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Influence of Teachers' TPACK, AI Utilization, and Students' Metacognitive Practices on Academic Writing Performance among Senior High School Students

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Abstract

The integration of educational technology and artificial intelligence in writing instruction offers new opportunities to support students' academic writing; however, evidence explaining how students' assessment of teachers' Technological Pedagogical Content Knowledge (TPACK), AI utilization, and metacognitive practices relate to writing skills remains limited. Anchored on Flavell's Metacognitive Theory and supported by the TPACK Framework and Technology Acceptance Model, this study examined if metacognitive practices shape AI utilization, teachers' TPACK, and academic writing among senior high school learners. Using a quantitative descriptive-correlational design. This study collected from 176 Grade 11 STEM students in a private Catholic institution in Cagayan de Oro City through validated questionnaires and a rubric-based writing output. Findings revealed generally high teacher TPACK, high AI utilization, and high metacognitive practices, while academic writing was average, with organization and coherence as the weakest dimension. Metacognitive practices had significant direct effects on AI utilization and teachers' TPACK, whereas AI utilization and TPACK had very weak direct contributions to writing performance. The study concludes that improving academic writing requires explicit instruction, guided feedback, deliberate practice, and stronger metacognitive scaffolding. It is recommended that educators integrate structured metacognitive strategies and guided AI-supported writing activities to help students translate their cognitive and technological readiness into measurable improvements in writing performance.

Keywords: Teachers' TPACK, AI Utilization, Metacognitive Practices, Academic Writing Skills, Senior High School Students

1. Introduction

1.1 Background of the Study

Academic writing is the ability to write well-researched essays, reports, and papers. It is very important for students in senior high school. In the Philippines, the K–12 curriculum includes English courses like English for Academic and Professional Purposes (EAPP) to help students build these writing skills. Despite these efforts, many students still find academic writing hard. Experts note that writing is an indispensable skill in education and that many students continue to experience difficulties in academic writing (Roxas, 2020). Common problems for Filipino high school students include having trouble developing ideas, organizing their work, using correct grammar, and giving proper citations. For example, students often struggle with learning complicated citation styles and writing clear arguments (Roxas, 2020). These challenges can make writing feel overwhelming and may discourage students from writing well. Teachers play a key role in helping students improve their writing. One factor is the teacher's Technological Pedagogical Content Knowledge (TPACK). TPACK means a teacher's knowledge of what to teach (content), how to teach it (pedagogy), and how to use technology in teaching. Research says that the TPACK framework is important because effective teaching requires not only technology skills, but also the ability to combine technology with teaching methods and subject content (Siloterio & Cajandig, 2025). If teachers have strong TPACK, they can use digital tools well in class. When teachers know how to choose and use technology correctly, they can make writing lessons more engaging. For example, a teacher with good TPACK might use online writing platforms or interactive activities so students can practice writing in fun and meaningful ways. Artificial intelligence (AI) tools are also becoming popular. Many Filipino senior high students use AI writing assistants like Grammarly or QuillBot to check their grammar and get ideas. A study of Filipino students found that they prefer tools like Grammarly and QuillBot, which help with grammar checking, content generation, and collaborative writing (Fabro et al., 2024). These AI tools help students by catching grammar errors and suggesting improvements to their writing. How students use these AI tools can also affect their writing. Using AI tools wisely – for example, to help plan and improve their drafts – may lead to better writing. If students use AI tools in smart ways during writing, it can help them organize their ideas and polish their work before submitting it. Another important factor is students' metacognitive awareness. This means knowing how to plan, monitor, and evaluate one's own learning. For example, good writers plan their essay before starting, check their progress while writing, and revise their work at the end. Studies in the Philippines found that students who use metacognitive strategies tend to do better in writing. Hacermida and Aboy (2021) noted that

metacognitive strategies are vital in enhancing students' writing competence. Villaruz and Palma (2024) also observed that students frequently use planning, monitoring, and evaluation as part of their writing process. In their study, students often planned what to write, checked their writing as they went, and evaluated it afterward. This suggests that teaching students to be aware of their own learning – for example, by checking drafts and asking themselves if their writing makes sense – can help improve their writing skills. Many previous studies have looked at these factors separately. For example, Roxas (2020) studied writing difficulties and local writing models, while Hacermida and Aboy (2021) and Villaruz and Palma (2024) studied metacognitive writing strategies. Other research examined teachers' TPACK or AI use alone. But few studies examine teachers' TPACK, students' AI use, and students' metacognition all together. This gap is what the present study addresses. International research also suggests that using AI together with metacognitive strategies can boost learning. For instance, Iqbal et al. (2025) found that generative AI tools can enhance academic achievement in education, especially when they encourage shared metacognition and support quality learning. This study also supports Sustainable Development Goal 4: Quality Education. SDG 4 aims to ensure inclusive and equitable quality education and lifelong learning opportunities for all. By examining how teacher knowledge (TPACK), technology use (AI tools), and student thinking skills (metacognitive practices) affect writing performance, this research contributes to efforts to improve teaching and learning quality. In other words, helping teachers and students use the best methods and tools supports the goal of giving every student access to a good education (United Nations, n.d.).

1.2 Theoretical Framework

The study assumes that students' metacognitive practices—planning, monitoring, and evaluation—shape their perceptions of teachers' Technological Pedagogical Content Knowledge (TPACK) and their ethical and effective use of Artificial Intelligence (AI), which in turn influence the quality of their academic writing in terms of content, organization, grammar, coherence, and integrity. This assumption is primarily grounded in Flavell's Metacognitive Theory (1979), and supported by the TPACK Framework (Mishra & Koehler, 2006) and the Technology Acceptance Model (TAM) (Davis, 1989). Flavell's Metacognitive Theory serves as the central framework, explaining how learners regulate their cognitive processes before, during, and after writing tasks. Through planning, monitoring, and evaluation, students become more capable of organizing ideas, refining language, and ensuring coherence and academic integrity. The TPACK framework complements this by explaining how teachers integrate content, pedagogy, and technology to deliver effective writing instruction. In this study, Teacher TPACK functions as a mediating instructional condition that enhances students' writing development when paired with active metacognitive engagement. Meanwhile, TAM explains how students' perceptions of AI—particularly its usefulness, ease of use, and ethical implications—shape their adoption and application of AI tools in writing. AI utilization, including functional use, critical evaluation, and ethical awareness, serves as a second mediating variable that supports improvements in writing accuracy, structure, and integrity. Overall, the study proposes a dynamic framework in which metacognitive practices directly and indirectly influence academic writing skills, with Teacher TPACK and AI utilization acting as key mediators that enhance students' writing performance.

1.3 Conceptual Framework, Scope, and Significance of the Study

This study examines how students' assessment of their teachers' Technological, Pedagogical, and Content Knowledge (TPACK), along with their own use of artificial intelligence (AI) tools and metacognitive strategies, relates to their academic writing performance. Using a structured survey questionnaire and a standardized writing assessment rubric, the study gathered data to determine how these variables influence students' writing outcomes. It specifically looked into how metacognitive planning, monitoring, and evaluation, as well as responsible AI use, contribute to improving students' writing skills. The findings of the study provided a basis for identifying which aspects of TPACK are most effective in teaching writing and how students can enhance their performance through better learning strategies. The study was conducted among Grade 11 Senior High School students, particularly those in the STEM strand of a private institution in Cagayan de Oro City. It focused only on academic writing tasks and did not include other subject areas or educational levels such as junior high school or college. The research examined only the students' assessment of their teachers' TPACK and did not measure the actual competencies of the teachers. It also did not explore specific AI tools in depth. The data were based on self-reports, which may be subject to bias or inaccuracies. Furthermore, other variables such as students' intelligence, socio-economic status, and motivation beyond metacognition were not included. Therefore, the findings are limited to the respondents of the study and may not be generalizable to other contexts. The significance of this study extends to several stakeholders. For students, the findings help them understand how their teachers' TPACK skills and their own learning strategies affect their writing performance, encouraging them to practice writing more effectively and use AI responsibly. For teachers, the results identify which components of TPACK are most beneficial in teaching writing and provide guidance on how to support students in developing metacognitive skills and proper AI use. School administrators may use the findings to design training programs and allocate resources that enhance teaching effectiveness and writing instruction across the school. Finally, for future researchers, this study offers a foundation by combining TPACK, AI use, and metacognitive awareness in one framework, which can be adapted or expanded in related studies or different educational contexts.

2. Material and methods

2.1 Research Design

This study used a descriptive correlational design to examine the relationship between senior high school students' academic writing and three variables: teachers' TPACK, AI utilization, and students' metacognitive awareness. This approach allowed the researcher to observe how these variables naturally interacted in real classroom settings without manipulation, providing a clear understanding of their relationships (Lappe, 2000). The study explored how teachers' integration of technology, pedagogy, and content influenced writing performance, as well as how students' metacognitive strategies and AI use supported or hindered their development. By analyzing students' perceptions and behaviors, the research identified significant associations among variables and generated insights to improve instruction and technology integration in academic writing.

2.2 Participants and Sampling Method of the Study

The study involved 176 Grade 11 students from a private Catholic school in Cagayan de Oro City (AY 2025–2026), selected through random sampling to ensure balanced representation and reduce bias. The sample, drawn from a population of 315 using the Taro Yamane formula, was sufficient for reliable analysis. This approach allowed the study to examine the relationships among teachers' TPACK, students' AI use, metacognitive awareness, and academic writing performance.

2.3 Research Instrument

The study used an analytic rubric to assess students' academic writing, focusing on content, organization, and language accuracy, validated for reliability. Likert-scale questionnaires measured students' perceptions of teachers' TPACK, AI utilization, and metacognitive practices, each validated for reliability and content accuracy. Instruments were based on established frameworks: TPACK (Mishra & Koehler, 2006), Self-Regulated Learning Theory (Zimmerman, 2002), and standardized writing rubrics (Hyland, 2003).

2.4 Data Gathering Procedure

Ethical clearance was obtained from the Research Ethics Committee, and data collection commenced only after school approval. Informed consent was secured from all 176 participants, who were assured of voluntary participation, confidentiality, and the right to withdraw without penalty. The study adhered to the Belmont Report principles—Respect for Persons, Beneficence, and Justice—ensuring minimal risk, fair treatment, and participant safety. Completed questionnaires were securely stored, coded, and entered into a password-protected database, with hard copies and digital files disposed of according to institutional guidelines.

2.5 Data Analysis Techniques

Data were analyzed using descriptive and inferential statistics. For Research Questions 1–4, frequency, percentage, weighted mean, and standard deviation described participants' responses and variability across Teacher TPACK, AI Utilization, Metacognitive Practices, and Academic Writing. For Research Question 5, Canonical Correlation, Multiple Regression, and Structural Equation Modeling (SEM) examined relationships and predictive effects, with model fit assessed via CMIN/df, CFI, SRMR, RMSEA, and PCLOSE. Regression weights determined direct effects. Detailed assumption checks and raw statistical tables are provided.

2.6 Ethical Considerations

The study complied with the National Ethical Guidelines for Health and Health-Related Research (2017) and the Data Privacy Act of 2012. School approval was obtained, and participation was voluntary. Informed consent from parents/guardians and student assent were secured, explaining the study's purpose, procedures, risks, benefits, and withdrawal rights. No personally identifiable information was collected; responses were anonymized and coded, with data stored securely and used solely for academic purposes, then disposed of after one year. The study posed minimal risk, and findings were reported in aggregate to inform teaching practices without causing harm.

3. Results and Discussion

3.1 What is the assessment of the participants of their teacher's TPACK in terms of

3.1.1 Content Knowledge

The result shows teachers' TPACK in Content Knowledge, with an overall mean of M = 4.71 (SD = 0.37), rated Very High. Most participants rated content knowledge as Very High (74.43%) or High (24.43%), indicating strong agreement and low variability. Top-rated indicators reflect strengths in delivering accurate concepts, relevant examples, visuals, real-world connections, clear explanations, and organized lessons (M = 4.74–4.82), supporting student understanding. Lower-rated areas, though still Strongly Agree (M = 4.53–4.72), suggest potential for improving differentiation, conceptual connections, and emphasis clarity. These results demonstrate consistently strong content knowledge, highlighting both mastery and effective presentation of subject matter. Minor refinements in differentiation and integration could further

enhance teaching effectiveness, student understanding, and alignment with TPACK principles (Schmid et al., 2024; Fukaya et al., 2024; Voogt et al., 2021; Greenhow et al., 2022).

3.1.2 Pedagogical Knowledge

The result presents teachers' TPACK in Pedagogical Knowledge, with an overall mean of M = 4.66 (SD = 0.38), interpreted as Very High. Most participants rated pedagogical knowledge as Very High (68.18%) or High (31.25%), reflecting strong agreement and low variability. Top-rated indicators show strengths in fostering an inclusive, engaging environment, using effective questioning, structuring lessons with clear objectives, encouraging collaboration, and sequencing instruction coherently (M = 4.63–4.82, SD = 0.42–0.55). Lower-rated areas, though still Agree to Strongly Agree (M = 4.50–4.63, SD = 0.63–0.67), highlight opportunities to enhance feedback, differentiation, instructional adaptability, and time management. Overall, the results indicate consistently strong pedagogical competence, with minor areas for improvement. Refining feedback, differentiation, and adaptive strategies can further strengthen teaching effectiveness, learner engagement, and responsiveness to diverse student needs (Akram et al., 2022; Langelaan et al., 2024; Sortwell et al., 2024).

3.1.3 Technological Knowledge

The result presents teachers' TPACK in Technological Knowledge, with an overall mean of M = 4.66 (SD = 0.39), interpreted as Very High. Most participants rated technological knowledge as Very High (72.16%) or High (27.27%), reflecting strong agreement and low variability. Top-rated indicators show strengths in using classroom technologies effectively, presenting content clearly with digital resources, promoting digital citizenship, integrating multimedia, and selecting tools aligned with content and student needs (M = 4.65–4.80, SD = 0.45–0.60). Lower-rated areas, though still Strongly Agree (M = 4.54–4.65, SD = 0.55–0.71), suggest opportunities to enhance purposeful integration, student skill development, data-driven instruction, and collaborative technology use. Overall, the results indicate consistently strong technological competence, with minor areas for refinement. Improving purposeful and learner-centered technology practices can further strengthen engagement, meaningful integration, and responsive learning experiences (Schmid et al., 2024; Revuelta-Domínguez et al., 2022).

3.1.4 Summary Results of the Participants' Teacher's TPACK

The result summarizes participants' ratings of the teacher's TPACK across Content, Pedagogical, and Technological Knowledge, with a composite mean of M = 4.68 (SD = 0.34), interpreted as Very High. Participants consistently perceive the teacher as highly competent in integrating content, pedagogy, and technology, reflecting balanced and well-developed teaching skills. The uniformly high ratings indicate not only strong individual knowledge areas but also effective integration in practice. This demonstrates a comprehensive, adaptive, and responsive instructional approach, aligning with TPACK principles and supporting dynamic teaching across varied learning contexts (Fontyn et al., 2025; Tschönhens et al., 2024).

3.2 What is the extent of the participants' AI Utilization considering:

3.2.1 Functional Application

The result presents participants' ratings of AI utilization in Functional Application, with a mean of M = 3.84 (SD = 0.75), interpreted as High. Most participants rated AI use as High (48.30%) or Moderate (29.55%), with greater variability than TPACK results, reflecting differences in familiarity, access, and consistency. Top-rated indicators show AI is primarily used for revising clarity, solving writing problems, improving efficiency, and enhancing output quality (M = 3.85–4.16, SD = 0.89–1.03), highlighting its role as a practical support tool. Lower-rated areas (M = 3.50–3.83, SD = 1.07–1.23) suggest less consistent use in time management, grammar improvement, idea generation, and summarizing sources. Overall, AI is widely recognized as helpful for academic writing, especially for revision and efficiency. Variations in use indicate a need for structured guidance to maximize its benefits and ensure more purposeful and consistent integration in learning tasks (Khalifa & Albadawy, 2024; Urzúa et al., 2025).

3.2.2 Critical Evaluation Process

The result presents participants' ratings of AI utilization in Critical Evaluation Processes, with a mean of M = 4.21 (SD = 0.62), interpreted as High. Most participants rated their evaluation practices as High (53.98%) or Very High (31.25%), reflecting responsible AI use through verification, cross-checking, and independent judgment. Moderate variability (SD = 0.62) indicates some differences in critical evaluation skills among participants. Top-rated indicators show strengths in cross-checking AI outputs, verifying accuracy, comparing multiple sources, assessing credibility, and maintaining independent judgment (M = 4.29–4.44, SD = 0.82–0.92). Lower-rated indicators (M = 3.86–4.26, SD = 0.83–1.03) suggest areas for growth in documenting uncertainties, applying formal evaluation criteria, integrating peer feedback, and evaluating potential biases. Overall, the findings indicate generally strong yet developing critical evaluation skills. Enhancing advanced evaluation practices can support more systematic, reflective, and academically rigorous AI use in writing and analysis (Khalifa & Albadawy, 2024; Urzúa et al., 2025).

3.2.3 Ethical and Responsible Use

The result presents participants' ratings of AI utilization in Ethical and Responsible Use, with a mean of M = 4.21 (SD = 0.56), interpreted as High. Most participants rated ethical use as High (55.11%) or Very High (30.68%), indicating general awareness of academic integrity, data privacy, and responsible decision-making. Variability (SD = 0.56) suggests some differences in consistency across participants. Top-rated indicators highlight strengths in paraphrasing to avoid plagiarism, protecting sensitive data, considering consequences of misuse, ensuring privacy compliance, and monitoring AI biases (M = 4.23–4.59, SD = 0.72–0.89). Lower-rated areas (M = 3.68–4.23, SD = 0.80–0.99) show room for improvement in disclosure, authorship attribution, discussing ethics with collaborators, and following institutional policies. Overall, participants demonstrate generally strong ethical AI use. Enhancing transparency, authorship practices, and open discussion can further strengthen responsible, accountable, and academically grounded AI utilization (Barari et al., 2025; Bittle & El-Gayar, 2025).

3.2.4 Summary Results of the Participants' AI Utilization

The result summarizes participants' AI utilization across Functional Application, Critical Evaluation, and Ethical Use, with an overall mean of M = 4.09 (SD = 0.49), interpreted as High. This indicates generally positive AI engagement, reflecting practical use alongside evaluation and ethical awareness. The findings show participants possess foundational competencies in critical evaluation and responsible use, verifying outputs, maintaining academic integrity, and considering ethical implications (Öner, 2025; Khalifa & Albadawy, 2024). However, variability in Functional Application suggests that consistent, purposeful use of AI in academic tasks could be further strengthened to maximize efficiency and learning outcomes. Overall, the results depict a developing yet promising profile of AI utilization, combining responsible, reflective, and practical practices, with room for growth in applying AI more systematically for academic productivity.

3.3 What is the level of the participants' metacognitive practices in terms of:

3.3.1 Planning

The result presents participants' planning practices in writing, with a mean of M = 4.46 (SD = 0.50), interpreted as High. Most participants rated planning as Very High (52.27%) or High (41.48%), reflecting consistent engagement in pre-writing activities such as organizing ideas, identifying purpose, and preparing resources. Low variability (SD = 0.50) indicates strong agreement on the importance of planning. Top-rated indicators highlight strengths in determining necessary knowledge, structuring ideas, aligning content with audience and purpose, and visualizing text structure (M = 4.48–4.69, SD = 0.55–0.73). Lower-rated areas (M = 4.28–4.48, SD = 0.71–0.94) suggest room for improvement in checklist use, goal-setting, time allocation, and outlining. Overall, participants demonstrate strong planning practices that support organized, purposeful writing. Enhancing structured, goal-driven strategies can further strengthen self-regulation, coherence, and overall writing quality (Teng & Zhan, 2023; Fernandez & Guilbert, 2024).

3.3.2 Monitoring

The result presents participants' self-regulation in writing (Monitoring), with a mean of M = 4.48 (SD = 0.47), interpreted as High. Most participants rated monitoring practices as Very High (51.70%) or High (44.32%), reflecting active engagement in checking, revising, and adjusting work during drafting. Low variability (SD = 0.47) shows strong agreement on these strategies. Top-rated indicators highlight strengths in revising for clarity, developing ideas, following planned structure, adjusting detail, and monitoring vocabulary and grammar (M = 4.56–4.69, SD = 0.56–0.70). Lower-rated areas (M = 4.13–4.47, SD = 0.68–0.94) suggest room for improvement in time management, peer feedback, focus, and environmental control. Overall, participants demonstrate strong monitoring practices, showing effective self-regulation in content, structure, and language. Enhancing behavioral strategies such as time management, peer collaboration, and focus can further support balanced, efficient, and higher-quality writing performance (Shi et al., 2025; Jin et al., 2025; Qi, 2025).

3.3.3 Evaluating

The result presents participants' evaluation practices in writing, with a mean of M = 4.54 (SD = 0.47), interpreted as Very High. Most participants rated evaluation as Very High (64.20%) or High (30.11%), reflecting consistent engagement in reviewing and refining content, language, and organization after drafting. Low variability (SD = 0.47) indicates strong agreement on these practices. Top-rated indicators highlight strengths in assessing content clarity, language accuracy, paragraph coherence, overall satisfaction, and critical thinking (M = 4.54–4.65, SD = 0.55–0.67). Lower-rated areas (M = 4.45–4.53, SD = 0.67–0.78) suggest room for improvement in integrating feedback, adhering to structure, evaluating audience understanding, and logical sequencing. Overall, participants demonstrate highly developed evaluation practices, actively refining their work to ensure clarity, coherence, and quality. Strengthening feedback integration and structural alignment can further enhance systematic, audience-aware, and academically rigorous writing (Yang et al., 2023; Wei & Liu, 2024).

3.3.4 Summary Results of the Participants' Metacognitive Practices

The result summarizes participants' metacognitive practices in writing, with an overall mean of M = 4.50 (SD = 0.42), interpreted as High. This indicates strong engagement in planning, monitoring, and evaluating throughout the writing

process, reflecting strategic and reflective control over their performance. Participants actively regulate thinking before, during, and after writing, using planning to organize ideas, monitoring to refine content, and evaluation to ensure clarity and coherence (Shen & Bai, 2024; Wang et al., 2025). Low variability (SD = 0.42) shows consistent application of these practices. While all dimensions are strong, planning is slightly less developed than monitoring and evaluation, suggesting room for enhancing pre-writing strategies. Strengthening planning can further improve organization, efficiency, and overall writing quality, reinforcing effective self-regulated learning and metacognitive strategy use across the writing process.

3.4 What is the participants' level of Academic Writing considering the following:

3.4.1 Content Relevance and Development

The result presents participants' academic writing in terms of content relevance and development, with a mean of M = 3.12 (SD = 0.57), interpreted as Average. This indicates a moderate ability to address topics and present ideas, though elaboration, depth, and clarity are limited. Most participants (72.16%) scored in the Average range, with few achieving Very Good and none reaching Excellent, showing writing that meets basic expectations but lacks advanced analysis and argument development (Yu, 2025; Zahari et al., 2025). Strengths include maintaining topic relevance, presenting understandable ideas, organizing basic supporting details, demonstrating general coherence, and addressing the main focus. Areas for improvement involve deepening explanations, providing stronger supporting details, and developing more sophisticated arguments. Overall, participants demonstrate foundational writing skills, but targeted instructional support is needed to enhance elaboration, critical thinking, and higher-order academic writing competence.

3.4.2 Organization and Coherence

The result presents participants' writing performance in terms of organization and coherence, with a mean of M = 2.58 (SD = 0.72), interpreted as Average. This indicates moderate but weaker ability in structuring ideas, maintaining paragraph unity, and ensuring logical flow, affecting clarity and readability (Taye & Mengesha, 2024; Goshu & Gebremariam, 2024). Most participants (55.11%) scored Average, with 32.39% Fair, 9.09% Poor, and only 3.41% Very Good, showing that difficulties in sequencing ideas, using transitions, and sustaining coherence are common. Some participants demonstrate basic organization skills, presenting ideas in a logical sequence and using minimal transitions, but these skills are not consistently applied. Overall, the findings highlight organization and coherence as key areas for improvement. Focused instruction on structuring ideas, employing transitions, and maintaining logical flow is needed to enhance the clarity, cohesion, and effectiveness of participants' written outputs.

3.4.3 Language Accuracy

The result presents participants' academic writing in terms of language accuracy, with a mean of M = 2.73 (SD = 0.65), interpreted as Average. This indicates moderate control over grammar, mechanics, and vocabulary, reflecting that participants can produce understandable texts but consistency in sentence structure, word choice, and punctuation requires improvement (Du & Nordin, 2025; Wang et al., 2025). Most participants (62.50%) scored Average, 26.70% Fair, 6.82% Poor, and 3.98% Very Good, showing that challenges in grammatical correctness and language use are common. While some demonstrate basic competence in sentence construction and vocabulary, many still struggle with errors that affect clarity, readability, and academic appropriateness. Overall, language accuracy remains an area needing further development. Focused grammar instruction, guided revision, and corrective feedback can help participants produce more accurate, polished, and academically appropriate written outputs, enhancing both clarity and overall writing quality.

3.4.4 Summary Results of the Participants' Level of Academic Writing

The result summarizes participants' overall academic writing, with a mean of M = 2.81 (SD = 0.61), interpreted as Average, indicating moderate performance. While participants can produce acceptable texts, their writing lacks depth, precision, and refinement for higher academic standards (Taye & Mengesha, 2024; Goshu et al., 2025). The consistently Average ratings across content relevance and development, organization and coherence, and language accuracy show foundational competence but highlight ongoing challenges. Organization and coherence are particularly weak, suggesting that participants may generate relevant ideas but struggle to present them logically and cohesively. Overall, the findings indicate that academic writing skills are developing, with a need to strengthen planning, structuring, and clarity. Focused guidance on organizing ideas, using transitions, and maintaining unity can enhance the overall quality, coherence, and academic rigor of participants' written outputs.

3.5 What model best fits participants' academic writing?

Preliminary analyses using canonical correlation and multiple regression showed no significant relationships or predictive effects of TPACK, AI Utilization, or Metacognitive Practices on Academic Writing (Appendix C–E), supporting the need for Structural Equation Modeling (SEM). *Model 1 demonstrated acceptable fit* (Cmin/df = 1.117; CFI = 0.940; RMSEA = 0.039; PCLOSE = 0.781; SRMR = 0.083). *Model 2 improved fit* (Cmin/df = 1.592; CFI = 0.973; RMSEA = 0.058; PCLOSE = 0.273; SRMR = 0.054) and was selected as the best-fitting model, representing relationships among TPACK, AI Utilization, Metacognitive Practices, and Academic Writing. *SEM results* revealed that Metacognitive Practices strongly predicted AI Utilization ($\beta = 0.803$, $p < .001$) and moderately predicted TPACK ($\beta = 0.385$, $p < .001$). In contrast, TPACK

(β = -0.110, p = .433) and AI Utilization (β = -0.090, p = .357) had minimal direct effects on Academic Writing, consistent with earlier analyses. This suggests that technological competence and AI use alone do not substantially improve writing outcomes. These findings highlight Metacognitive Practices as central, supporting both TPACK and AI use, but high levels of these variables alone are insufficient to enhance Academic Writing. The results reflect a gap between perceived competence, tool use, and actual regulated learning, consistent with evidence that self-reported TPACK and frequent AI use may not translate into improved instructional enactment or writing performance (von Kotzebue, 2022; Gao et al., 2025; Zhai et al., 2024). Overall, Model 2 supports a framework in which metacognition mediates the influence of TPACK and AI Utilization on Academic Writing. Effective interventions should combine metacognitive strategies, guided practice, feedback, and technology use to translate these competencies into meaningful improvements. These findings underscore that academic writing development requires integrated, context-sensitive approaches rather than isolated enhancement of technological, AI-related, or metacognitive skills.

4. Conclusion & Recommendations

The study concludes that high teacher TPACK, extensive AI utilization, and strong metacognitive practices do not automatically result in superior academic writing performance among Grade 11 students. While students rated their teachers highly in terms of content, pedagogical, and technological knowledge and reported frequent and responsible AI use, their writing performance remained at an average level, with organization and coherence being the weakest dimension. The structural model highlighted metacognitive practices as the central factor influencing both teacher competence and AI use, emphasizing that active planning, monitoring, and evaluation are critical for transforming available resources and skills into actual writing outcomes. Overall, the findings suggest that academic writing proficiency relies more on deliberate, reflective cognitive engagement than on perceived teacher competence or technology use alone.

Based on these findings, several recommendations are proposed. English teachers are encouraged to provide explicit instruction in organization and coherence, offer targeted feedback on reasoning and flow, scaffold responsible AI use for planning and revision, and integrate metacognitive strategies such as self-monitoring guides and reflection logs. School administrators may support professional development in writing instruction, establish clear policies for ethical AI use, and provide resources that enhance writing skills beyond surface-level corrections. Students are advised to practice structured planning and outlining, use AI critically and responsibly, and consistently apply metacognitive routines during writing tasks. Future researchers are encouraged to explore additional variables such as prior writing competence, reading comprehension, motivation, and feedback quality, employ mixed-methods designs to better understand gaps between self-reported behavior and performance, and conduct intervention-based studies to test the effectiveness of targeted instruction, structured AI integration, and explicit metacognitive training in improving academic writing.

Despite these contributions, the study has several limitations. The reliance on self-reported measures for TPACK, AI utilization, and metacognitive practices may not fully reflect actual behaviors or skill application. Academic writing performance was assessed through a single short writing output, which limits the generalizability of the findings to other writing tasks. The study was conducted in a single private school in Cagayan de Oro City, which may reduce the external validity of the results. Additionally, factors such as prior writing ability, language proficiency, and classroom dynamics were not controlled, which could have influenced the outcomes. These limitations indicate that the findings should be interpreted cautiously, and future studies should adopt broader and more diverse methodologies to strengthen the understanding of factors influencing academic writing.

Compliance with ethical standards

This study adhered to institutional and academic ethical standards for research involving human participants at Lourdes College, Cagayan de Oro City, in accordance with the National Ethical Guidelines for Research Involving Human Participants (NEGRIHP, 2022) and WHO ethical standards. No experimental procedures were conducted. All respondents participated voluntarily, and confidentiality, anonymity, and responsible data handling were strictly observed.

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Conflict of interest statement

The researcher declares no financial or personal conflicts of interest in the conduct, analysis, or publication of this research. No external entity influenced the study's processes or outcomes.

Statement of ethical approval

The study involved survey-based data collection with prior permission from school authorities. Formal ethics approval was granted by the Lourdes College Research Ethics Committee (LC-REC Code 20252026103-103-RAS) through expedited review. As the research posed minimal risk, all procedures complied with accepted ethical guidelines for social science research.

Statement of informed consent

Informed consent was obtained from all respondents. Participants were fully informed about the study's purpose, voluntary nature, confidentiality measures, and their right to withdraw at any time. No personal identifiers were included in the final report.

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