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The Role of AI Writing Tools in Enhancing Self-Directed Learning in Civil Engineering Education

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Abstract
The integration of artificial intelligence (AI) writing tools in higher education has expanded rapidly, particularly in engineering disciplines, however, their influence on students' self-directed learning remains underexplored in developing country contexts. This study investigated the role of AI writing tools as catalysts for self-directed learning in civil engineering education, focusing on the perceptions and usage practices of students and faculty at the Polytechnic University of the Philippines. A descriptive–quantitative research design was employed using an online survey administered to 105 fourth-year civil engineering students enrolled in a thesis course and 15 full-time faculty members. The findings indicate that AI writing tools are widely adopted and frequently used for academic writing tasks such as brainstorming, outlining, drafting, and revision. Students reported learning-oriented motivations for AI use, including writing skill development, understanding feedback, and knowledge acquisition. Evidence of self-directed learning behaviors was observed, particularly in learning monitoring, reflective evaluation, and application of acquired knowledge. However, the results also revealed inconsistent application of self-regulated learning strategies, especially in goal setting, time management, and distraction control. Faculty members generally perceived AI writing tools as having a positive impact on academic writing, although a statistically significant difference was found between student and faculty perceptions. The study concludes that AI writing tools can support self-directed learning in civil engineering education when integrated through structured pedagogical frameworks. The findings emphasize the need for AI literacy, ethical guidelines, and instructional strategies that position AI tools as learning supports rather than substitutes for cognitive engagement.

Keyword: *Artificial Intelligence, Civil Engineering, Engineering Education, Self-directed learning, Writing*

I. INTRODUCTION

The rapid advancement of artificial intelligence (AI) has significantly transformed contemporary higher education, particularly through the emergence of AI-powered writing tools that support content generation, feedback provision, and academic scaffolding. These technologies, driven by natural language processing and machine learning, are increasingly integrated into teaching and learning environments, reshaping how students engage with knowledge and regulate their own learning processes. Within engineering education, where analytical reasoning, technical communication, and lifelong learning are essential competencies, AI writing tools present new opportunities to foster self-directed learning (SDL) and learner autonomy.

Self-directed learning is widely recognized as a critical educational outcome in engineering programs, enabling students to diagnose their learning needs, set goals, identify resources, implement strategies, and evaluate outcomes independently. As engineering practice continues to evolve alongside digital and intelligent systems, the capacity of future engineers to learn autonomously has become indispensable. AI writing tools, when used as learning aids rather than mere productivity shortcuts, can function as cognitive partners that support reflection, iterative learning, and metacognitive development. Understanding their pedagogical role is therefore crucial, particularly in disciplines such as civil engineering that demand both technical rigor and effective professional communication.

This study directly addresses several United Nations Sustainable Development Goals (UN SDGs), most notably SDG 4: Quality Education, which emphasizes inclusive, equitable, and quality education while promoting lifelong learning opportunities for all United Nations. (2015). By examining how AI writing tools influence self-directed learning among civil engineering students, the study contributes to efforts aimed at enhancing learning quality through educational technologies. Furthermore, the research aligns with SDG 9: Industry, Innovation, and Infrastructure, as it supports the integration of innovative digital tools in engineering education to prepare learners for technologically advanced professional environments. The promotion of digitally competent, autonomous engineering graduates also indirectly supports SDG 8: Decent Work and Economic Growth, as such competencies are increasingly demanded in the global labor market.

In the Philippine higher education context, the adoption of AI technologies has accelerated in recent years, particularly following the shift to flexible and technology-mediated learning modalities. Universities have begun integrating AI-supported platforms for learning management, assessment, and academic writing, although implementation levels vary widely across institutions. Public universities, such as the Polytechnic University of the Philippines (PUP), have increasingly explored digital tools to support student learning amid resource constraints and large class sizes, especially in engineering programs.

Within engineering education, AI applications in the Philippines are commonly observed in areas such as computer-aided design, simulation software, automated assessment, and, more recently, AI-assisted writing and feedback tools. These tools are used to support technical report writing, project documentation, research proposals, and reflective learning tasks. However, despite growing experimentation, empirical research examining how AI writing tools influence learning behaviors, particularly self-directed learning, remains limited in the local context. Faculty perceptions, ethical considerations, and pedagogical strategies for integrating AI meaningfully into engineering curricula are still emerging areas of inquiry.

Internationally, a growing body of Scopus-indexed research has explored the educational implications of AI-based writing and feedback systems. Studies published in leading journals such as *Computers & Education*, *Educational Technology & Society*, and *IEEE Transactions on Education* suggest that AI-supported writing tools can enhance students' motivation, metacognitive awareness, and self-regulation when integrated with appropriate instructional design [2-3]. AI-driven feedback systems have been shown to support iterative learning cycles by providing timely, personalized responses that encourage students to revise and reflect on their work Shibani, A., Knight, S., & Buckingham Shum, S. (2019).

In engineering education, prior research indicates that AI-assisted tools can improve technical communication skills and support independent problem-solving, particularly in project-based and inquiry-based learning environments Ullmann, T. D., De Liddo, A., & Bachler, M. (2022). However, scholars also caution that without clear pedagogical framing, AI tools may undermine deep learning or promote overreliance Kasneci, G., E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., … (2023). These findings highlight the importance of examining AI not merely as a technological artifact but as a pedagogical intervention that interacts with learners' self-directed learning capacities.

Despite the expanding global literature, there remains a notable gap in context-specific studies focusing on AI writing tools within civil engineering education, particularly in developing country contexts such as the Philippines. Engineering education research has long emphasized the need to cultivate autonomous, reflective learners capable of adapting to complex and evolving professional challenges. Investigating how AI writing tools function as catalysts for self-directed learning can provide critical insights into how these technologies may be leveraged to enhance learning outcomes while addressing ethical, instructional, and cultural considerations.

This study focuses on civil engineering students and faculty at the Polytechnic University of the Philippines, aiming to examine perceptions, usage patterns, and the influence of AI writing tools on students' self-directed learning practices. By grounding the analysis in both student and faculty perspectives, the research contributes to evidence-based recommendations for integrating AI technologies into engineering curricula in ways that support autonomy, academic integrity, and sustainable educational innovation. The study seeks to inform engineering educators, policymakers, and educational technologists on how AI writing tools can be aligned with the broader goals of quality education and sustainable development.

II. METHODS

A. Data Gathering and Analysis

A descriptive–quantitative research design was adopted to examine the use of AI writing tools in civil engineering education. Data were collected through a structured online survey administered to fourth-year Civil Engineering students enrolled in the Thesis 1 (CEPROJECT1) course and to full-time faculty members of the Civil Engineering Department at the Polytechnic University of the Philippines.

The survey instrument was distributed using Google Forms and remained open for responses from October to December 2025. Participation was restricted to respondents who accessed, completed, and submitted the survey during the data collection period. Only complete responses were retained for analysis, while incomplete or duplicate submissions were excluded from the final dataset to ensure data integrity.

B. The respondents and sampling

The study comprised a total of 120 respondents, including 105 fourth-year Civil Engineering students and 15 full-time faculty members. A complete enumeration approach was applied to the faculty population, whereby all full-time faculty members of the Civil Engineering Department were invited to participate. In contrast, student participants were selected using a convenience sampling approach, limited to fourth-year Civil Engineering students enrolled in the *Thesis 1* course who voluntarily responded to the survey. The survey instrument was administered using Google Forms, and the survey link was disseminated through institutional email channels and official social media platforms to facilitate access. Data collection was conducted over a one-month period. Only fully completed and voluntarily submitted responses were included in the final dataset for analysis.

C. The Research Instrument

A survey questionnaire was deployed to the respondents which was patterned from the study of Wang et. al. (2024). Minor modifications were made to fit with the purpose of the current study. The questionnaire was divided into five (5) parts, the profile of the respondents, AI Tools Used in Academic Writing, Frequency of Usage of AI in Academic Writing, AI tools Used for Academic Writing and Respondents' Perception on the Use of AI in Academic Writing Wang, C., Li, Z., Bonk, C., (2024).

D. Statistical Treatment of Data

One-way Analysis of Variance (ANOVA) was utilized to determine the significant difference on the responses of the student respondents and the faculty members. The Respondents' perception on the Impact of AI Tools on Academic Writing is the variable being analyzed.

III. RESULTS AND DISCUSSION

A. Respondents' Profile

Table 1 presents the demographic and academic profile of the respondents, disaggregated by student and faculty groups. A total of 120 respondents participated in the study, consisting of 105 fourth-year Civil Engineering students and fifteen full-time faculty members.

In terms of sex distribution, the student respondents comprised 50 males (48%) and 55 females (52%), indicating a balanced gender representation with a slight predominance of female students. In contrast, the faculty respondents were male, with twelve males (80%) and three females (20%). This distribution reflects the existing gender composition commonly observed in engineering faculty populations, particularly within civil engineering departments.

Overall, the respondent profile demonstrates adequate variation in terms of sex and academic specialization among students, as well as full coverage of the faculty population. This diversity supports the relevance of the dataset for examining the use of AI writing tools and their influence on self-directed learning.

Table 1. Respondent's Profile

Sex	Students		Faculty	
	Number	Percentage (%)	Number	Percentage (%)
Male	50	48%	12	80
Female	55	52%	3	20
Total	**105**	**100%**	**15**	**100**

B. AI Tools Used in Academic Writing

Table 2 presents the distribution of AI writing tools utilized by fourth-year Civil Engineering students for academic writing tasks. Among the 105 student respondents, ChatGPT emerged as the most frequently used AI tool, with 41 respondents indicating its use. This was followed by Google Gemini, reported by 24 respondents, and QuillBot, used by 19 respondents. Grammarly was utilized by fifteen respondents, while Microsoft Copilot recorded the lowest usage, with six respondents.

The distribution indicates a clear preference for large language model–based tools that support content generation and idea development, as reflected by the higher usage of ChatGPT and Google Gemini. Tools primarily designed for grammar checking and paraphrasing, such as Grammarly and QuillBot, exhibited moderate usage, while integrated productivity-based AI systems, such as Microsoft Copilot, showed limited adoption among the respondents.

The predominance of generative AI tools suggests a shift in students' academic writing practices toward platforms that provide comprehensive assistance, including drafting, restructuring, and conceptual clarification. This trend highlights the growing reliance on AI as a cognitive support mechanism rather than solely as a surface-level editing aid. In the context of civil engineering education, such tools may facilitate improved articulation of technical concepts, enhance drafting efficiency, and support iterative learning during research-intensive courses such as thesis writing.

However, the uneven distribution of tool usage also underscores the need for structured guidance on the pedagogically appropriate use of AI writing technologies. The limited adoption of certain tools may reflect varying levels of awareness, accessibility, or perceived relevance to engineering-specific writing tasks. These findings imply that institutions and faculty should consider integrating AI literacy components into engineering curricula to ensure that students can critically and ethically leverage AI tools in support of self-directed learning outcomes.

Overall, the results indicate that AI writing tools are already embedded in students' academic workflows. This underscores the importance of developing instructional policies and assessment strategies that acknowledge AI use while promoting academic integrity, metacognitive engagement, and independent learning in engineering education.

Table 2. AI Tools Used by Students in Academic Writing

Which AI tools do you use for academic writing?	Students	Percentage (%)
1. CHATGPT	41	39%
2. Google Gemini	24	23%
3. Grammarly	15	15%
4. Quillbot	19	18%
5. Microsoft Copilot	6	6%
TOTAL	**105**	**100%**

C. Frequency of Usage of AI in Academic Writing

Table 3 presents the frequency with which fourth-year Civil Engineering students utilize AI tools in academic writing activities. Among the 105 respondents, 44 students (42%) reported using AI tools on a weekly basis, representing the largest proportion of users. Daily usage was reported by 39 students (37%), indicating a substantial level of regular engagement with AI writing technologies. In contrast, fifteen students (14%) indicated rare usage, while only seven students (7%) reported monthly use.

The distribution demonstrates that most students (79%) engage with AI writing tools either daily or weekly, suggesting that AI-assisted writing has become a routine component of academic work rather than an occasional or supplementary practice. The relatively smaller proportion of infrequent users indicates that non-adoption or minimal reliance on AI tools is limited within the sampled population.

The high frequency of AI tool usage implies that AI writing technologies are deeply embedded in students' academic writing processes, particularly in research-intensive tasks common in senior-level engineering courses. Regular engagement with AI tools may support self-directed learning by enabling students to independently refine ideas, seek clarification, and iteratively improve written output without immediate instructor intervention.

However, the prevalence of frequent usage also raises important pedagogical considerations. Without explicit instructional frameworks, high reliance on AI tools may lead to superficial engagement or reduced development of independent writing and critical thinking skills. These findings highlight the need for clear institutional and instructional guidelines that position AI tools as supportive learning aids rather than substitutes for cognitive effort.

For engineering education, the results suggest an opportunity to integrate AI-assisted writing into structured learning activities that promote reflection, revision, and metacognitive awareness. Aligning AI usage with learning outcomes related to technical communication and self-regulation can help maximize educational benefits while mitigating potential risks associated with overdependence and academic integrity concerns.

- **How often do you observe signs that students may be using AI tools in their writing?**

The table presents faculty responses regarding the frequency with which signs of AI tool usage are observed in students' academic writing. Among the fifteen faculty respondents, six faculty members (40%) indicated that such signs are observed *very often*, while another six respondents (40%) reported observing these signs *often*. The remaining three faculty members (20%) reported observing indications of AI tool usage *sometimes*.

The distribution suggests that a substantial majority of faculty members (80%) frequently observe indicators that students may be using AI tools in their writing. This pattern indicates that AI-assisted writing practices are highly visible within the academic outputs of civil engineering students, particularly in writing-intensive tasks. The consistent observation of AI-related indicators across faculty respondents implies that the use of AI tools has become a common and recognizable feature of student writing.

The results highlight an opportunity to reposition AI tools as transparent learning support rather than covert aids. Integrating explicit instruction on ethical AI use, citation of AI assistance, and reflective engagement with AI-generated content may help align student practices with learning objectives while mitigating concerns related to misuse. In this context, faculty observations serve as critical input for shaping responsive and sustainable approaches to AI integration in civil engineering education.

Table 3. Frequency of Usage of AI in Academic Writing

Frequency of using AI in Academic Writing	Students	Percentage (%)
Daily	39	37%
Weekly	44	42%
Monthly	7	7%
Rarely	15	14%
TOTAL	**105**	**100%**
How often do you observe signs that students may be using AI tools in their writing?	**Faculty**	**Percentage (%)**
Very Often	6	40%

Often	6	40%
Sometimes	3	20%
TOTAL	15	**100%**

Respondents' Perception on the Use of AI in Academic Writing

Table 4 presents the perception of the respondents on the Use of AI in Academic Writing

A. For which writing tasks do you use AI tools?

Table 4 presents the distribution of writing-related tasks for which students utilize AI tools in academic writing. Among the identified tasks, the most frequently reported use of AI tools was for brainstorming ideas, cited by 18 students (17%). This indicates that AI tools are primarily employed during the initial stages of the writing process to support idea generation and conceptual development.

The use of AI tools to assist in creating an outline was reported by fifteen students (14%), suggesting that AI systems are also utilized to support structural planning. Several tasks exhibited comparable usage rates, including turning ideas into clear sentences, improving wording, grammar, or sentence structure, and organizing or improving overall writing structure, each reported by thirteen students (12%). These findings indicate consistent use of AI tools across multiple stages of drafting and revision.

Additional reported uses include checking sentence coherence and developing or improving content, each cited by 12 (11%) and eleven students (11%), respectively. The least frequently reported task involved using AI tools to check whether writing aligns with stated goals or instructions, reported by eleven students (10%). Overall, the distribution demonstrates that AI tools are employed across a wide range of writing activities, from ideation to refinement and self-evaluation.

The results suggest that AI tools function as multipurpose academic writing aids rather than being confined to a single stage of the writing process. Their predominant use for brainstorming and outlining indicates that students rely on AI to support cognitive scaffolding during the initial phases of writing, which may facilitate self-directed learning by enabling independent exploration of ideas and organizational strategies.

B. What motivates you to use AI tools in writing?

Table 4 presents the distribution of student-reported motivations for using AI tools in academic writing. Among the identified motivational factors, the most frequently reported reason was the desire to understand the rationale behind the suggestions or feedback provided by AI tools, cited by 27 students (25%). This indicates that AI tools are perceived not only as writing aids but also as explanatory resources that support deeper understanding of writing conventions and improvement strategies.

The need to develop writing skills using AI tools was reported by 22 students (21%), followed closely by enjoyment in learning new writing-related information through AI tools, reported by 21 students (20%). These findings suggest that intrinsic learning-oriented motivations play a significant role in AI tool adoption among students. The motivation to learn writing with AI tools was cited by 19 students (18%), further reinforcing the role of AI as a perceived learning facilitator.

The least frequently reported motivation involved sharing experiences related to AI-assisted writing with others, reported by 16 students (15%). While still notable, this suggests that collaborative or social motivations are less prominent than individual learning and skill-development factors in driving AI tool usage.

The results indicate that students' motivations for using AI tools in academic writing are primarily aligned with learning enhancement rather than convenience or productivity alone. The emphasis on understanding AI-generated feedback and improving writing skills suggests that AI tools are functioning as cognitive and metacognitive supports that facilitate self-directed learning processes.

C. How do you manage your writing process when using AI tools?

Table 4 presents the distribution of self-regulated writing behaviors exhibited by students when using AI tools for academic writing. The most frequently reported behavior involved following a personal writing or study plan while using AI tools, cited by thirteen students (12%). This suggests that a subset of students integrates AI tools within pre-established writing strategies rather than relying on them in an unstructured manner.

Several behaviors were reported at comparable frequencies, including seeking help when encountering writing problems and taking responsibility for writing-related learning, each reported by eleven students (11%). The use of different strategies to enhance the usefulness of AI tools was reported by eleven students (10%), indicating adaptive engagement with AI technologies. Reviewing AI-generated writing suggestions based on individual needs and staying organized during AI-assisted writing were each reported by ten students (9%).

Lower frequencies were observed for behaviors associated with time management and goal setting. Managing time effectively and setting writing goals while using AI tools were each reported by nine students (8%). The ability to guide one's own writing progress was also reported by nine students (9%), while expectations of impressive performance when using AI tools were reported by eight students (7%). The least frequently reported behavior involved avoiding distractions from other applications while using AI tools, cited by five students (5%).

Overall, the distribution indicates varied levels of self-regulated learning behaviors among students when engaging with AI-assisted writing, with greater emphasis on planning and responsibility-taking than on goal setting, time management, and distraction control.

The findings suggest that while students demonstrate some degree of self-directed management in AI-assisted writing, key components of self-regulated learning are not consistently applied. The emphasis on following personal plans and taking responsibility indicates foundational self-directed behaviors; however, the lower prevalence of goal setting, time management, and distraction avoidance suggests areas where instructional support may be necessary.

D. How do you monitor your learning when using AI tools?

The table presents the distribution of student-reported learning monitoring behaviors when using AI tools for academic writing. The most frequently reported behavior involved carefully evaluating latest ideas suggested by AI tools, cited by thirty-nine students (37%). This indicates that a substantial proportion of students actively engage in critical appraisal of AI-generated content rather than accepting suggestions without scrutiny.

The practice of asking follow-up questions to gain a clearer understanding of writing concepts was reported by 36 students (35%). This finding suggests that students frequently use AI tools interactively to clarify uncertainties and deepen their understanding of writing-related knowledge. The ability to apply writing knowledge learned from AI tools to academic or practical tasks was reported by 29 students (28%), indicating a transfer of learning beyond immediate writing tasks.

Overall, the distribution demonstrates that students engage in multiple learning-monitoring behaviors when using AI tools, with emphasis on evaluation, inquiry, and application of knowledge.

The findings suggest that AI tools support key aspects of self-directed learning by facilitating active monitoring of understanding and learning progress. The high frequency of evaluative and inquiry-based behaviors indicates that students are not merely passive recipients of AI-generated content but are engaging in reflective and interactive learning processes.

Table 4. Perception on the Use of AI in Academic Writing

Perception on the Use of AI in Academic Writing	**Students**	
	No.	**Percentage**
A. For which writing tasks do you use AI tools?		
1. I use AI tools to brainstorm ideas	18	17%
2. I use AI tools to help me make an outline	15	14%
3. I use AI tools to turn my ideas into clear sentences.	13	12%
4. I use AI tools to improve wording, grammar, or sentence structure.	13	12%
5. I use AI tools to check if my sentences connect well.	12	11%
6. I use AI tools to organize or improve the structure of my writing.	13	12%
7. I use AI tools to develop or improve the content of my writing.	11	11%
8. I use AI tools to check if my writing fits my goals or the instructions.	11	10%
TOTAL	**105**	**100%**
B. What motivates you to use AI tools in writing?	**No.**	**Percentage**
1. I feel motivated to learn writing with AI tools.	19	18%
2. I feel a need to learn writing skills using AI tools.	22	21%
3. I enjoy learning new writing information through AI tools.	21	20%
4. I want to understand the reasons behind the suggestions or feedback AI	27	25%

tools give.		
5. I like sharing my experiences using AI tools for writing with others.	16	15%
TOTAL	**105**	**100%**
C. How do you manage your writing process when using AI tools?	**No.**	**Percentage**
1. I follow my own writing or study plan while using AI tools.	13	12%
2. I look for help when I encounter writing problems.	11	11%
3. I manage my time well when using AI tools.	9	8%
4. I set writing goals when using AI tools.	9	8%
5. I expect myself to perform well when writing with the help of AI tools.	8	7%
6. I use different strategies to make AI tools more helpful for my writing.	11	10%
7. I stay organized while learning writing through AI tools.	10	9%
8. I can guide my own writing progress even when using AI tools.	9	9%
9. I avoid distractions from other apps while using AI tools.	5	5%
10. I review the writing suggestions from AI tools based on my needs.	10	9%
11. I take responsibility for my writing learning while using AI tools.	11	11%
TOTAL	**105**	**100%**
D. How do you monitor your learning when using AI tools?	**No.**	**Percentage**
1. I carefully evaluate the new ideas that AI tools suggest.	39	37%
2. I ask follow-up questions to understand writing better.	36	35%
3. I can apply the writing knowledge I learn from AI tools to real tasks in school or life.	29	28%
TOTAL	**105**	**100%**

Perceived Impact of AI Tools on Writing Skills

Table 5 presents the perceptions of both students and faculty regarding the impact of AI tools on academic writing. The findings indicate an overall positive evaluation from both respondent groups, as reflected in their respective weighted mean scores and corresponding interpretations.

For the item assessing the overall impact of AI tools on academic writing, student respondents reported a weighted mean of 4.27, interpreted as a *Positive Impact*. Faculty respondents likewise rated the impact positively, with a weighted mean of 4.10. These results suggest a shared recognition across both groups of the beneficial role of AI tools in supporting academic writing tasks.

With respect to writing skill improvement, students reported a weighted mean of 4.17, corresponding to an *Agree* interpretation, while faculty respondents recorded a slightly lower weighted mean of 4.00, also interpreted as *Agree*. This indicates convergence in perceptions that AI tools contribute to the enhancement of writing skills, albeit with faculty demonstrating a more conservative evaluation.

Similarly, perceptions regarding the usefulness of AI tools for writing yielded a weighted mean of 4.43 among students and 3.80 among faculty, both interpreted as *Agree*. The higher student rating suggests stronger perceived utility at the learner level, while the comparatively lower faculty rating may reflect pedagogical caution or concerns related to appropriate use.

The computed grand mean further reinforces these findings. Students registered a grand mean of 4.29, interpreted as *Positive Impact*, while faculty respondents obtained a grand mean of 3.97, likewise interpreted as *Positive Impact*. Collectively, these results indicate a consensus that AI tools exert a favorable influence on academic writing, with students expressing a more pronounced positive perception than faculty members.

Overall, the findings demonstrate alignment between student and faculty perceptions regarding the constructive role of AI tools in academic writing, while also highlighting nuanced differences in the intensity of perceived impact. These differences underscore the importance of guided integration of AI tools in academic contexts to balance perceived benefits with instructional oversight.

Table 5. Perception on the Impact of AI Tools on Academic Writing

Perception on the Impact of AI Tools on Academic Writing	**Students**		**Faculty**	
	Weighted Mean	**Interpretation**	**Weighted Mean**	**Interpretation**
Overall, how would you rate the impact of AI tools on your writing?	4.27	Positive Impact	4.10	Positive Impact
AI tools have improved my writing skills.	4.17	Agree	4.00	Agree
AI tools are helpful for writing.	4.43	Agree	3.80	Agree
GRAND MEAN	**4.29**	**Positive Impact**	**3.97**	**Positive Impact**

Analysis of Variance Result

Table 6 presents the results of the one-way analysis of variance (ANOVA) conducted to determine whether a statistically significant difference exists between the perceptions of students and faculty members regarding the impact of AI tools on academic writing.

The ANOVA results indicate that the computed F-value of 7.738 exceeds the critical F-value of 7.709 at the 0.05 level of significance. In addition, the obtained p-value of 0.050 meets the threshold for statistical significance. These results suggest that there is a statistically significant difference between the perceptions of students and faculty members regarding the impact of AI tools on academic writing.

The between-groups sum of squares (SS = 0.157) reflects the variability attributable to differences between the two respondent groups, while the within-groups sum of squares (SS = 0.081) represents variability within each group. The higher between-groups mean square (MS = 0.157) compared to the within-groups mean square (MS = 0.020) further supports the presence of a measurable difference in perception levels.

Overall, the findings indicate that although both students and faculty members perceive AI tools as having a positive impact on academic writing, the degree of perceived impact differs significantly between the two groups. This result underscores the importance of considering both learner and instructor perspectives when designing policies, guidelines, and instructional strategies for the integration of AI writing tools in engineering education.

Table 6. ANOVA Result on the Impact of AI Tools on Academic Writing

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.157	1	0.157	7.738	0.050	7.709
Within Groups	0.081	4	0.020			
Total	0.238	5				

IV. CONCLUSIONS

This study examined the role of AI writing tools as catalysts for self-directed learning in civil engineering education, drawing on the perceptions and experiences of fourth-year civil engineering students and faculty members at the Polytechnic University of the Philippines. The findings indicate that AI writing tools are already deeply embedded in students' academic writing practices and are predominantly used for idea generation, organization, drafting, and revision tasks. The high frequency of AI usage, particularly in research-intensive courses, reflects the normalization of AI-assisted writing within contemporary engineering education.

The results further demonstrate that students' engagement with AI writing tools is largely driven by learning-oriented motivations, including the desire to understand feedback, improve writing skills, and acquire new knowledge. Students exhibited multiple self-directed learning behaviors when using AI tools, particularly in monitoring their learning through evaluation of AI-generated ideas, asking follow-up questions, and applying acquired knowledge to real academic tasks. These behaviors suggest that AI writing tools function not merely as productivity aids but as cognitive and metacognitive supports that facilitate independent learning.

However, the findings also reveal uneven application of self-regulated learning strategies. While planning, responsibility-taking, and reflective monitoring were evident, lower levels of goal setting, time management, and distraction control indicate areas where self-directed learning remains underdeveloped. This suggests that the effectiveness of AI writing tools as learning catalysts is contingent upon the presence of explicit instructional guidance and structured pedagogical integration.

Faculty perceptions corroborated the overall positive impact of AI tools on academic writing, although statistical analysis revealed a significant difference between student and faculty perceptions. While both groups acknowledged the benefits of AI-assisted writing, faculty members demonstrated a more cautious stance, likely reflecting concerns related to overreliance, academic integrity, and pedagogical alignment. The frequent observation of AI use by faculty further underscores the visibility and pervasiveness of AI tools in student writing outputs.

Taken collectively, the findings suggest that AI writing tools have substantial potential to support self-directed learning in civil engineering education when positioned as transparent, guided, and ethically framed learning supports. From a broader perspective, the study contributes to the advancement of SDG 4 (Quality Education) by highlighting how AI-enhanced learning environments can promote learner autonomy and lifelong learning skills. It also supports SDG 9 (Industry, Innovation, and Infrastructure) by emphasizing the preparation of future engineers who can navigate AI-integrated professional contexts.

The general implication of this study is that engineering education institutions should move beyond restrictive or purely compliance-based responses to AI adoption and instead develop pedagogically grounded frameworks that integrate AI literacy, self-directed learning strategies, and ethical guidelines into the curriculum. By doing so, AI writing tools can be leveraged not as substitutes for learning, but as catalysts that enhance reflective practice, technical communication, and autonomous learning among future civil engineers.

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