
- AI-supported research in higher mathematics; and
- long-term effects of AI use on mathematical reasoning.

VII. DISCUSSION

The literature suggests that AI and digital mathematics tools should not be treated as a single technological category. GeoGebra, Wolfram|Alpha, and Gamma AI perform substantially different functions. GeoGebra is primarily a dynamic mathematical visualization and exploration environment. Wolfram|Alpha is primarily a computational knowledge system capable of sophisticated mathematical computation. Gamma AI is primarily an AI-assisted communication and content-generation platform.

Complementary Functional Division

- GeoGebra ➔ Explore
- Wolfram|Alpha ➔ Compute
- Gamma AI ➔ Communicate
- Teacher ➔ Guide and Validate
- Student ➔ Reason and Reflect

This division of roles provides a more educationally meaningful approach than asking one technology to perform every task.

VIII. CONCLUSION

Artificial Intelligence and digital tools are creating significant opportunities for mathematics education. GeoGebra supports dynamic visualization and mathematical exploration, Wolfram|Alpha supports computation and mathematical investigation, and Gamma AI supports the creation and communication of educational content.

The educational value of these tools does not arise simply from their technological capabilities. It depends on the design of mathematical tasks, teacher guidance, student engagement, and opportunities for reasoning and reflection.

Current research supports the growing role of AI in mathematics education while emphasizing the continuing importance of teachers and pedagogical design (Yoon & Kwon, 2024). Research on GeoGebra similarly indicates its potential to support visualization, conceptual understanding, problem solving, and engagement, while highlighting the importance of teacher preparation and appropriate infrastructure (Muslim et al., 2023; Izdahara & Irvan, 2025).

Therefore, the future of mathematics education should not be understood as “AI versus teacher”, but as “teacher + student + AI + digital mathematics tools.”

Central Principle: Technology should make mathematical thinking deeper, not make mathematical thinking unnecessary.

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