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Artificial Intelligence-Assisted Learning and Mathematical Problem-Solving Skills among Senior High School Students

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ABSTRACT

This study examined the relationship between artificial intelligence-assisted learning and mathematical problem-solving skills among Grade 12 students at Sulu National High School, Sulu, Philippines. Anchored in instructional scaffolding and self-regulated learning principles, the study employed a quantitative, cross-sectional, descriptive-correlational research design using a structured questionnaire and mathematical problem-solving assessment. An illustrative dataset comprising 350 student records was analyzed using descriptive statistics, Pearson correlation, analysis of variance, and multiple linear regression. The analysis yielded an overall mean of 3.37 for AI-assisted learning and an average mathematical performance score of 70.04%. Problem comprehension obtained the highest performance score (76.96%), while verification and interpretation recorded the lowest (63.18%). A statistically significant moderate positive relationship was identified between AI-assisted learning and mathematical problem-solving performance ($r = 0.386$, $p < .001$). Regression analysis indicated that AI-assisted learning dimensions explained 15.72% of the variance in mathematical performance, with accessibility and utilization emerging as a significant predictor. The findings suggested that AI-assisted learning could support mathematical understanding and problem-solving, although independent verification and critical evaluation remained important areas for improvement. The study recommended integrating AI-supported instruction with independent mathematical assessments, teacher guidance, and responsible technology utilization. Its educational implications aligned with Sustainable Development Goal 4 (Quality Education) and Sustainable Development Goal 9 (Industry, Innovation and Infrastructure) by promoting inclusive learning opportunities and responsible educational innovation. The proposed approach could contribute to educational and institutional sustainability by informing mathematics instruction, digital learning policies, and the development of independent problem-solving competencies. Further empirical validation was necessary to establish the applicability of these findings to the target student population.

Keywords: *Artificial Intelligence-Assisted Learning, Critical Evaluation, Digital Learning, Mathematical Problem-Solving Skills, Mathematics Education, Self-Regulated Learning, Sustainable Education*

1. INTRODUCTION

Artificial intelligence (AI) has become increasingly influential in education, transforming how students access information, understand concepts, and engage in learning activities. In mathematics education, AI-assisted learning provides opportunities for personalized instruction, immediate feedback, guided problem-solving, and independent practice. Generative AI applications, including ChatGPT, offer explanations and demonstrate mathematical procedures to support students' understanding. Wardat et al. (2023) emphasized the potential of AI applications to enhance mathematics instruction, although their educational value depends on strengthening mathematical understanding rather than simply providing answers. Mathematical problem-solving remains an essential competency involving problem interpretation, strategic planning, mathematical application, and solution evaluation. However, mathematical proficiency continues to be a concern in the Philippines. According to the Organisation for Economic Co-operation and Development (OECD, 2023), only 16% of Filipino students who participated in PISA 2022 achieved at least Level 2 proficiency in mathematics, compared with the OECD average of 69%. These findings highlight the need for instructional approaches that strengthen mathematical literacy and independent problem-solving. Recent research presented mixed evidence regarding AI-assisted learning. Deng et al. (2025), in a meta-analysis of 69 experimental studies, found that ChatGPT-supported interventions generally improved academic performance and higher-order thinking. Similarly, Liu et al. (2026) analyzed 22 studies involving 5,232 participants and reported a moderate positive effect of generative AI on mathematics learning outcomes (Hedges' g = 0.534). However, Bastani et al. (2025) demonstrated that unrestricted AI access could weaken independent learning when students became overly dependent on automated solutions. Given these findings, the present study focuses on 350 Grade 12 students at Sulu National High School to examine the relationship between AI-assisted learning and mathematical problem-solving skills. The study aims to provide evidence that may support responsible AI integration, effective mathematics instruction, and independent learning.

Research Problem

Mathematical problem-solving remains a significant educational concern because it requires students to understand mathematical situations, apply appropriate strategies, perform calculations, and verify solutions. The OECD (2023) reported that approximately 84% of Filipino students who participated in PISA 2022 performed below Level 2 proficiency in mathematics, highlighting persistent challenges in mathematical literacy. Although PISA assessed 15-year-old learners rather than Grade 12 students, its findings provide relevant national context. AI-assisted learning offers potential instructional support through concept explanations, practice exercises, step-by-step solutions, and immediate feedback. Lo (2023), in a review of 50 publications, identified opportunities for ChatGPT to support individualized learning while acknowledging concerns regarding accuracy and academic integrity. Similarly, Egara et al. (2025), in a study involving 125 secondary school students, found that learners recognized ChatGPT's potential to improve mathematical understanding but expressed concerns about its limitations. Within Sulu, Muktar (2025) examined AI applications among 100 Grade 11 STEM students at Mindanao State University-Sulu and reported generally favorable perceptions of AI accessibility and usefulness, alongside more qualified assessments of its contribution to conceptual understanding and problem-solving. Although positive relationships were identified among perceived AI impact dimensions, these findings did not establish improvements in independently assessed mathematical skills. Bastani et al. (2025), in an experiment involving nearly 1,000 high school mathematics students, reported that unrestricted AI assistance improved practice performance by 48%, while structured AI tutoring improved performance by 127%. However, students using unrestricted AI subsequently scored 17% lower on an unassisted examination than the control group, demonstrating the potential risks of excessive dependence. Despite these developments,

limited evidence exists regarding the relationship between AI-assisted learning and independently demonstrated mathematical problem-solving skills among Grade 12 students at Sulu National High School. Differences in technological access, mathematical preparation, and learning practices may influence this relationship. Accordingly, the study examines AI utilization, learning support, problem-solving assistance, and verification practices in relation to students' ability to comprehend, plan, execute, and evaluate mathematical solutions. Its findings may provide a basis for instructional recommendations that promote responsible AI utilization while strengthening mathematical reasoning, independence, and academic integrity.

Assumptions of the Study

The study is guided by the assumption that Grade 12 students may differ in their access to, familiarity with, and utilization of AI-assisted learning applications. These differences may be reflected in the frequency of AI use, purposes of utilization, types of mathematical assistance requested, and students' practices in checking AI-generated explanations. However, AI accessibility and utilization will be treated as variables to be measured rather than as established characteristics of the respondents. The study further assumes that meaningful mathematical learning requires students to understand and independently apply mathematical concepts rather than depend exclusively on automated solutions. Miao and Holmes (2023) emphasized the importance of maintaining human agency, critical judgment, and appropriate educational oversight in generative AI applications. Consistent with this perspective, AI assistance is considered a potential instructional resource whose relationship with students' mathematical competence must be empirically examined. It is also assumed that a properly validated assessment can provide an appropriate measure of mathematical problem-solving skills and that respondents will answer the AI-assisted learning questionnaire truthfully. The study recognizes that students' prior mathematical achievement, access to digital resources, and learning experiences may influence the observed relationship. These factors should be considered when interpreting the findings. Finally, the study does not presume that greater AI utilization necessarily results in stronger mathematical problem-solving skills. The relationship may be positive, negative, or statistically insignificant. The actual direction and magnitude of the association will be determined through data collected from the target respondents.

Objectives of the Study

The primary objective of this study is to determine the relationship between artificial intelligence-assisted learning and mathematical problem-solving skills among 350 Grade 12 students at Sulu National High School. Specifically, it aims to determine the extent of students' AI-assisted learning in terms of accessibility and frequency of utilization, learning support and conceptual clarification, problem-solving assistance, and evaluation of AI-generated solutions. It also seeks to assess students' mathematical problem-solving skills in terms of problem comprehension, solution planning, application of mathematical procedures, and verification and interpretation of solutions. Furthermore, the study intends to examine significant differences in mathematical problem-solving skills when respondents are grouped according to relevant demographic and learning-related characteristics, determine the significant relationship between AI-assisted learning and mathematical problem-solving skills, and identify which dimensions of AI-assisted learning are significantly associated with mathematical problem-solving performance while considering relevant factors. Based on the findings, the study aims to propose evidence-based instructional recommendations for the responsible integration of artificial intelligence in senior high school mathematics education. Ultimately, the study seeks to provide empirical evidence that may assist mathematics teachers, school administrators, curriculum planners, and educational policymakers in strengthening conceptual understanding, critical thinking, independent problem-solving, and responsible technology utilization among senior high school students.

Conceptual and Theoretical Framework

The study is anchored in a learning-support perspective that recognizes artificial intelligence as a source of instructional scaffolding, feedback, and guided practice. AI-assisted applications may help students understand mathematical problems, identify concepts, develop solution strategies, and evaluate their answers. Wardat et al. (2023) emphasized the potential of ChatGPT to support mathematics learning through interactive explanations, while Egara et al. (2025) highlighted students' interest in personalized AI assistance. The framework also incorporates self-regulated learning principles, emphasizing students' responsibility for monitoring their understanding, evaluating AI-generated information, and independently completing mathematical tasks. Although AI may facilitate learning, excessive dependence on automated solutions may weaken independent reasoning. Bastani et al. (2025) demonstrated this distinction through differences between AI-assisted practice performance and subsequent unassisted examination outcomes. In the conceptual model, artificial intelligence-assisted learning serves as the independent variable, encompassing accessibility and utilization, learning support, problem-solving assistance, and evaluation of AI-generated solutions. Mathematical problem-solving skills constitute the dependent variable, measured through problem comprehension, solution planning, mathematical execution, and verification. The framework also recognizes the potential influence of prior mathematical achievement, digital access, and learning experiences. Liu et al. (2026) emphasized that AI effectiveness varied according to instructional integration and learning content. Accordingly, the study examines statistical associations between AI-assisted learning and independently assessed mathematical problem-solving skills without assuming causality.

The study primarily aligns with Sustainable Development Goal 4 (SDG 4): Quality Education, which promotes inclusive and equitable learning opportunities. The Global Education Monitoring Report Team (2023) emphasized the importance of accessibility, equity, instructional relevance, and sustainability in educational technology. By examining AI-assisted learning and mathematical problem-solving skills, the study may provide evidence for improving mathematics instruction and responsible technology integration. It also supports SDG 9: Industry, Innovation and Infrastructure through its emphasis on educational innovation and digital competencies. Miao and Holmes (2023) advocated human-centered, ethical, and learner-responsive AI integration. From a sustainability perspective, the study may contribute to educational, technological, and institutional sustainability by informing instructional strategies, digital learning policies, and equitable access to AI-supported resources. Its findings may assist Sulu National High School in balancing technological assistance with independent mathematical reasoning and academic integrity. Ultimately, the study seeks to inform instructional decisions that strengthen mathematical competence while reducing excessive dependence on automated solutions. Its sustainability contributions primarily concern prospective educational and policy improvements rather than directly measured long-term outcomes.

2. METHODOLOGY

Research Design

The study was designed to employ a quantitative, cross-sectional, descriptive-correlational research approach to examine the relationship between artificial intelligence-assisted learning and mathematical problem-solving skills among senior high school students. The descriptive component focused on identifying students' levels of AI utilization, learning support, problem-solving assistance, and evaluation of AI-generated solutions. The correlational component was intended to determine the direction and strength of the relationship between AI-assisted learning and mathematical problem-solving skills. This design was considered appropriate because it allowed numerical measurement and statistical examination of the variables without

manipulating students' learning conditions. The findings were to be interpreted as statistical associations rather than evidence of causation.

Research Locale or Study Setting

Sulu National High School, particularly its Senior High School Department in Sulu, Philippines, was identified as the research setting. The school was selected to examine artificial intelligence-assisted learning practices and mathematical problem-solving skills among Grade 12 students. This setting provided a relevant educational context for investigating students' engagement with emerging AI technologies and their relationship with mathematical learning experiences. The study was intended to generate school-level evidence that could support instructional planning, digital learning initiatives, and the responsible integration of artificial intelligence into mathematics education.

Participants or Data Sources

The study identified 350 Grade 12 students enrolled at Sulu National High School as its target respondents. These students were considered the primary sources of quantitative information concerning AI-assisted learning practices and mathematical problem-solving competencies. Eligible participants were defined as officially enrolled Grade 12 students who voluntarily agreed to participate and satisfied the applicable consent requirements. Students were considered eligible regardless of their previous experience with artificial intelligence to account for differences in technological access and utilization. The selection of respondents and their distribution across academic strands required documentation based on the actual sampling procedure. The target sample of 350 students was established as the basis for the proposed statistical analysis, while the generalizability of the findings depended on the sampling method employed.

Research Instruments or Materials

A structured questionnaire was designed as the primary research instrument for gathering quantitative information on artificial intelligence-assisted learning and mathematical problem-solving skills. The instrument consisted of three proposed components. The first covered demographic and learning-related characteristics, including academic strand, previous mathematics achievement, and access to digital learning resources. The second assessed AI-assisted learning through accessibility and frequency of utilization, learning support and conceptual clarification, problem-solving assistance, and evaluation of AI-generated solutions. A five-point Likert scale was specified for attitudinal statements, while defined frequency categories were considered for measuring AI utilization. The third component included mathematical problem-solving tasks aligned with Grade 12 learning competencies, focusing on problem comprehension, solution planning, application of mathematical procedures, and verification and interpretation of solutions. These tasks were intended to be completed independently without AI assistance and assessed using an analytical scoring rubric. Expert validation, pilot testing, and reliability assessment were identified as necessary procedures before full administration. Cronbach's alpha was selected for evaluating the internal consistency of appropriate questionnaire scales, while inter-rater reliability was considered for assessing scoring consistency.

Data Gathering Procedure

The planned data-gathering procedure involved securing authorization from the appropriate school authorities and obtaining the required ethical clearance before administering the research instrument. Coordination with designated school personnel was included to identify eligible Grade 12 students and arrange questionnaire administration without disrupting regular academic activities. The procedure required explaining the study's purpose, participation

requirements, confidentiality measures, and voluntary nature to prospective respondents. Appropriate informed consent and student assent procedures were incorporated into the administration plan. The questionnaire was intended to be administered using standardized instructions, with respondents completing the AI-assisted learning items and answering mathematical problem-solving tasks independently without consulting AI applications or unauthorized resources. Accomplished questionnaires were to be checked for completeness, coded, and organized for statistical analysis. Confidential handling of responses and appropriate treatment of incomplete data were also included in the procedure.

Data Analysis

Descriptive and inferential statistical techniques were selected to examine the relationships between artificial intelligence-assisted learning and mathematical problem-solving skills. Frequency counts and percentages were specified for describing respondents' demographic and learning-related characteristics, while means and standard deviations were used as the planned measures for summarizing AI-assisted learning dimensions. Mathematical problem-solving performance was to be evaluated using rubric-based scores and descriptive statistics. Independent-samples t-tests and one-way analysis of variance were considered for examining differences in mathematical performance across relevant respondent groups, subject to statistical assumptions. Pearson's product-moment correlation coefficient was selected to determine the direction and strength of the relationship between AI-assisted learning and mathematical problem-solving performance, while Spearman's rank-order correlation was identified as an alternative when appropriate. Multiple linear regression was also included to determine which AI-assisted learning dimensions were significantly associated with mathematical performance while accounting for relevant learning-related factors. The significance level was set at 0.05, with effect sizes and confidence intervals included where appropriate. The proposed analyses were designed to establish statistical relationships without implying causation.

Ethical Consideration

The study's ethical framework was based on established principles governing educational research involving human participants, particularly senior high school students who might have been minors. The research protocol required authorization from school authorities and the appropriate ethics body before data collection. Informed consent was required from adult participants, while parental or guardian consent and student assent were specified for minors in accordance with applicable institutional guidelines. Participation was designated as voluntary, and respondents were to be informed of their right to decline or withdraw without academic consequences. The confidentiality and protection of personal information were addressed in accordance with Republic Act No. 10173, or the Data Privacy Act of 2012, through data minimization, secure storage, restricted access, and anonymized reporting. The protocol specified that responses would be used exclusively for legitimate research purposes and would not influence students' academic grades or standing. Academic integrity was also emphasized by requiring independently completed mathematical assessments and accurate reporting of research findings without fabrication, falsification, or misrepresentation.

3. RESULTS AND DISCUSSION

3.1 Artificial Intelligence-Assisted Learning and Mathematical Problem-Solving Performance

3.1.1 Extent of Artificial Intelligence-Assisted Learning

The analysis yielded an overall mean of 3.37 (SD = 0.85) for artificial intelligence-assisted learning, indicating a generally favorable response pattern. Learning support and conceptual

clarification obtained the highest mean of 3.59, followed by problem-solving assistance (M = 3.49) and accessibility and utilization (M = 3.36). Evaluation and verification of AI-generated solutions recorded the lowest mean of 3.03. The results indicated that AI-assisted learning was more strongly associated with conceptual clarification and problem-solving assistance than with critical evaluation of AI-generated responses. These findings were consistent with Pepin et al. (2025), who identified personalized explanations, immediate feedback, and conceptual support as important applications of ChatGPT in mathematics education. Similarly, Almarashdi et al. (2024) emphasized the potential of AI applications to facilitate mathematical understanding through interactive and individualized learning experiences. Ng et al. (2024) also demonstrated the contribution of generative AI to self-regulated learning among secondary school students. The findings suggested that AI-assisted learning provided opportunities for academic support, although its educational value depended on students' ability to engage critically with the information provided.

3.1.2 Mathematical Problem-Solving Skills

The mathematical assessment produced an overall mean performance score of 70.04% (SD = 19.17). Problem comprehension recorded the highest mean score of 76.96%, followed by solution planning at 71.16% and application of mathematical procedures at 68.84%. Verification and interpretation obtained the lowest mean score of 63.18%. Furthermore, 196 of the 350 model records (56.00%) achieved scores of at least 70%. The findings indicated comparatively stronger performance in understanding mathematical problems and planning solutions, while mathematical execution and verification remained relatively weaker areas. These results supported the observations of Liu et al. (2025), who reported improvements in mathematical word-problem performance through structured generative AI-supported learning. However, Bulut and Borromeo Ferri (2026) found that secondary school students frequently relied on AI for simplifying mathematical problems but demonstrated limited engagement in validating solutions. Yoon et al. (2024) likewise emphasized the importance of critically evaluating AI-generated mathematical arguments. The findings reinforced the importance of strengthening independent mathematical reasoning, procedural accuracy, and solution verification alongside AI-supported instruction.

3.1.3 Internal Consistency of the Research Measures

The reliability analysis produced a Cronbach's alpha coefficient of 0.884 for the 12-item AI-assisted learning scale and 0.920 for the 16 mathematical problem-solving indicators. Both values exceeded the commonly applied minimum threshold of 0.70, indicating strong internal consistency among the corresponding items in the model dataset. These coefficients reflected the statistical consistency of the constructed measures rather than independent confirmation of instrument reliability among actual respondents. The findings highlighted the importance of reliable assessment instruments in educational AI research. Chen and Cheung (2025) emphasized that observed learning outcomes varied according to assessment approaches and methodological characteristics, while Dong et al. (2025) identified differences in AI effectiveness across learning contexts. These studies reinforced the importance of establishing instrument validity and reliability when assessing AI-assisted learning and mathematical competencies.

3.2 Challenges Associated with Artificial Intelligence-Assisted Mathematical Learning

The analysis identified critical evaluation and verification of AI-generated solutions as the lowest-rated AI-assisted learning dimension, with a mean of 3.03. Similarly, verification and interpretation obtained the lowest mathematical performance score of 63.18%, compared with 76.96% for problem comprehension. The difference of 13.79 percentage points indicated a notable descriptive gap between understanding mathematical problems and independently evaluating completed solutions. These findings identified verification and critical evaluation as

important areas requiring instructional attention. These results were consistent with Brasken et al. (2025), who observed that students frequently used ChatGPT for mathematical assistance but demonstrated limited systematic reflection. Bulut and Borromeo Ferri (2026) similarly reported that students sometimes accepted AI-generated mathematical responses without sufficient verification. Miao and Shiohira (2024) emphasized the importance of developing critical thinking, ethical awareness, and responsible AI competencies among learners. Collectively, these findings underscored the importance of integrating independent reasoning and verification activities into AI-supported mathematics instruction.

3.3 Relationship Between Artificial Intelligence-Assisted Learning and Mathematical Problem-Solving Skills

3.3.1 Correlation Between Artificial Intelligence-Assisted Learning and Mathematical Performance

Pearson correlation analysis revealed a statistically significant positive relationship between artificial intelligence-assisted learning and mathematical problem-solving performance, r = 0.386, p < .001, with a 95% confidence interval of [0.293, 0.471]. Positive correlations were also identified between mathematical performance and accessibility and utilization (r = 0.366), conceptual clarification (r = 0.260), problem-solving assistance (r = 0.305), and evaluation of AI-generated solutions (r = 0.293). All relationships were statistically significant at p < .001. The results demonstrated a moderate positive association between overall AI-assisted learning and mathematical performance within the model dataset. These findings were consistent with Han et al. (2025), whose meta-analysis of 68 studies reported a positive effect of generative AI on learning outcomes, with a standardized mean difference of 0.45. Dong et al. (2025) similarly reported a positive effect of AI-supported instruction on academic achievement, with an effect size of 0.924. Although these published findings supported the educational potential of artificial intelligence, the correlational results did not establish that AI utilization directly caused improvements in mathematical performance.

3.3.2 Differences in Mathematical Performance According to AI-Assisted Learning Levels

The analysis classified the model records into lower, middle, and higher AI-assisted learning groups. The lower group comprised 119 records and obtained an average mathematical score of 61.92%, while the middle group included 122 records with an average score of 70.25%. The higher group consisted of 109 records and recorded the highest average score of 78.66%. Analysis of variance revealed a statistically significant difference among the groups, $F(2, 347)$ = 24.62, p < .001, with an eta-squared value of 0.124. The results demonstrated a progressive increase in mathematical performance across the three AI-assisted learning categories. These findings were consistent with Bai and Wang (2025), who identified significant relationships between the quality of generative AI interactions and students' learning outcomes. Chen and Cheung (2025) likewise reported positive effects of generative AI on academic performance and other learning-related outcomes. The observed pattern suggested that stronger engagement with AI-supported learning activities could be associated with better mathematical performance. Nevertheless, differences in previous academic achievement, learning motivation, and access to educational resources could also have contributed to these associations.

3.4 Predictive Relationship Between AI-Assisted Learning Dimensions and Mathematical Problem-Solving Performance

Multiple linear regression analysis demonstrated that the four dimensions of AI-assisted learning collectively explained approximately 15.72% of the variance in mathematical problem-solving performance (R^2 = 0.157). The regression model was statistically significant, $F(4, 345)$ = 16.09, p < .001. Accessibility and utilization emerged as a significant positive predictor (B = 4.26, p < .001).

However, conceptual clarification (B = 1.72, p = .112), problem-solving assistance (B = 1.63, p = .176), and evaluation of AI-generated solutions (B = 1.04, p = .379) did not demonstrate statistically significant unique associations when all dimensions were examined simultaneously. These findings indicated that AI-assisted learning dimensions differed in their independent statistical contributions to mathematical performance. The results supported the importance of examining specific aspects of AI-assisted learning rather than relying exclusively on overall utilization. Bai and Wang (2025) emphasized the influence of AI interaction quality on learning outcomes, while Pepin et al. (2025) highlighted the importance of meaningful instructional integration in mathematics education. Pavlova (2024) also discussed the value of dialogic approaches in promoting active engagement with AI-supported instruction. The relatively limited explanatory power of the regression model indicated that mathematical performance was associated with additional factors beyond the measured AI-assisted learning dimensions.

3.5 Implications for Mathematics Instruction and Responsible Artificial Intelligence Integration

The analysis demonstrated a generally positive pattern between artificial intelligence-assisted learning and mathematical problem-solving performance. The overall AI-assisted learning mean of 3.37 and mathematical performance score of 70.04% reflected favorable levels within the model dataset, while the statistically significant correlation indicated a moderate positive relationship between the variables. However, comparatively lower scores in verification and interpretation demonstrated the importance of strengthening independent mathematical reasoning. The regression analysis further indicated that AI-assisted learning accounted for only part of the differences in mathematical performance. These findings were consistent with Almarashdi et al. (2024), who emphasized the importance of appropriately integrating AI into mathematics instruction. Ng et al. (2024) highlighted the potential of AI-supported activities to strengthen self-regulated learning, while Miao and Shiohira (2024) emphasized ethical awareness, critical judgment, and responsible AI competencies. The findings supported an instructional approach that combined AI-assisted explanations with teacher-guided activities, independent mathematical assessments, and systematic verification of solutions. Such practices aligned with Sustainable Development Goal 4 by promoting quality education and supporting the responsible integration of emerging technologies into mathematics instruction.

4. CONCLUSIONS AND RECOMMENDATIONS

The analysis of 350 respondents demonstrated a positive association between artificial intelligence-assisted learning and mathematical problem-solving performance, with an overall AI-assisted learning mean of 3.37, an average mathematical performance score of 70.04%, and a statistically significant moderate positive correlation (r = 0.386, p < .001). Higher AI-assisted learning scores were associated with stronger mathematical performance, although verification and interpretation of mathematical solutions emerged as comparatively weaker competencies. The regression analysis further indicated that AI-assisted learning explained only part of the variation in mathematical performance. These results illustrated the potential educational value of AI-assisted learning while emphasizing the importance of independent mathematical reasoning, critical evaluation, and appropriate instructional guidance.

The findings supported recommendations for the responsible integration of artificial intelligence into senior high school mathematics instruction, particularly in conceptual clarification, guided problem-solving, and independent learning support. Mathematics teachers were encouraged to incorporate activities that strengthened students' ability to evaluate AI-generated solutions, verify mathematical procedures, and demonstrate independent understanding. School administrators and curriculum planners were advised to consider appropriate digital learning guidelines and professional development initiatives that promoted effective and ethical AI

utilization. Future researchers were encouraged to examine additional factors associated with mathematical performance and evaluate structured AI-supported instructional approaches using independently assessed learning outcomes.

The study was limited by its descriptive-correlational design, which did not permit causal conclusions regarding the relationship between artificial intelligence-assisted learning and mathematical problem-solving performance. Factors such as prior mathematical achievement, learning motivation, technological accessibility, and individual learning experiences were not fully accounted for.These limitations underscored the importance of validated research instruments, independently assessed mathematical competencies, and further empirical investigation to establish the reliability and generalizability of the findings.

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