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Relationship Among Students' Artificial Intelligence Use, Mathematics Proficiency, and Challenges in Secondary Schools

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ABSTRACT

Artificial intelligence (AI) has linked students' study habits, their mathematical performance, and their teachers' work in new ways. This study examined the relationship among students' AI use, mathematics proficiency, and the challenges experienced by secondary mathematics teachers in selected schools in General Santos City, Philippines, during School Year 2025–2026. Using a descriptive-correlational design anchored on the Technology Acceptance Model, Constructivist Learning Theory, and Self-Determination Theory, data were gathered from 256 students and 121 teachers through validated four-point questionnaires (α = 0.84) and analyzed using descriptive statistics and correlation tests at $p \leq .05$. Students' AI use (M = 3.12) and proficiency (M = 3.14) were Good, and teachers' challenges were high (M = 3.16), led by academic integrity and institutional support. Students' profiles were related to AI use in 32 of 40 pairs and to proficiency in 29 of 40, with device access, frequency, purpose, and type of AI use, and math average outweighing age and gender. Teachers' profiles were related to 16 of 25 challenge pairs, with educational attainment the most consistent correlate and institutional support unrelated to any teacher characteristic. All 75 relationships among AI use, proficiency, and teachers' challenges were positive and significant: AI use with proficiency (r = .432 to .841), AI use with challenges (r = .421 to .823), and proficiency with challenges (r = .372 to .836), with academic integrity and higher-order thinking forming the strongest links and application and institutional support the weakest. The findings describe a closely connected triad in which reflective AI use, higher-order proficiency, and integrity demands rise together. Reflective AI practices, integrity-focused assessment, expanded teacher training, and stronger institutional support are recommended.

Introduction

Artificial intelligence (AI) has altered the relationships that make up a mathematics classroom. A student who once worked through a problem alone or with a teacher's help can now consult a chatbot or problem solver that returns a full solution, and a teacher who once judged understanding from written work must now ask how much of that work the student produced. These changes link three variables that are usually studied apart: how students use AI, how proficient they are in mathematics, and what challenges their teachers face.

Research on each variable separately is growing. AI offers immediate feedback, adaptive practice, and personalized support (Holmes et al., 2022), and a meta-analysis found a small positive effect of AI on K–12 mathematics achievement (Yi et al., 2025). Yet students may accept AI outputs uncritically and lose opportunities to develop problem-solving (Susnjak,

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2022), and teachers face new difficulties in assessing competence and protecting academic integrity (Zawacki-Richter et al., 2019). For many Filipino students, digital habits were formed during pandemic-era remote schooling, whose effects on their mental health persisted well after classrooms reopened (Panela, 2025c). In the Philippines more broadly, AI integration is uneven, shaped by device access, digital literacy, and the support available to teachers (Lucas et al., 2021; Co, 2025).

Little local evidence describes how these three variables relate to one another. This study examined the relationship among students' AI use, mathematics proficiency, and teachers' challenges in selected secondary schools in General Santos City during School Year 2025–2026. It determined the profiles of students and teachers and the levels of the three variables; tested the relationships of students' profiles with AI use and proficiency and of teachers' profiles with their challenges; and tested the relationships among AI use, proficiency, and challenges, as a basis for an intervention plan for responsible AI integration.

Literature Review

AI Use and Mathematics Proficiency

Studies of AI in mathematics report gains in problem-solving and procedural skills when tools adapt to students and provide targeted feedback (Ximenes, 2025; Panqueban & Huincahue, 2024), and meta-analytic evidence confirms small positive effects on achievement (Yi et al., 2025). The link depends on how students use AI. Its benefits appear when learners evaluate and integrate outputs into their reasoning (Zawacki-Richter et al., 2019) and when AI supports rather than replaces thinking (Holmes et al., 2019); when students use it chiefly for quick answers, understanding may suffer (Chen et al., 2020). Generative AI requires users to verify outputs (Kasneci et al., 2023), and information literacy is needed to judge AI-generated content (Galagala & Bacarrisas, 2025). Mathematics proficiency itself spans conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning (Kilpatrick et al., 2001), in which conceptual and procedural knowledge reinforce one another (Rittle-Johnson et al., 2015), together with critical thinking (Facione, 2015; Lai, 2018) and real-world application (NCTM, 2014; OECD, 2019; Boaler, 2016).

AI Use and Teachers' Challenges

When students use AI, teachers must find new ways to monitor learning, protect academic integrity, and design assessments that reveal reasoning (Bretag, 2019; Eaton & Turner, 2020; Black & Wiliam, 2018). AI-supported learning analytics may help, but they require preparation (Salas-Pilco et al., 2022; Holstein et al., 2019). Policy guidance urges schools to equip teachers for these tasks through training and institutional support (UNESCO, 2022a, 2023b).

Proficiency and Teachers' Challenges

Teaching for conceptual understanding and higher-order thinking is demanding in any context (Hiebert & Grouws, 2017), and the presence of AI adds another layer, since more capable students may use AI in more sophisticated ways that are harder to monitor and assess. Teachers' ability to adapt depends on technological pedagogical content knowledge (Mishra & Koehler, 2006; Koehler & Mishra, 2019).

Learner and Teacher Characteristics

Students' device access, digital literacy, and confidence influence how they use technology (OECD, 2020; Kauffman, 2015; Scherer & Teo, 2019; Wang & Tahir, 2020). Teachers' age, beliefs, confidence, and training influence their integration of technology (Ertmer & Ottenbreit-Leftwich, 2010; Tondeur et al., 2017; OECD, 2021b; UNESCO, 2022b). Philippine reviews note that teacher training gaps, infrastructure limits, and digital divides constrain AI integration (Escorial & Pajo, 2025; Estrellado & Miranda, 2023; Pajo & King, 2025), and pre-service teachers require targeted AI competency development (Vera et al., 2025). Qualitative research with Filipino teachers shows that capacity grows when institutions address the specific barriers teachers encounter rather than offering generic programs (Panela, 2025e).

Theoretical Framework

The Technology Acceptance Model explains students' AI use as a function of perceived usefulness and ease of use, shaped by external conditions (Davis, 1989). Constructivist Learning Theory views students as active builders of knowledge for whom AI is a mediator (Piaget, 1967). Self-Determination Theory explains the motivation of students and teachers through autonomy, competence, and relatedness (Deci & Ryan, 2000). The study's framework treats students' and teachers' profiles as inputs, AI use, proficiency, and challenges as interrelated variables, and an intervention plan as the intended output.

Methodology

Research Design

The study followed a quantitative descriptive-correlational design, describing variables as they occur and determining the strength and direction of their relationships without manipulation (Creswell & Creswell, 2018; Ary et al., 2014).

Population and Sample

The respondents were 256 secondary students and 121 mathematics teachers from selected schools in General Santos City, Philippines, selected through simple random and quota sampling. Only those who agreed voluntarily were included.

Research Instruments

The instrument was adapted from published questionnaires on students' engagement with AI tools (Al Mashagbeh et al., 2025), mathematics self-efficacy and skills, and teachers' challenges in AI use, and was modified for the study context. It had four parts: respondents' profiles; students' AI use (accuracy verification behavior, complexity of tasks, integration with independent learning, time spent, and confidence); mathematics proficiency (conceptual understanding, procedural skills, problem-solving ability, critical thinking skills, and application of mathematical concepts); and teachers' challenges (monitoring AI use, academic integrity, assessment design, instructional adaptation, and institutional support). Each dimension had five items rated on a four-point scale, with means interpreted as Excellent (3.26–4.00), Good (2.51–3.25), Less Satisfactory (1.76–2.50), or Least Satisfactory (1.00–1.75).

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Validation and Pilot Testing

Experts in educational technology, mathematics education, and research methodology examined the instrument's content, and revisions suggested by the adviser and panel were incorporated. Pilot testing yielded a Cronbach's alpha of 0.84, indicating acceptable reliability.

Data Gathering

Formal approval was obtained from the research adviser and school administrators. Respondents were informed of the study's purpose and the confidentiality of their answers, completed the questionnaires within adequate time, and returned them to the researchers. Completed forms were checked, cleaned, and encoded.

Statistical Treatment

Frequencies and percentages summarized profiles, and weighted means and standard deviations summarized levels. Normality was assessed using the Shapiro-Wilk test, skewness and kurtosis, and Q-Q plots. Relationships were tested with Pearson's r or Spearman's rho as appropriate, point-biserial correlation for dichotomous variables, eta for categorical variables, and the Kruskal-Wallis H test for multi-group differences, at $p \leq .05$. Because gender was among the profile variables, the analysis took into account recent Philippine evidence that the meaning of gender comparisons depends on whether an instrument functions equivalently across groups (Panela, 2025a).

Ethical Considerations

Participation was voluntary, written informed consent was obtained, and respondents could withdraw without penalty. Responses were anonymized, identifiers were kept separately, and digital and paper records were secured and later destroyed in accordance with the Data Privacy Act of 2012.

Results and Discussion

Profiles of the Respondents

Table 1
Selected Profile Characteristics of Student Respondents (n = 256)

Variable	Category	f	%
Age (M = 15.33, SD = 1.39)	15 / 16 / 14 years old	72 / 61 / 49	28.13 / 23.83 / 19.14
Gender	Female / male / LGBT	138 / 103 / 15	53.91 / 40.23 / 5.86
Grade level	Grade 9 / Grade 10 / Grade 8	57 / 52 / 43	22.27 / 20.31 / 16.80
Device access	Smartphone with internet	132	51.56
	Laptop or desktop / tablet	48 / 36	18.75 / 14.06
	Shared device / no regular access	29 / 11	11.33 / 4.30
Frequency of AI use	Few times a week / multiple times daily	81 / 67	31.64 / 26.17
	Once daily / weekly or less / rarely	58 / 34 / 16	22.66 / 13.28 / 6.25
Purpose of AI use	Chatbots / problem solvers	96 / 71	37.50 / 27.73
	Learning platforms / content creation / games	48 / 27 / 14	18.75 / 10.55 / 5.47
Math average (M = 84.87)	85–89 / 80–84 / 90–100 / 75–79	93 / 82 / 46 / 35	36.33 / 32.03 / 17.97 / 13.67

Table 2
Profile of Teacher Respondents (n = 121)

Variable	Category	f	%
Age (M = 39.12, SD = 11.84)	31–40 / 41–49 / 21–30	36 / 30 / 27	29.75 / 24.79 / 22.31
	50–59 / 60–65	18 / 10	14.88 / 8.26
Gender	Female / male / LGBT	74 / 43 / 4	61.16 / 35.54 / 3.32
Educational attainment	Master's degree / master's units	38 / 31	31.40 / 25.62
	Bachelor's / doctoral units / doctorate	22 / 18 / 12	18.18 / 14.88 / 9.92
Teaching experience (M = 14.62)	1–10 / 11–20 / 21 years and above	42 / 45 / 34	34.71 / 37.19 / 28.10
AI trainings (M = 4.38)	1–3 / 4–6 / 7–10 / above 10	52 / 36 / 22 / 11	42.98 / 29.75 / 18.18 / 9.09

Most students were mid-adolescents in Grades 8 to 10, and girls formed the majority. Smartphones were the main gateway to AI for more than half, while 4.30% had no regular device access. About four in five (80.47%) used AI at least a few times a week, and chatbots and problem solvers accounted for nearly two-thirds of AI use. Most students had averages between 80 and 89. Teachers were largely in early to mid-career, mostly female, and

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academically well qualified, with 57.02% holding or working toward a master's degree and 24.80% with doctoral units or a doctorate. Their AI training was limited, however, with 42.98% reporting only one to three trainings.

These profiles shape the relationships examined below. Reliance on phones can limit the depth of digital learning (OECD, 2020), and quick-answer uses of AI raise the risk of dependency (Chen et al., 2020). Technology use is woven into adolescents' academic and social lives (UNESCO, 2023a). The combination of strong academic qualifications and thin AI training among teachers suggests that their professional knowledge has not yet been extended to AI, a gap that skills-mapping research among Filipino teachers recommends identifying precisely before training is designed (Panela, 2025d). Older and more experienced teachers may also need more structured support (OECD, 2021b; UNESCO, 2022b; Holmes et al., 2019).

Levels of the Three Variables

Students' AI use was Good overall (M = 3.12, SD = 0.73). Accuracy verification ranked highest (M = 3.16), led by reviewing AI-provided steps (3.24) and checking answers before submission (3.21), while comparing AI solutions with one's own calculations was lowest (3.08). Confidence followed (M = 3.12), with independent and accurate completion of work using AI the weakest item (3.05). Task complexity and integration with independent learning each averaged 3.11, both lowest on items reflecting deeper reliance (2.98), and time spent averaged 3.10. Students use AI regularly and with some care but not yet with full self-regulation, consistent with the view that AI's value lies in how students evaluate and integrate it (Zawacki-Richter et al., 2019; Holmes et al., 2019; Kasneci et al., 2023) and with research linking confidence and purposeful engagement to learning (Kauffman, 2015; Crompton & Burke, 2018; Holstein et al., 2019; OECD, 2021a).

Mathematics proficiency was Good overall (M = 3.14). Conceptual understanding and critical thinking were highest (3.15), procedural skills and application followed (3.14), and problem-solving was lowest (3.11), with solving unfamiliar problems the weakest item (3.05). Students are secure in core understanding and procedure but less so in novel problems, in line with work on the interdependence of proficiency strands (Kilpatrick et al., 2001; Rittle-Johnson et al., 2015; Hiebert & Grouws, 2017).

Teachers' challenges were at a high level (M = 3.16). Academic integrity and institutional support were most pressing (3.18 each), with preventing AI misuse in assessments (3.24) and limited institutional support (3.23) the highest items, followed by monitoring (3.15), assessment design (3.15), and instructional adaptation (3.14). These demands sit on top of regular teaching loads; Philippine research on teacher well-being shows how such accumulated pressures surface as workplace stress (Panela, 2026). The findings align with research on integrity and assessment in digital learning (Bretag, 2019; Eaton & Turner, 2020; Black & Wiliam, 2018) and on institutional conditions for technology integration (Tondeur et al., 2017; UNESCO, 2022a).

Relationships of Profiles With AI Use, Proficiency, and Challenges

Students' profiles were significantly related to AI use in 32 of 40 pairs and to proficiency in 29 of 40 pairs. Age had the fewest significant relationships, two with AI use (independent learning and confidence) and two with proficiency (procedural skills and critical thinking). Gender and grade level were related to most AI dimensions with modest and sometimes inverse coefficients. Frequency of AI use, purpose of use, type of AI tools, and math general average showed the strongest relationships, with frequency reaching $r = .801$ with task complexity and $r = .742$ with problem-solving, and math average reaching $r = .945$ with independent learning. Device access was positively related to verification ($r = .612$) and critical thinking ($r = .591$) but inversely to task complexity ($r = -.421$) and problem-solving ($r = -.402$). Application of mathematical concepts was unrelated to every profile variable. Students' technology circumstances and academic standing, rather than their demographics, thus relate most closely to how they use AI and how proficient they are, as the Technology Acceptance Model and research on access and personalization suggest (Davis, 1989; Luckin et al., 2016; Crompton & Burke, 2023; UNESCO, 2023b).

Table 3

Correlations Between Teachers' Profile and Challenges in Managing AI Use

Teacher Profile	MON	INT	ASD	IAS	ISR
Age	.214*	.236*	.189	.201*	.118
Gender	.268*	−.241*	.183	.295*	−.097
Educational attainment	.332*	.289*	.214*	.356*	.098
Years of teaching experience	.241*	.218*	−.193	.276*	.104
Number of AI trainings	.241*	.218*	−.193	.276*	.104

Note. MON = monitoring students' AI use; INT = ensuring academic integrity; ASD = designing assessments; IAS = instructional adaptation and strategy; ISR = institutional support and resources. *p ≤ .05.

Teachers' profiles were related to their challenges in 16 of 25 pairs (Table 3), all weak to modest. Educational attainment was the only variable related to four challenge areas, including assessment design ($r = .214$), and it produced the largest coefficients, for instructional adaptation ($r = .356$) and monitoring ($r = .332$). Age, gender, experience, and number of AI trainings were each related to monitoring, integrity, and instructional adaptation. Institutional support was unrelated to every teacher characteristic, suggesting that it is a school-level condition experienced similarly by all teachers. These results agree with research showing that teacher knowledge and beliefs shape technology integration (Koehler & Mishra, 2019; Tondeur et al., 2017).

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Table 4

Summary of Relationships Among the Main Variables

Relationship	Significant	Range of r	Strongest Pair
AI use and proficiency	25/25	.432–.841	Independent learning × Problem-solving (.841)
AI use and teachers' challenges	25/25	.421–.823	Confidence × Academic integrity (.823)
Proficiency and teachers' challenges	25/25	.372–.836	Critical thinking × Academic integrity (.836)

Note. All coefficients were positive and significant at $p \leq .05$.

Table 4 summarizes the three central relationships. All 75 coefficients were positive and significant, forming a closely connected triad.

AI use and proficiency. The coefficients ranged from .432 to .841. Integration with independent learning showed the strongest relationship with problem-solving, and accuracy verification with critical thinking (r = .836). Time spent showed the weakest relationships, and application of mathematical concepts was the domain least related to AI use (r = .432 to .618). Proficiency relates most closely to reflective and integrative uses of AI rather than to the amount of time spent with it, which is consistent with constructivist accounts of learning (Piaget, 1967) and with research on the conditions under which AI benefits learners (Zawacki-Richter et al., 2019; Holmes et al., 2019; Chen et al., 2020).

AI use and teachers' challenges. Coefficients ranged from .421 to .823. Academic integrity was most strongly related to every dimension of AI use, peaking with confidence. Instructional adaptation and monitoring followed, and institutional support showed the weakest relationships (.421 to .492). As students use AI more confidently and extensively, teachers find it harder to ensure honest work and to adjust their teaching (Holmes et al., 2019; UNESCO, 2023b).

Proficiency and teachers' challenges. Coefficients ranged from .372 to .836. Critical thinking and problem-solving were most strongly related to academic integrity (r = .836 and .801), and application and institutional support formed the weakest pair (r = .372). Higher proficiency coincides with heavier integrity and instructional demands, perhaps because more proficient students use AI in ways that are harder to monitor (Zawacki-Richter et al., 2019; UNESCO, 2023b).

The Relationship Triad

The three relationships reinforce one another. Reflective AI use, higher-order proficiency, and integrity challenges rise together, and in each relationship academic integrity or a higher-order domain forms the strongest link. Two elements consistently form the weakest links: application of mathematical concepts on the student side and institutional support on the teacher side. The first appears to depend on direct instruction rather than on AI; the second appears to be a school-wide condition rather than a function of classroom dynamics. Because the design is correlational and student and teacher data come from different respondents, the triad describes

co-occurrence rather than causation. The pattern nonetheless indicates where intervention is most likely to matter: in shaping how students use AI, in protecting the integrity of assessment, and in strengthening institutional support.

Conclusion

Students' AI use, mathematics proficiency, and teachers' challenges in General Santos City secondary schools are closely related. Students use AI regularly and at a Good level, with verification ahead of planning and self-regulation, and they show balanced Good proficiency with non-routine problem-solving as the weaker area. Teachers face high challenges, chiefly in academic integrity and institutional support. Students' device access, AI habits, and achievement relate more strongly to AI use and proficiency than age or gender, and teachers' education, experience, and training relate to classroom-level challenges but not to institutional support. AI use, proficiency, and teachers' challenges are positively and significantly related to one another, most strongly through academic integrity and higher-order thinking.

Schools should therefore guide students toward reflective AI practices that combine verification with their own reasoning, adopt clear integrity policies and assessments that reveal students' thinking, and provide teachers with training beyond the few sessions most have attended, focused on monitoring, integrity, and instructional adaptation. Institutional support, including infrastructure, tools, and technical help, should be strengthened as a school-wide priority, and application of mathematics to real situations should receive direct instructional attention. Because today's learners carry the effects of years of disrupted, screen-based schooling on their well-being (Panela, 2025b), AI integration plans should also include guidance on healthy digital habits. Future research should match students to their own teachers and use designs that can test the direction of these relationships.

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