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Enhancing Problem-Solving Skills and Level of Engagement in Mathematics Through AI-Supported Task-Based Learning

Sharmaine T. Llena [1], Pablo B. Bose Jr., EdD [1]
tacisssharmaine@gmail.com / 0009-0007-7305-6928

1 – Abra State Institute of Sciences and Technology

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Abstract

This study examined the effectiveness of AI-supported task-based learning in enhancing students' problem-solving skills and level of engagement in mathematics. Through the quasi-experimental research design, the researcher assessed the performances of the students before, during, and after exposure to the intervention across topics such as permutation, combination and probability.

Findings revealed that prior to the intervention, the students demonstrated a low level of problem-solving skills with a mean of 73.29 categorized as "Did Not Meet Expectation", particularly on the areas of making the problem-solving plan, carrying out the plan, and looking back at the completed solution which could be associated with planning, execution and reflection which requires higher order thinking skills. However, a substantial improvement was made during implementation and was sustained after in the posttest results, indicating mastery of both cognitive and metacognitive skills.

In terms of the level of student's engagement, the students achieved a Very High level of engagement with an overall mean of 3.88 interpreted as "Very Highly Engaged" across all three components: behavioral, cognitive and affective engagement. This indicates that the intervention not only improved academic performance but also fostered active participation. However, the relationship between engagement and problem-solving skills varied across AI tools, emphasizing the need for structured guidance and feedback.

The study concludes that AI-supported task-based learning is an effective and transformative tool for instruction that can significantly enhance the skills and engagement especially in the field of Mathematics.

Keywords: *AI-supported, task-based, problem-solving, artificial intelligence*

1. Introduction

Mathematical problem-solving is a fundamental skill that significantly influences academic achievement and real-life decision-making. Students who develop strong problem-solving abilities generally achieve better results in mathematics and other academic areas. Problem-solving skills also promote critical thinking, analytical reasoning, and informed decision-making, allowing learners to identify problems, process information, and generate appropriate solutions (Banawi et al., 2024; Ahmady & Shahbazi, 2020). Furthermore, critical thinking enables individuals to evaluate evidence, examine situations from multiple perspectives, and assess possible solutions systematically (Prakong, 2024).

Despite its importance, many students continue to experience difficulties in mathematical problem-solving. Students often rely on memorization and procedural knowledge rather than conceptual understanding, making it difficult for them to solve unfamiliar or complex problems (Hasan, 2024). Learners frequently struggle during the initial stages of problem-solving, particularly in understanding problems and selecting appropriate strategies (Kusumadewi & Retnawati, 2020). Additionally, traditional assessment practices emphasize memorization rather than conceptual understanding, limiting students' ability to recognize the practical applications of mathematics (Nilimaa, 2023).

To address these concerns, mathematics education has increasingly adopted task-based learning approaches. Task-based learning allows students to engage in authentic and meaningful activities that connect mathematical concepts with real-life situations (Costello, 2022). Through contextual, problem-based, and case-based activities, students develop deeper conceptual understanding instead of merely memorizing procedures. These approaches strengthen critical thinking and problem-solving abilities while helping students apply mathematics in everyday contexts (Hasan, 2024).

Research indicates that students taught through problem-based and task-based methods perform better and retain mathematical concepts longer than those taught using traditional methods (Al-Hassan et al., 2025). Contextual tasks also improve functional mathematical literacy by enabling students to apply mathematical knowledge beyond the classroom (Abylkassymova et al., 2024). Moreover, real-life tasks increase students' motivation, engagement, and interest in mathematics, resulting in improved learning outcomes (Magdalena et al., 2023).

According to research (Al-Hassan et al., 2025), students who are taught through problem and/or task-based teaching methods show greater performance and long-term retention of mathematical concepts than their counterparts who receive traditional instruction. In addition to providing students with opportunities to learn beyond the classroom, contextual-based tasks (Abylkassymova et al., 2024) significantly increase their level of functional mathematical literacy. Furthermore, real-world tasks increase student motivation, engagement, and interest in mathematics, leading to improved academic achievement (Magdalena et al., 2023).

Kolb's Experiential Learning Theory provides a solid foundation for the use of task-based teaching methods. According to Kolb's theory, learning is an ongoing cycle consisting of

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concrete experience, reflective observation, abstract conceptualization, and active experimentation. Using experiential learning allows students to apply theories to real-life situations, reflect upon their experiences, develop new ideas and test them in the actual world, thus developing their ability to think critically creatively and solve problems (Kolb, 1984). Studies also indicate that students will retain more knowledge and improve their problem-solving ability through experiential learning as opposed to traditional teaching methods (Hulaikah et al., 2020). Experiential learning environments supported by technology promote collaboration, reflective thought, and self-awareness (Lin et al., 2024).

AI is new and emerging as an innovative area within educational mathematics. AI-based technology such as intelligent tutoring systems, adaptive learning platforms, and AI chat-bots can enhance student engagement and improve academic performance by providing personalized instruction, immediate feedback and individualized support (Canonigo, 2024). Applications of Artificial Intelligence, such as ChatGPT, provide students with instant explanations and assistance with solving problems, thus improving motivation, self-confidence and understanding of mathematical concepts (Qothrunnada & Maghfiroh, 2025). By providing automated assessment assistance, data analytics and regulatory assistance for instructional planning, AI also helps support educators (Wardat et al., 2024).

Educators can use AI-supported education systems to create customized instructional materials for each student based on their individual needs and patterns of learning, allowing for prompt feedback so students can quickly identify and correct their errors (Taşkın, 2025; Salameh, 2025). Evidence has shown that including AI in experiential learning (task-based and otherwise) increases student engagement, critical thinking, and problem-solving abilities (Said et al., 2025; Bayaga, 2024). In addition, students in AI-supported environments tend to perform better than peers in traditional learning environments (Zhou et al., 2025). Nevertheless, important issues such as ensuring ethical practices of use, fairness in data (including algorithms), reliability of outputs, and appropriate human/technology interactions need to be continually addressed (Rane, 2023).

This research addresses the limited investigation regarding the combined effect of using both AI instruction along with task-based pedagogical techniques, specifically with respect to mathematics instruction. The aim of this research is to develop an AI-supported, task-based approach to instruction that develops students' mathematical problem solving, critical thinking and application to real-world situations while managing the cognitive demands placed on students, as defined by Kolb's Experiential Learning Theory, Constructivist Learning Theory, and Cognitive Load Theory (Sweller, 1988; Devi, 2019; Twabu, 2025).

Statement of the Problem

This study aimed to determine the effectiveness of AI-supported task-based learning in enhancing the mathematical problem-solving skills of students.

This study deliberately intended to answer the following questions:

1. What is the level of students' problem-solving skills before the implementation of AI-supported task-based learning in mathematics?

2. What is the level of students' problem-solving skills in mathematics during the implementation of AI-supported task-based learning?

3. What is the level of students' problem-solving skills in mathematics after exposure to AI-supported task-based learning?

4. Is there a significant difference in the problem-solving performance of the students in the pretest and posttest taught using AI-supported task-based learning?

5. To what extent does AI-supported task-based learning influence students' learning in terms of:

a. Behavioral Engagement;

b. Cognitive Engagement; and

c. Affective Engagement?

6. Is there a significant relationship between problem-solving skills and the extent of engagement to which AI-supported task-based learning influences students' learning?

Hypotheses

1. There is a significant difference in the problem-solving performance of the students in the pretest and posttest taught using AI-supported task-based learning.

2. There is a significant relationship between problem-solving skills and the extent of engagement to which AI-supported task-based learning influences students' learning.

2. Materials and Methods

Research Design

This study used the quasi-experimental research design. This design is deemed appropriate because the target participants come from an intact class, and the researcher utilized a Pretest and Posttest approach. This design is intended to show how AI-supported task-based learning enhances the problem-solving skills and level of engagement of Grade 10 mathematics students.

Participants

The respondents came from one Grade 10 class, comprising 42 students from Divine Word College of Bangued, Abra, Inc., High School Department during the Fourth Quarter of School Year 2025-2026.

Instruments

This study used a researcher-made Problem-Solving Skills Pretest/Posttest taken from textbooks and aligned with the Mathematics Curriculum Guide, and focused on Polya's problem-solving steps. It was evaluated using the adopted scoring rubric for the mathematical problem-solving ability test from Muzammil et al. (2020). It also utilized AI-supported learning tools such as ChatGPT for prompts, PhotoMath, and MathGPT. These tools helped the students to learn faster and more easily. Lastly, it used a questionnaire to test students' engagement. All of these tools underwent Validation and Reliability before implementation.

Procedure

In the preparation phase, the researcher first subjected the tools to validation and reliability. Then, the researcher sought permission from the school administration and provided informed consent to the participation of minors. Then, oriented the participants on the purpose, ethical considerations, and confidentiality of the results.

Upon approval, the researcher conducted a Pretest. Then, she employed the AI-supported task-based learning approach. At the end of the quarter, the researcher conducted the Posttest to identify the learning progress of the student participants. The researcher then collated the results and subjected them to statistical treatment.

Data Analysis

The data gathered from the pretest, posttest, and engagement questionnaire were analyzed using the **weighted mean** to determine the overall level of students' performance in problem-solving and the general trend of students' engagement and attitude towards the learning intervention. A **t-test** was used to compare the pretest and posttest scores to determine whether there was a significant improvement in students' problem-solving performance after the intervention. The **bivariate correlation analysis** was used to determine the significant relationship between problem-solving skills and the extent to which AI-supported task-based and experiential learning influences students' learning.

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3. Results

Table 1 shows the level of problem-solving skills before the implementation of AI-supported task-based learning in mathematics.

Table 1. The level of students' problem-solving skills before the implementation of AI-supported task-based learning in mathematics

Content/Topics	Problem-Solving Skills	Mean	DR
Permutation	a. Understand the Problem	78.36	FS
	b. Make the Problem-solving Plan	75.07	FS
	c. Carry Out the Problem-solving Plan	75.00	FS
	d. Look back at the Completed Solution	73.40	DNME
	Composite Mean	*74.50*	*FS*
Combination	a. Understand the Problem	78.67	FS
	b. Make the Problem-solving Plan	76.24	FS
	c. Carry Out the Problem-solving Plan	75.93	FS
	d. Look back at the Completed Solution	75.52	FS
	Composite Mean	*75.02*	*FS*
Probability	a. Understand the Problem	75.93	FS
	b. Make the Problem-solving Plan	74.33	DNME
	c. Carry Out the Problem-solving Plan	73.62	DNME
	d. Look back at the Completed Solution	72.31	DNME
	Composite Mean	*73.50*	*DNME*
Overall	a. Understand the Problem	76.60	FS
	b. Make the Problem-solving Plan	73.71	DNME
	c. Carry Out the Problem-solving Plan	73.21	DNME
	d. Look back at the Completed Solution	71.86	DNME
As a whole		**73.29**	**DNME**

Scale	Descriptive Rating
90-100	Outstanding (O)
85-89.99	Very Satisfactory (VS)
80-84.99	Satisfactory (S)
75-79.99	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

The results reveal that students demonstrated generally **low to moderate proficiency,** with an overall mean of 73.29 interpreted as *Did Not Meet Expectation (DNME)*. Across the three content areas, students performed relatively better in *Permutation* (M = 74.50, FS) and *Combination* (M = 75.02, FS), while *Probability* registered the lowest composite mean (M = 73.50, DNME). Four of the problem-solving components produced consistently high means (M=76.60, FS); that indicates that learners at a basic level can understand the concept of the problem. However, the successive stages ("Make the Problem-Solving Plan", "Carry Out the Plan", and "Look Back at the Completed Solution" [M=71.86, DNME]), show declining levels of

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performance, indicating learners' inability to use higher-order thinking skills during the metacognitive reflection phase.

Table 2 shows the level of students' problem-solving skills in mathematics during the implementation of AI-supported task-based learning.

Table 2. The level of students' problem-solving skills in mathematics during the implementation of AI-supported task-based learning

Content Topics	Problem-Solving Skills	MathGPT		Photomath		ChatGPT		Overall	
		Mean	DR	Mean	DR	Mean	DR	Mean	DR
Permutation	a. Understand the Problem	92.83	O	91.50	O	91.24	O	91.84	O
	b. Make the Problem-solving Plan	99.07	O	99.21	O	94.93	O	97.75	O
	c. Carry Out the Problem-solving Plan	96.95	O	97.50	O	85.98	VS	93.50	O
	d. Look back at the Completed Solution	92.76	O	94.88	O	82.21	S	90.01	O
	Composite Mean	95.68	O	95.81	O	88.43	VS	93.32	O
Combination	a. Understand the Problem	91.61	O	92.33	O	91.88	O	91.94	O
	b. Make the Problem-solving Plan	100.00	O	100.0	O	98.74	O	99.58	O
	c. Carry Out the Problem-solving Plan	98.54	O	96.83	O	93.88	O	96.43	O
	d. Look back at the Completed Solution	94.46	O	95.74	O	89.40	VS	93.25	O
	Composite Mean	96.20	O	95.88	O	93.55	O	95.21	O
Probability	a. Understand the Problem	89.85	O	93.19	O	94.48	O	92.45	O
	b. Make the Problem-solving Plan	100.0	O	99.69	O	98.67	O	99.45	O
	c. Carry Out the Problem-solving Plan	98.56	O	97.76	O	94.62	O	96.96	O
	d. Look back at the Completed Solution	94.71	O	94.86	O	90.60	O	93.43	O
	Composite Mean	95.68	O	96.33	O	94.71	O	95.56	O
Ov	a. Understand the	91.46	O	92.45	O	92.62	O	92.1	O

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Problem							5	
b. Make the Problem-solving Plan	99.66	O	99.57	O	97.19	O	98.81	O
c. Carry Out the Problem-solving Plan	97.71	O	96.95	O	90.52	O	95.06	O
d. Look back at the Completed Solution	93.17	O	94.50	O	85.98	VS	91.27	O
As a whole	**95.71**	**O**	**95.95**	**O**	**91.90**	**O**	**94.52**	**O**

Scale	**Descriptive Rating**
90-100	Outstanding (O)
85-89.99	Very Satisfactory (VS)
80-84.99	Satisfactory (S)
75-79.99	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

The results show a remarkable improvement across all content areas and problem-solving components, with the overall mean of 94.52 interpreted as *Outstanding (O).* All three tools yielded high performance, with Photomath (M = 95.95) and MathGPT (M = 95.71) slightly outperforming ChatGPT (M = 91.90), though all remained within the Outstanding level. Across topics, Combination (M = 95.21) and Probability (M = 95.6) posted the highest gains , while Permutation (M = 93.32) also achieved Outstanding level. All four stages of problem solving were rated at an "Outstanding" level consistently, with "Make the Problem-solving Plan" (M = 98.81) being the strongest rated skill and thus indicating that students' strategic thinking improved significantly.

Table 3. The level of students' problem-solving skills in mathematics after exposure to AI-supported task-based learning

Content/Topics	Problem-Solving Skills	Mean	DR
Permutation	a. Understand the Problem	94.00	O
	b. Make the Problem-solving Plan	100.00	O
	c. Carry Out the Problem-solving Plan	98.88	O
	d. Look back at the Completed Solution	98.50	O
	Composite Mean	*97.29*	*O*
Combination	a. Understand the Problem	93.17	O
	b. Make the Problem-solving Plan	100.00	O
	c. Carry Out the Problem-solving Plan	97.71	O
	d. Look back at the Completed Solution	99.33	O
	Composite Mean	*96.62*	*O*
Probability	a. Understand the Problem	92.14	O
	b. Make the Problem-solving Plan	100.0	O
	c. Carry Out the Problem-solving Plan	98.88	O
	d. Look back at the Completed Solution	98.76	O

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Overall	*Composite Mean*	*96.88*	*O*
	a. Understand the Problem	92.69	O
	b. Make the Problem-solving Plan	100.0	O
	c. Carry Out the Problem-solving Plan	98.57	O
	d. Look back at the Completed Solution	98.71	O
As a whole		**96.83**	**O**

Scale	Descriptive Rating
90-100	Outstanding (O)
85-89.99	Very Satisfactory (VS)
80-84.99	Satisfactory (S)
75-79.99	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

The results reveal a consistently Outstanding level of performance across all content areas and problem-solving components, with an overall mean of 96.83 interpreted as *Outstanding (O).* Among the content areas, Permutation obtained the highest composite mean (M = 97.29), followed by Probability (M = 96.88) and Combination (M = 96.62), all within the Outstanding range. Across the four problem-solving stages, "Make the problem-solving Plan" achieved a perfect mean (M = 100.00), indicating mastery of strategic planning. This was followed by very high scores in "Carry Out the Plan" (M = 98.57) and "Look Back at the Completed Solution" (M = 98.71), while "Understand the Problem" (M = 92.69 also remained at an outstanding level. These results demonstrate that students not only improved but attained a high degree of proficiency in all aspects of mathematical problem-solving.

Table 4. Comparison of the problem-solving skills of the students in the pretest and posttest exposed to AI-supported task-based learning

Content/ Topics	Problem-Solving Skills	Pretest	Posttest	Effect Sizes (Hedges' g)	T-Value	T-prob Value
Permutation	a. Understand the Problem	78.36	94.00	10.70	15.64	<0.01
	b. Make the Problem-solving Plan	75.07	100.00	5.38	24.93	<0.01
	c. Carry Out the Problem-solving Plan	75.00	98.88	4.53	23.88	<0.01
	d. Look back at the Completed Solution	73.40	98.50	13.37	25.10	<0.01
	Composite Mean	*74.50*	*97.29*	*3.73*	*22.79*	*<0.01*
Combination	a. Understand the Problem	78.67	93.17	13.23	14.50	<0.01
	b. Make the Problem-solving Plan	76.24	100.00	17.57	23.76	<0.01

	c. Carry Out the Problem-solving Plan	75.93	97.71	16.33	21.79	<0.01
	d. Look back at the Completed Solution	75.52	99.33	17.38	23.81	<0.01
	Composite Mean	*75.02*	*96.62*	*10.93*	*21.60*	*<0.01*
Probability	a. Understand the Problem	75.93	92.14	8.25	16.21	<0.01
	b. Make the Problem-solving Plan	74.33	100.00	9.40	25.67	<0.01
	c. Carry Out the Problem-solving Plan	73.62	98.88	12.98	25.26	<0.01
	d. Look back at the Completed Solution	72.31	98.76	14.88	26.45	<0.01
	Composite Mean	*73.50*	*96.88*	*7.22*	*23.38*	*<0.01*
Overall	a. Understand the Problem	76.60	92.69	8.11	16.10	<0.01
	b. Make the Problem-solving Plan	73.71	100.00	7.51	26.29	<0.01
	c. Carry Out the Problem-solving Plan	73.21	98.57	8.91	25.36	<0.01
	d. Look back at the Completed Solution	71.86	98.71	10.77	26.86	<0.01
As a whole		**73.29**	**96.83**	**5.25**	**23.55**	**<0.01**

Table 4 presents the comparison of students' problem-solving skills in Mathematics before and after exposure to AI-supported task-based learning, including the magnitude of change as measured by Hedges' g. The results show **substantial increases across all content areas and problem-solving components,** with all posttest means reaching the *Outstanding* level from predominantly *Did Not Meet Expectation* and *Fairly Satisfactory* levels in the pretest. More importantly, the computed effect sizes are exceptionally large, far exceeding conventional benchmarks ($g = 0.20$ small, 0.50 medium, 0.80 large), with values ranging from 3.73 to as high as 17.57. The overall effect size ($g = 5.25$) indicates a very strong practical impact of the intervention. Amons the components, "Look back at the Completed Solution" and "Make the Problem-solving Plan" yielded the largest gains, with effect sizes reaching up to $g = 17.38$ and $g = 17.57$, respectively, particularly in the Combination topic. Furthermore, all computed t-values are statistically significant ($p < 0.01$), confirming that the observed improvements are not due to chance but are attributable to the intervention.

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Table 5. The extent of engagement of students with AI-supported task-based learning in problem-solving

Indicators	Mean	DR
Behavioral Engagement		
1. I actively participate in AI-supported math tasks.	3.93	VHE
2. I complete all assigned AI-supported exercises on time.	3.86	VHE
3. I collaborate effectively with peers during AI-supported activities.	4.12	VHE
4. I seek help from teachers or AI tools when I face difficulties.	4.10	VHE
5. I stay focused and avoid distractions during AI-supported tasks.	4.07	VHE
Composite Mean	*4.01*	*VHE*
Cognitive Engagement		
1. I apply mathematical concepts learned through AI tasks to new problems.	3.98	VHE
2. I analyze and evaluate solutions during AI-supported learning activities.	3.95	VHE
3. I use AI tools to deepen my understanding of mathematical concepts.	4.07	VHE
4. I seek multiple approaches to solve problems using AI-supported exercises.	3.81	VHE
5. I attempt challenging tasks that require higher-order thinking in AI activities.	3.79	VHE
Composite Mean	*3.92*	*VHE*
Affective Engagement		
1. I feel excited when participating in AI-supported math activities.	3.71	VHE
2. I feel confident when solving problems using AI tools.	3.52	VHE
3. I enjoy learning mathematics through AI-supported tasks.	3.71	VHE
4. I feel motivated to engage in AI-supported learning every day.	3.83	VHE
5. I feel a sense of accomplishment when I understand difficult concepts via AI tasks.	3.76	VHE
Composite Mean	*3.71*	*VHE*
Overall	**3.88**	**VHE**

Scale Range	Verbal Interpretation
3.21 – 4.00	Very Highly Engaged (VHE)
2.41 – 3.20	Highly Engaged (HE)
1.61 – 2.40	Moderately Engaged (ME)
0.81 – 1.60	Slightly Engaged (SE)
0.00 – 0.80	Not Engaged (NE)

The results indicate a very great extent of engagement (VHE) in all domains, with an overall mean of 3.88. among the three dimensions, *behavioral engagement* obtained the highest composite mean (M = 4.01), followed by *cognitive engagement* (M = 3.92) and affective engagement (M = 3.71), all interpreted as very highly engaged. Specifically, students reported strong participation, timely completion of tasks, and active collaboration with peers, with collaboration (M = 4.12) and help-seeking behavior (M = 4.10) emerging as the highest indicators. In terms of cognitive engagement, students demonstrated high levels of analytical thinking and application of knowledge, particularly in using AI tools to deepen understanding (M =4.07). Meanwhile, affective engagement, though slightly lower, still reflects positive emotional responses, with students expressing motivation, enjoyment, and a sense of accomplishment during AI-supported learning activities.

Table 6. Correlation Matrix Showing the Relationship Between problem-solving skills and the extent of engagement to Which AI-Supported Task-Based Learning Influences Students' learning

Content Topic	AI Tools	Problem-Solving Skills	Behavioral	Cognitive	Affective	Overall
Permutation, Combination, Probability	MathGPT	a. Understand the Problem	-0.065	0.088	0.106	0.057
		b. Make the Problem-solving Plan	0.022	-0.098	-0.159	-0.094
		c. Carry Out the Problem-solving Plan	0.153	0.054	-0.087	0.035
		d. Look back at the Completed Solution	-0.158	0.011	-0.056	-0.064
		Overall	*0.003*	*0.041*	*-0.073*	*-0.01*
Permutation, Combination, Probability	Photomath	a. Understand the Problem	0.136	0.053	0.132	0.113
		b. Make the Problem-solving Plan	-0.045	-0.078	-0.157	-0.105
		c. Carry Out the Problem-solving Plan	0.129	0.062	0.137	0.116
		d. Look back at the Completed Solution	0.289	.322*	.455**	.391*
		Overall	*0.231*	*0.14*	*0.257*	*0.224*

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Permutation, Combination, Probability	ChatGPT	a. Understand the Problem	0.26	0.215	0.057	0.188
		b. Make the Problem-solving Plan	0.052	0.133	0.188	0.141
		c. Carry Out the Problem-solving Plan	-0.039	-0.04	-0.067	-0.053
		d. Look back at the Completed Solution	0.105	0.055	0.033	0.067
		Overall	*0.039*	*0.04*	*-0.002*	*0.027*
As a whole			**0.091**	**0.074**	**0.061**	**0.08**

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Data shows that the relationship across the AI tools and engagement varies, with many correlations being weak or negligible. For MathGPT, correlations with behavioral, cognitive, and affective engagement range from -0.073 to 0.041, and the overall correlation with problem-solving skills is virtually zero ($r = 0.003$), indicating minimal association. ChatGPT shows similarly weak correlations across all components and overall engagement (ranging from -0.067 to 0.260). In contrast, Photomath exhibits **notably stronger correlations** in certain areas, particularly for “Looking Back at the Completed Solution,” where affective engagement ($r = 0.455$, $p < 0.01$) and cognitive engagement ($r = 0.322$, $p < 0.05$) are significantly associated with problem-solving skills. The overall correlations for Photomath are modest but positive ($r = 0.140$–0.257), suggesting that some level of engagement with this AI tool is meaningfully related to performance.

4. Discussion

Interpretation of findings

The results of the study show that students struggled with planning for, carrying out, and thinking about what they had just done when working on math-related problems. However, when the study included some sort of AI support for task-based learning, there were noticeable improvements to students’ cognitive, metacognitive, and reflective skills. The students improved their problem-solving capabilities, demonstrated increased engagement with their tasks, demonstrated more self-regulated behavior, and achieved significantly better overall results in math, with a more complete understanding of the concept behind the problem.

Comparison to existing studies

These findings support and confirm the effectiveness of using AI tools in conjunction with a task-based learning approach as shown in prior studies (Holmes, et al., 2022; Kasneci, et al., 2023; Chen, et al., 2020; Ouyang and Jiao, 2021) which also concluded that using AI tools help to improve students' problem-solving capabilities, engagement level, metacognitive skills, and academic performance when students had been provided with feedback tailored to their learning needs and through their active participation in completing tasks assigned to them.

Implications for practice and policy

Through this research, educators may use task-based learning strategies with an emphasis on providing AI support to promote students' high-order thinking and problem-solving abilities in mathematics classes. Schools and districts may work to develop and put into writing policies related to the use of AI tools to provide guidance to teachers and legislation that allows for the professional development of teachers and access to the technology needed to effectively implement the AI tools to promote innovative and learner-centered practices in mathematics.

Study limitations

The study looked at only one particular group of students and a limited number of types of tools related to AI. This may limit the generalization of the findings from this study to a variety of different students or groups of people in different situations or institutions. Furthermore, there are a number of things that need to be taken into consideration in future research, such as differences in students' technological proficiency, the availability of technology, and the differing ways that students used the AI applications.

5. Conclusion

Summarize outcomes

Overall, this study found that task-based learning supported by artificial intelligence was a highly effective means of instruction for fostering problem-solving skills and engagement in mathematics.

Recommendations for future research or implementation

1. Teachers may use AI-supported task-based learning approaches during classes to develop problem-solving skills in students. In addition, teachers must provide support to students through each step in problem-solving, particularly at the planning and reflection stages.
2. Schools may facilitate the implementation of AI technologies by providing teachers with the required means to apply them. There should be professional development programs for teachers aimed at helping them master AI-enabled learning methods.
3. Teachers may include AI-supported learning and task-based approaches in the curricula, which develop critical thinking, self-reflection skills, and problem-solving in real-life

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settings among other competencies. Activities should be organized in such a way as to achieve maximum efficiency through AI incorporation.

4. AI-powered learning tools may be used by students as learning companions, not assistants providing ready-made solutions. Students should learn to reflect on their own work, explore different solutions to problems, and deepen their understanding of the subject.

5. Further research may focus on how AI-enabled learning impacts learners in the long term, the application of such technology in other fields of mathematics, and how it affects different types of learners. It would also be feasible to conduct comparative analyses of various AI tools to identify those with the most desirable attributes.

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