

# Utilization of Ai-Assisted Instruction in Enhancing Mathematics Engagement and Achievement of Senior High School Students

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## ABSTRACT

This study examined the utilization of AI-assisted instruction in enhancing the mathematics engagement and achievement of Grade 11 senior high school students in Data and Probability. A quasi-experimental pretest-posttest design with partial counterbalancing of instructional conditions was used among 131 students. The study compared traditional instruction, MathGPT-assisted instruction, and Wolfram Alpha-assisted instruction in terms of behavioral engagement, emotional engagement, overall learning experience, mathematics achievement, and perceived usability and accessibility. Mathematics engagement and usability/accessibility were measured using Likert-scale questionnaires, while mathematics achievement was measured through pretest and posttest scores based on six identified competencies. Weighted mean, standard deviation, Friedman test,

and paired-samples t-test were used to analyze the data. Results showed that all instructional approaches produced high levels of mathematics engagement. MathGPT obtained the highest behavioral engagement rating (WM = 4.07, SD = 0.80), while Wolfram Alpha obtained the highest emotional engagement rating (WM = 3.93, SD = 0.89). For overall learning experience, MathGPT received the highest weighted mean (WM = 3.97, SD = 0.89), followed by Wolfram Alpha (WM = 3.95, SD = 0.84), and traditional instruction (WM = 3.75). Wolfram Alpha and MathGPT both obtained the highest usability and accessibility rating (WM = 4.03). Paired-samples t-test results indicated significant improvement between pretest and posttest scores across all competencies and treatment groups, with p-values below 0.05. However, the Friedman test showed no significant difference in mathematics engagement among the three instructional approaches,  $\chi^2(2) = 2.42$ ,  $p = 0.299$ . The study concludes that traditional instruction, MathGPT, and Wolfram Alpha all contributed positively to mathematics engagement and achievement, with AI-assisted instruction showing slight descriptive advantages. An enhanced AI-assisted mathematics instructional plan is proposed to guide responsible, teacher-mediated AI integration in Data and Probability.

**Keywords:** *AI-assisted instruction, Data and Probability, MathGPT, mathematics achievement, mathematics engagement, Wolfram Alpha*

## INTRODUCTION

Artificial intelligence has increasingly entered modern education because of its capacity to provide personalized learning support, adaptive feedback, automated assessment, and learner-centered instruction. In mathematics education, AI-assisted tools are useful because they can give step-by-step explanations, computational verification, visual representations, and immediate feedback. These affordances are relevant in learning abstract mathematical concepts that may be difficult for learners to understand through lecture-based instruction alone.

Mathematics performance remains a continuing concern in the Philippine education system. International and national assessment results show that many Filipino learners continue to struggle with mathematical

reasoning, problem solving, and the application of concepts in real-life contexts. Senior high school mathematics, especially Data and Probability, requires learners to interpret data, perform statistical procedures, test relationships, and make evidence-based conclusions. These competencies require both conceptual understanding and active engagement.

Traditional classroom instruction continues to be important because it allows teachers to explain concepts, model procedures, ask questions, and guide learners directly. However, traditional instruction may not always provide sufficient individualized support for learners with different levels of readiness, confidence, and pace of learning. AI-assisted tools such as MathGPT and Wolfram Alpha may help address these needs by giving students additional opportunities for explanation, computation, verification, practice, and self-paced exploration.

Recent studies suggest that AI-supported learning environments may improve students' engagement, confidence, conceptual understanding, and problem-solving performance when properly guided by teachers. At the same time, scholars caution that AI tools should not replace the teacher or encourage dependence on generated answers. Their use should be teacher-mediated, ethically guided, and aligned with instructional objectives. These concerns are especially important in mathematics, where students must understand the process and reasoning behind an answer.

The present study examined the utilization of AI-assisted instruction in enhancing the mathematics engagement and achievement of Grade 11 students in Data and Probability at Polillo National High School. It compared traditional instruction, MathGPT, and Wolfram Alpha using a quasi-experimental pretest-posttest design with partial counterbalancing. The study also assessed students' perceived usability and accessibility of AI-assisted instruction and proposed an enhanced AI-assisted mathematics instructional plan based on the findings.

## Literature Review

### *AI-Assisted Instruction in Mathematics Education*

AI-assisted instruction refers to the use of intelligent systems, adaptive platforms, automated feedback, and data-driven tools to support teaching and learning. In mathematics, these tools can provide explanations, computational checks, visual outputs, learning diagnosis, and individualized support. Studies on AI in education emphasize that artificial intelligence can enhance adaptive instruction and feedback while supporting teachers in identifying learners' needs.

MathGPT represents the generative and conversational side of AI-assisted mathematics learning. It can provide natural-language explanations, guided solution steps, and immediate responses to students' questions. Wolfram Alpha, on the other hand, represents computational and symbolic support. It can verify calculations, generate outputs, and help students interpret mathematical relationships. Together, these tools can support both explanation and verification when used responsibly.

The literature also stresses that AI-assisted mathematics instruction must be teacher-guided. AI-generated answers may be incomplete, inaccurate, or misunderstood by learners. Thus, teachers remain essential in clarifying concepts, validating outputs, monitoring responsible use, and requiring students to justify their reasoning. In this sense, AI-assisted instruction is best understood as a supplemental support within a teacher-mediated mathematics classroom.

### *Mathematics Engagement and Achievement*

Mathematics engagement involves students' behavioral, emotional, and cognitive participation in learning. Behaviorally engaged students participate in activities, complete tasks, follow instructions, and remain focused. Emotionally engaged students show interest, confidence, enjoyment, and willingness to continue learning. In Data and Probability, engagement is important because students must actively interpret information, analyze relationships, and reflect on findings.

Mathematics achievement refers to learners' performance in mathematics tasks and assessments. In this study, achievement was measured through pretest and posttest scores in identified Data and Probability competencies. Achievement may improve when learners receive guided practice, immediate feedback, multiple

explanations, and opportunities to verify their work. AI-assisted tools may support these processes, but achievement gains still depend on lesson design, teacher guidance, learner readiness, and responsible use.

Prior studies indicate that AI-assisted learning may improve motivation, conceptual understanding, self-efficacy, and achievement. However, other studies warn against superficial engagement and overreliance on AI-generated responses. These findings support the need to compare AI-assisted instruction with traditional instruction in a structured classroom setting and to examine both engagement and achievement outcomes.

### ***Constructivist Basis of AI-Assisted Instruction***

This study is anchored on Constructivist Learning Theory, which views learning as an active process of constructing knowledge through experience, interaction, feedback, and reflection. The theory is appropriate because students learn mathematics more effectively when they connect new concepts with prior knowledge, explore solution strategies, test ideas, and receive guided support. MathGPT and Wolfram Alpha can function as scaffolding tools that help students revisit concepts, check solutions, and reflect on mathematical processes. However, the teacher remains the facilitator who ensures that students interpret AI outputs correctly and connect them to accepted mathematical principles.

## **METHODS**

### **Research Design**

The study employed a quasi-experimental pretest-posttest design with partial counterbalancing of instructional conditions. The design allowed students to experience traditional instruction, MathGPT-assisted instruction, and Wolfram Alpha-assisted instruction in a systematic sequence while reducing possible order, sequence, and carryover effects. This design was appropriate because the study compared engagement and achievement outcomes after exposure to different instructional approaches using intact Grade 11 classes.

### **Research Locale and Respondents**

The study was conducted at Polillo National High School among Grade 11 senior high school students officially handled by the researcher. A total of 131 students participated in the study. The participants were organized into three instructional groups and exposed to the three instructional approaches according to the partial counterbalanced rotation. The study focused on Data and Probability topics and competencies covered during the intervention period.

Table 1. *Instructional Approaches Compared in the Study*

Instructional approach	Core instructional feature	Role in the study
Traditional instruction	Teacher-led discussion, board work, textbook exercises, teacher explanation, and guided practice	Served as the conventional comparison condition
MathGPT-assisted instruction	Step-by-step explanations, conversational support, alternative examples, and guided problem-solving	Represented natural-language AI support in mathematics learning
Wolfram Alpha-assisted instruction	Computational verification, symbolic processing, visual representation, and mathematical checking	Represented computational AI support in mathematics learning

### **Research Instruments**

The study used Likert-scale questionnaires to measure students' mathematics engagement and perceived usability/accessibility of AI-assisted instruction. Mathematics engagement covered behavioral engagement, emotional engagement, and overall learning experience after exposure to the instructional approaches. Mathematics achievement was measured using a pretest and posttest in Data and Probability based on six competencies identified in the table of specifications. The instruments were validated, and the study used survey and test data to answer the research questions.

### **Data Gathering Procedure**

Permission was secured from the school authorities before data gathering. Students were oriented on the purpose of the study, procedures, voluntary participation, and responsible use of AI tools. The instructional

implementation followed a partial counterbalanced schedule. Students were exposed to traditional instruction, MathGPT, and Wolfram Alpha under teacher guidance. Engagement, usability/accessibility, and achievement data were collected after the relevant instructional phases.

### Data Analysis

Weighted mean and standard deviation were used to interpret students' engagement, learning experience, usability, and accessibility. Mean and standard deviation were used for pretest and posttest achievement results. The Friedman test was used to determine whether significant differences existed in engagement across the three instructional approaches because the same students experienced and rated the approaches. Paired-samples t-test was used to test significant differences between pretest and posttest scores in Data and Probability. The level of significance was set at 0.05.

### Ethical Consideration

The study observed voluntary participation, informed consent and assent procedures, confidentiality, anonymity, and responsible data handling. Students were informed that participation was voluntary and that they could withdraw without penalty. Responsible AI use was emphasized during implementation. Students were reminded to use MathGPT and Wolfram Alpha for explanation, verification, and practice rather than copying answers. Students with device, internet, or platform limitations were supported through teacher demonstration, guided group use, and classroom-based access arrangements.

## RESULTS AND DISCUSSION

### Students' Mathematics Engagement Across Instructional Approaches

The findings showed that students were engaged in mathematics to a great extent under all three instructional approaches. Traditional instruction obtained a behavioral engagement mean of 3.93, indicating that learners actively participated, followed teacher instructions, completed tasks, and maintained attention during teacher-led lessons. MathGPT obtained the highest behavioral engagement rating with a weighted mean of 4.07, suggesting that conversational explanations and step-by-step support encouraged students to participate more actively in learning activities.

In emotional engagement, Wolfram Alpha recorded the highest weighted mean of 3.93. This indicates that learners felt positively engaged when using the tool for computation, verification, and visual support. The result suggests that students may feel more confident and interested when they can check mathematical procedures and verify the accuracy of their solutions. Overall, all three approaches were interpreted as experienced to a great extent, showing that both traditional and AI-assisted instruction can support mathematics engagement when properly facilitated.

Table 2. *Summary of Engagement and Learning Experience Across Instructional Approaches*

Dimension	Traditional instruction	Wolfram Alpha	MathGPT	Interpretation
Behavioral engagement	WM = 3.93	High/descriptively favorable	WM = 4.07	All approaches supported active participation; MathGPT was highest.
Emotional engagement	High/descriptively favorable	WM = 3.93	High/descriptively favorable	Wolfram Alpha obtained the highest emotional engagement rating.
Overall learning experience	WM = 3.75; SD = 0.99	WM = 3.95; SD = 0.84	WM = 3.97; SD = 0.89	AI-assisted tools had slight descriptive advantages, but all were experienced to a great extent.

### Overall Learning Experience

The summary of overall learning experience showed that MathGPT obtained the highest weighted mean of 3.97, followed closely by Wolfram Alpha with 3.95, while traditional instruction obtained 3.75. The grand weighted mean of 3.89 indicated that students experienced the instructional approaches to a great extent. These findings suggest that AI-assisted tools may provide additional support through immediate explanations, computational checking, alternative representations, and self-paced learning opportunities.

### Mathematics Achievement in Data and Probability

The pretest-posttest results showed consistent gains in students' mathematics achievement across the six competencies and three treatment groups. Paired-samples t-test results indicated significant differences between pretest and posttest scores, with p-values below 0.05. This means that students' performance improved after the instructional interventions. The largest descriptive gains included Competency 3 for Group C (mean gain = 2.78), Competency 4 for Group A (mean gain = 2.14), Competency 4 for Group C (mean gain = 2.04), and Competency 6 for Group C (mean gain = 2.04).

The findings imply that structured instruction, whether traditional or AI-assisted, can improve students' achievement in Data and Probability. However, the differences in gains across groups and competencies suggest that improvement may depend on the complexity of the competency, learners' readiness, the sequence of instruction, and the way the teacher guided the use of AI tools. Therefore, achievement gains should be understood as a result of structured instructional support rather than as evidence that one tool alone caused all learning improvement.

Table 3. *Summary of Achievement Gains and Statistical Results*

Assessment focus	Key finding	Statistical result	Interpretation
<b>Pretest-posttest achievement</b>	Consistent gains occurred across all six competencies and treatment groups.	Paired-samples t-test; p-values below 0.05	Students' mathematics achievement significantly improved after instruction.
<b>Largest descriptive gains</b>	Competency 3 Group C = 2.78; Competency 4 Group A = 2.14; Competency 4 Group C = 2.04; Competency 6 Group C = 2.04	Reported mean differences	Several competencies showed notable improvement after the intervention.
<b>Smallest noted gain</b>	Competency 4 Group B = 0.27	Reported mean difference	Improvement was not uniform across all competencies and groups.

### Difference in Mathematics Engagement Across Instructional Approaches

The Friedman test was used to determine whether there was a significant difference in students' mathematics engagement among traditional instruction, Wolfram Alpha, and MathGPT. Results showed  $\chi^2(2) = 2.42$ ,  $p = 0.299$ . Since the p-value was greater than 0.05, the null hypothesis was not rejected. This means that there was no statistically significant difference in students' mathematics engagement across the three instructional approaches. Although MathGPT and Wolfram Alpha obtained slightly higher descriptive ratings, traditional instruction remained statistically comparable.

Table 4. *Friedman Test Results on Mathematics Engagement*

Instructional approach	Mean rank	$\chi^2$	p-value	Decision	Interpretation
Traditional instruction	1.89	2.42	0.299	Fail to reject H0	No significant difference
Wolfram Alpha	2.05				
MathGPT	2.06				

### Perceived Usability and Accessibility of AI-Assisted Instruction

Students perceived MathGPT and Wolfram Alpha as usable and accessible tools for mathematics learning. Both AI-assisted tools obtained an overall weighted mean of 4.03, interpreted as High Usability and Accessibility.

These results show that learners generally found the tools helpful, understandable, and accessible during the learning process. However, usability and accessibility still require teacher support because students' device availability, internet connectivity, free-version limitations, and digital literacy may differ.

Table 5. *Summary of Usability and Accessibility Across Instructional Approaches*

Instructional approach	Overall weighted mean	Interpretation	Instructional implication
Traditional instruction	High/descriptively favorable	Accessible through teacher-led classroom learning	Teacher guidance remains important as the baseline support system.
Wolfram Alpha	4.03	High usability and accessibility	Useful for computation, verification, and visual output when students are guided.
MathGPT	4.03	High usability and accessibility	Useful for explanations, guided solutions, and conversational assistance when monitored.

### Enhanced AI-Assisted Mathematics Instructional Plan

Based on the findings, an enhanced AI-assisted mathematics instructional plan was proposed. The plan emphasizes responsible AI orientation, teacher-guided use of MathGPT and Wolfram Alpha, guided problem-solving, verification of AI-generated responses, formative assessment, accessibility support, and student reflection. This plan is intended to help teachers integrate AI tools ethically and meaningfully while maintaining the central role of the teacher in instruction.

Table 6. *Proposed Enhanced AI-Assisted Mathematics Instructional Plan*

Component	Basis from findings	Recommended strategy	Expected outcome
Responsible AI orientation	AI tools were helpful but require proper use.	Orient students on ethical use, verification, and avoidance of copying AI answers.	Students use AI as a learning aid rather than a shortcut.
Teacher-guided MathGPT use	MathGPT had the highest behavioral engagement and overall learning experience.	Use MathGPT for guided explanations, alternative examples, and reflective questioning.	Students receive clearer explanations while still justifying their reasoning.
Teacher-guided Wolfram Alpha use	Wolfram Alpha had the highest emotional engagement and high usability/accessibility.	Use Wolfram Alpha for computation, visualization, and answer verification.	Students improve accuracy and confidence in Data and Probability tasks.
Formative assessment	Achievement improved across competencies but gains were not uniform.	Use short checks, exit tickets, and competency-based remediation after each AI-assisted task.	Teachers identify gaps and provide immediate support.
Accessibility support	Access to tools may vary among students.	Provide group use, demonstrations, shared devices, and offline teacher-prepared guides.	Students with limited access are not disadvantaged.
Reflection and validation	Friedman test showed comparable engagement across approaches.	Require students to explain AI outputs and compare them with teacher-led procedures.	Students develop deeper reasoning and responsible AI habits.

### CONCLUSION

The study concludes that traditional instruction, MathGPT-assisted instruction, and Wolfram Alpha-assisted instruction all contributed positively to students' mathematics engagement and achievement in Data and Probability. Students experienced high behavioral engagement, emotional engagement, and overall learning experience under the three instructional approaches. Although AI-assisted tools obtained slightly higher descriptive ratings in several dimensions, the Friedman test showed that the difference in engagement among the three approaches was not statistically significant.

Students' mathematics achievement significantly improved from pretest to posttest across all competencies and treatment groups. This indicates that the instructional interventions were effective in improving performance in Data and Probability. The improvement was not uniform across all competencies, which suggests that teacher guidance, learner readiness, competency complexity, and instructional sequencing should be considered when using AI tools in mathematics instruction.

MathGPT and Wolfram Alpha were perceived as usable and accessible instructional supports. MathGPT was helpful for conversational explanations and guided problem-solving, while Wolfram Alpha was useful for computation, visualization, and verification. However, the teacher remains central in ensuring that students use AI responsibly, understand mathematical procedures, and validate AI-generated responses.

### Recommendation

Mathematics teachers should integrate AI-assisted tools such as MathGPT and Wolfram Alpha as supplementary supports for Data and Probability lessons. These tools should be used for explanation, verification, practice, and reflection, but teachers should continue to provide direct instruction, conceptual clarification, monitoring, and assessment.

Schools should provide orientation sessions on responsible AI use, including academic integrity, verification of generated responses, and the proper role of AI as a learning support. Administrators may also provide access support through reliable internet, shared devices, guided demonstrations, and classroom policies for ethical AI use.

Curriculum implementers and mathematics coordinators may use the proposed enhanced AI-assisted mathematics instructional plan as a guide for teacher training and classroom implementation. Future researchers may conduct similar studies with longer intervention periods, larger samples, other mathematics topics, qualitative follow-up interviews, and comparisons of additional AI-supported platforms.

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