MERGING AI INSIGHTS WITH RUBRIC PRECISION IN TECHNICAL WRITING

Cheryl S. Ranoco[1]

[1] *Student, Graduate School, North Eastern Mindanao State University*

ABSTRACT

This compelling study investigates the remarkable synergy of structured rubrics and AI-generated feedback, particularly from ChatGPT, in significantly boosting the technical writing capabilities of fourth-year Civil Engineering students at North Eastern Mindanao State University–Bislig Campus. Utilizing a descriptive-correlational design, this groundbreaking research delves into how these innovative feedback mechanisms influence crucial aspects of technical writing: clarity, organization, grammar adherence, fluency, and critical thinking. This study rigorously assesses the impact of rubric-guided peer assessment and AI-generated insights in enhancing student performance. A remarkable cohort of 60 students participated, split into two dynamic groups—one receiving invaluable peer feedback via structured rubrics and the other benefiting from ChatGPT-generated insights. Data was meticulously gathered through pre-tests, post-tests, rubrics, and surveys, and analyzed using robust statistical tools, including ANCOVA and descriptive statistics. Results demonstrated that students who engaged with both structured rubrics and AI feedback experienced remarkable enhancements in their technical writing abilities, with the AI-feedback group showcasing exceptionally high improvements in clarity, grammar, and fluency. Nevertheless, the successful utilization of this feedback was largely contingent on students' capacity to interpret and implement the suggestions. The findings strongly advocate incorporating rubrics and AI-driven feedback systems in technical writing education. The study emphasizes the transformative potential of AI in enriching traditional feedback methods and proposes effective instructional strategies that empower educators to elevate writing instruction for engineering students. It concludes by recommending targeted interventions aimed at further amplifying writing instruction through a blended feedback approach.

Keyword: *Technical Writing, Structured Rubric, AI-Generated Feedback, Peer feedback, Clarity, Precision*

1. INTRODUCTION

Technical writing is a fundamental skill in engineering education, equipping students with the ability to communicate complex concepts clearly and precisely. As engineers are expected to produce technical reports, proposals, and documentation that adhere to professional standards, mastering technical writing is essential for both academic success and professional readiness. However, engineering students often face challenges in developing strong writing skills, as technical writing requires not only subject-matter expertise but also clarity, organization, grammatical accuracy, fluency, and critical thinking. This study explores the contribution of structured rubrics and AI-generated feedback—specifically ChatGPT—in enhancing the technical writing skills of civil engineering students at North Eastern Mindanao State University–Bislig Campus. It examines how these feedback mechanisms influence key aspects of writing proficiency and investigates their relationship in fostering students' ability to produce well-structured and technically accurate written outputs.

Previous studies have highlighted the role of feedback in improving writing proficiency. Liu and Carless (2006) emphasize the benefits of peer feedback in fostering critical thinking and collaboration, allowing students to reflect on their strengths and weaknesses while improving their writing through revision. Banihashem et al. (2024) also advocate for peer feedback as a complementary approach to instructor-led assessment, enhancing student engagement and accountability in the writing process. Meanwhile, Cantera et al. (2021) explored rubric-based assessment in evaluating engineering students' writing, showing its effectiveness in structuring performance expectations and guiding student improvement. In the evolving landscape of education, AI-generated feedback has emerged as a promising tool for providing personalized, real-time suggestions to refine writing skills (Yagelski,

2018). AI tools like ChatGPT have been recognized for their potential to support language learning by offering immediate corrections, enhancing coherence, and guiding students in revisions. However, while both structured rubrics and AI-generated feedback have been individually studied, their combined impact on technical writing proficiency—especially in engineering education—remains underexplored.

Despite the growing research on feedback mechanisms in writing instruction, limited studies have compared the effectiveness of structured rubrics and AI-generated feedback in technical writing, particularly among engineering students. Existing literature primarily focuses on general writing skills or traditional instructional feedback, leaving a gap in understanding how AI tools and rubrics interact to support students in refining their technical writing. Additionally, engineering students in institutions like NEMSU-Bislig Campus face challenges in producing well-structured, professional-quality technical documents, often receiving inconsistent or minimal feedback. This study addresses these gaps by analyzing how AI-generated feedback and rubric-guided assessment contribute to students' writing development, how students integrate AI feedback into revisions, and whether a structured rubric enhances the effectiveness of AI-generated feedback in technical writing.

The findings of this study hold both theoretical and practical significance. By comparing AI-generated and rubric-guided feedback, the study provides insights into optimizing feedback mechanisms in technical writing instruction, which can guide educators in integrating these tools effectively. The research also contributes to the ongoing discourse on AI in education, particularly in developing adaptive feedback strategies for language learning in technical fields. Practically, the study can benefit engineering instructors by streamlining the writing assessment process, reducing workload, and ensuring consistent, high-quality feedback. For students, improved technical writing proficiency can enhance their academic performance and better prepare them for professional communication in the global workforce. Ultimately, this research supports the goal of developing engineers who not only excel in technical expertise but also possess strong writing and communication skills essential for their careers.

1.1 Theoretical Framework

This research endeavors to examine the influence of the integration of structured, rubric-based peer feedback alongside AI-generated feedback via ChatGPT, with the objective of augmenting the technical writing competence of engineering students at North Eastern Mindanao State University–Bislig Campus. Anchored in the principles of Constructivism, the investigation underscores the notion that learning constitutes an active endeavor that is molded through social interactions and experiential contexts (Conrad, 2022; Van Geert, 2017). The facilitation of peer feedback within a constructivist paradigm promotes active learning, thereby empowering students to critically engage with the works of their peers (Bodnar & Kadlowec, 2018). Sociocultural Theory, particularly Vygotsky's notion of the Zone of Proximal Development, corroborates the significance of collaborative learning and scaffolding achieved through systematic peer assessments (Nyikos & Hashimoto, 1997; Bukhari et al., 2021). The Cognitive Process of Writing Theory (Flower & Hayes, 1981) delineates writing as a recursive endeavor that encompasses planning, translating, and reviewing—phases that are augmented by both peer input and AI-generated feedback to enhance clarity, coherence, and intent (Hyland, 2016). The incorporation of Experiential Learning Theory (Kolb, 1984) accentuates the function of AI instruments such as ChatGPT in delivering immediate, reflective educational experiences (Biswas, 2023). Collectively, these theoretical frameworks establish a thorough foundation that substantiates the study's assertion: the amalgamation of peer and AI-assisted feedback within a systematic approach markedly elevates technical writing capabilities. While prior investigations have predominantly scrutinized these theoretical constructs in isolation (Banihashem et al., 2024; Liu & Carless, 2006), this research distinctly synthesizes them to propel advancements in writing pedagogy within engineering education.

1.2 Conceptual Framework

The research posits that the implementation of a structured rubric-guided approach alongside AI-generated feedback, particularly utilizing ChatGPT, will substantially enhance the technical writing capabilities of engineering students enrolled at North Eastern Mindanao State University–Bislig Campus. Acknowledging that students within the civil engineering discipline frequently exhibit deficiencies in their technical writing focus, this investigation accentuates the necessity of mastering this essential skill, given that engineers are anticipated to produce meticulously organized and precise documentation within their professional endeavors. The primary objective of this study is to assess the efficacy of two feedback modalities—structured-rubric peer feedback and AI-generated feedback—in augmenting six critical dimensions of technical writing: clarity, organization, grammar, fluency, critical thinking, and argumentation. The independent variables, namely structured peer feedback and AI-generated feedback, are theoretically informed by Constructivist, Sociocultural, and Cognitive Load theories. Peer feedback

promotes collaboration and critical reflection (Liu & Carless, 2006), whereas AI feedback provides immediate and consistent evaluations, particularly advantageous for rectifying grammatical and structural issues (Sweller, 2011). Each of these feedback mechanisms possesses distinct advantages—peer feedback facilitates enhanced conceptual comprehension, while AI feedback guarantees technical accuracy. The dependent variable is the advancement of technical writing abilities, evaluated through the aforementioned six dimensions, drawing upon theoretical frameworks established by scholars such as Flower and Hayes (1981), Hyland (2016), and Bloom (1956). A significant intervening variable is the students' perceptions of and engagement with the feedback process, as favorable experiences have the potential to elevate motivation and self-regulatory practices (Nicol & Macfarlane-Dick, 2006). Furthermore, the study proposes strategic integration techniques for these feedback mechanisms within writing pedagogy, elucidating how their synergistic application can yield superior learning outcomes. This relationship is graphically depicted in a schematic diagram, demonstrating the interaction between feedback type and student perception, which collectively influence writing performance.

1.3 Objectives of the Study

This study assesses the contribution of a structured rubric and AI-generated feedback, specifically ChatGPT-generated feedback, in enhancing the technical writing skills of engineering students at North Eastern Mindanao State University–Bislig Campus, Bislig City, Surigao del Sur. It aims to describe the influence of these tools on various aspects of writing proficiency and examine the relationships between AI-generated feedback, rubric-guided assessment, and students' ability to produce well-structured, coherent, and technically accurate written outputs.
Specifically, the study seeks to answer the following research questions:

1. How does AI-generated feedback influence various aspects of technical writing, including:
   1.1. Clarity;
   1.2. Organization;
   1.3. Adherence to conventions of grammar;
   1.4. Fluency; and
   1.5. Critical Thinking and Argumentation**?**
2. In what ways do well-structured rubrics classify performance expectations and enhance students' technical writing performance based on the identified indicators?
3. Is there a significant relationship between AI-generated feedback and the effectiveness of well-structured rubrics in improving technical writing performance?
4. Is there a significant relationship between the use of well-structured rubrics and students' ability to integrate AI feedback into their revisions?

2. METHODOLOGY

2.1 Research Design

This study employs a descriptive-correlational research design to examine the role of structured rubric assessment and AI-generated feedback—specifically, ChatGPT-generated feedback—in enhancing the technical writing skills of engineering students at North Eastern Mindanao State University–Bislig Campus. This design is appropriate for investigating both the descriptive aspects of how these feedback mechanisms influence students' writing proficiency and the correlational aspects that determine the relationships among key variables. According to Creswell and Creswell (2017)**,** descriptive-correlational research is particularly useful in educational studies where researchers seek to analyze trends, describe existing conditions, and examine relationships between variables without manipulation or experimental control.

The descriptive component of this research focuses on characterizing the specific effects of AI-generated feedback and rubric-guided assessment on students' writing skills. It examines various dimensions of technical writing proficiency, including clarity, organization, adherence to grammar conventions, fluency, and critical thinking or argumentation. Ary, Jacobs, and Sorensen (2019**)** emphasize that descriptive research is essential for understanding the nature of educational phenomena, allowing researchers to systematically observe and document how students interact with different forms of feedback.
The correlational component of the study seeks to determine the relationships between different variables to understand how AI-generated feedback and rubric-guided assessment interact in improving students' writing

proficiency. Specifically, it examines whether AI-generated feedback significantly enhances students' ability to revise and improve their work and whether structured rubrics effectively guide students toward meeting performance expectations. Pallant (2020) states that correlational studies are essential in educational research for identifying associations between instructional interventions and student performance outcomes.

A descriptive-correlational design is well-suited for this research because it allows for a systematic analysis of naturally occurring phenomena without manipulating variables. Fraenkel, Wallen, and Hyun (2019) argue that in educational research, this design is particularly useful for assessing instructional methods and their effectiveness in real-world classroom settings.

2.2 Research Participants

The participants of this study are fourth-year Bachelor of Science in Civil Engineering (BSCE) students enrolled in the Technical Writing course at North Eastern Mindanao State University (NEMSU) - Bislig Campus during the second semester. These students are selected as the research participants due to their direct engagement with technical writing tasks, making them suitable for examining the effects of structured rubric assessment and AI-generated feedback on their writing proficiency.

A total of 60 students are included in the study, divided into two sections, each exposed to a distinct feedback mechanism. One section receives peer-generated feedback, while the other utilizes AI-generated feedback through ChatGPT. The assignment to each section is determined by their regular class schedules, ensuring that no external factors influence group composition. This setup allows for a comparative analysis of how different feedback mechanisms contribute to writing improvement.

The study employs a complete enumeration method, meaning that all students enrolled in the two sections are included in the research. This approach ensures comprehensive representation, minimizing sampling bias and allowing for a thorough assessment of the impact of both feedback mechanisms. Additionally, to gain deeper insights into students' experiences, a subset of 20 participants (10 from each section) is selected for the qualitative phase of the study, where interviews will be conducted to explore their perceptions, challenges, and engagement with AI-generated and peer-generated feedback.

Table 1. Distribution of Research Participants

Section	Feedback Mechanism	Number of Participants	Number of Interviewees (Qualitative Phase)
Section 1	Peer-generated feedback	30	10
Section 2	AI-generated feedback	30	10
Total		60	20

This participant selection strategy enables a balanced and structured examination of the relationship between AI-generated feedback, rubric-based assessment, and students' writing proficiency. The inclusion of both quantitative and qualitative data ensures a well-rounded analysis of how students interact with feedback tools and how these mechanisms influence their writing development.

2.3 Research Instruments

This study employs three research instruments to ensure a comprehensive evaluation of the effectiveness of peer-generated and AI-generated feedback in enhancing the technical writing skills of engineering students. These instruments include (1) lesson guides tailored for each feedback mechanism, (2) rubrics for evaluating technical writing performance, and (3) a survey questionnaire designed to examine students' behaviors and perceptions regarding their interaction with AI tools in the revision process. This study examines the quantitative approach to gain deeper insights into the impact of different feedback mechanisms on students' writing proficiency.

The lesson guides serve as structured instructional materials to facilitate students' engagement with feedback. Specifically, the peer-generated feedback guide provides a framework for peer review sessions, outlining structured criteria for assessing clarity, organization, grammar, and critical thinking. This guide ensures that students follow a systematic approach when evaluating their peers' work, offering constructive criticism, and incorporating suggestions into their revisions. On the other hand, the AI-generated feedback guide introduces students to AI tools such as ChatGPT, equipping them with guidelines for utilizing AI-generated insights to refine organization, tone,

and technical accuracy in their writing. These lesson guides underwent expert validation to ensure alignment with best practices in technical writing instruction, ensuring that students receive structured and meaningful guidance in both peer and AI feedback mechanisms. Furthermore, to enhance reliability, inter-rater reliability testing was conducted, where multiple evaluators assessed sample writing outputs. A high inter-rater agreement coefficient was achieved, confirming the consistency of rubric-based scoring.

The survey questionnaire serves as a key tool for understanding students' behaviors and perceptions regarding their use of AI in the writing revision process. The questionnaire includes both Likert-scale and open-ended questions to gather data on various aspects of AI integration, such as the stages of writing where AI is used (brainstorming, drafting, revising, or grammar checking), the extent of AI's influence on revisions (full acceptance, selective application, minimal use, or rejection), and the perceived benefits and challenges of AI-generated feedback. Content validity was established through expert review to ensure that the questionnaire effectively captures relevant aspects of AI's role in technical writing. Additionally, reliability analysis was conducted through a pilot survey, with Cronbach's Alpha used to measure the internal consistency of responses. The resulting high reliability score indicates strong coherence among the questionnaire items, confirming that the survey can produce consistent and reliable results.

To further ensure the validity and reliability of the research instruments, expert evaluations were conducted on all three tools—the lesson guides, rubrics, and survey questionnaire—by faculty members specializing in technical writing, engineering education, and AI-enhanced learning. Their feedback was incorporated to refine the instruments and ensure their alignment with the study's objectives. A pilot study was also conducted with a small sample of students enrolled in technical writing to assess test-retest reliability, ensuring consistency in survey responses over time. Additionally, inter-rater reliability was established for rubric-based writing evaluations, verifying that multiple assessors applied the scoring criteria consistently.

2.4 Data Gathering Procedure

The data gathering procedure for this study is organized the following phases:

Preliminary Phase. Upon the necessary approval of the study, the research respondents are introduced to the study's objectives and informed about the task they are required to complete. This involves writing a technical composition that will serve as the basis for both the pre-test and post-test assessments. The students are given clear instructions and a rubric outlining the criteria for technical writing, ensuring they understand the key aspects that will be evaluated. For the feedback, a structured rubric is introduced to the students. These include clarity and precision, organization, adherence to the convention of grammar, fluency, and critical thinking and argumentation. The researcher also made sure that these criteria of the rubric has been discussed in the class for the students to be aware on the measures that they need to look into and anticipate in the writing process and output of the students.

Implementation of the Intervention Phase. The feedback mechanism interventions take place during the midterm coverage, with each group receiving one of the two feedback mechanisms: peer-generated feedback or AI-generated feedback (specifically, ChatGPT-generated feedback). The feedback interventions are carried out in the following manner:

Peer-Generated Feedback, In this group, students are paired or placed in small groups to review and provide feedback on each other's technical writing compositions. Guided by a structured rubric, students assess their peers' work based on the established criteria, offering constructive feedback aimed at improving the technical quality of the writing. They are encouraged to focus on specific areas such as clarity, organization, adherence to the convention of grammar, fluency, and critical thinking and argumentation, ensuring that the feedback is both comprehensive and actionable. After the feedback session, students revise their compositions based on the suggestions and observations made by their peers. AI-Generated Feedback, In the second group, students receive feedback generated by ChatGPT, an AI-based language model, which evaluates their technical writing based on the Insight of an AI (chatGPT) rubric. Students will be instructed on how to use the AI feedback, allowing them to connect to a network or Internet Access on their mobile phone and Instruct to feed their work on the AI too (chatGPT) with the AI insight rubric to ensure AI will identify the technical writing composition of the students for improvement and better revisions. This feedback is delivered in a written format, and students are given time to review and revise their compositions accordingly. Post-Test Phase Following the feedback interventions, students revise their initial compositions based on the feedback received, either from their peers or from the AI. These revised compositions are then assessed in the post-test phase, using the same rubric to ensure consistency in evaluation. Data Analysis and Interpretation, Once the data is collected, the quantitative data from the pre-test and post-test scores are analyzed using the appropriate statistical methods to identify significant differences in writing performance. Through this approach, the study aims to contribute valuable insights into the role of feedback in enhancing technical writing skills, offering substantial

techniques and recommendations for integrating both peer-generated and AI-generated feedback mechanisms into engineering curricula.

2.5 Statistical Treatment of Data

Each research question is addressed using appropriate statistical tools and techniques. The quantitative component focuses on comparing the pre-test and post-test scores of students exposed to structured-rubrics to be used and AI-generated feedback. The following statistical treatments are applied:

Descriptive Statistics**,** including means, standard deviations, and percentages, are computed for the pre-test and post-test scores of both groups. Analysis of Covariance (ANCOVA) is employed to control for potential confounding variables, such as baseline writing proficiency (pre-test scores). By adjusting for these factors, ANCOVA provides a more accurate comparison of the effectiveness of the two feedback mechanisms. On the other hand, the qualitative component seeks to explore the perceptions and experiences of students regarding the feedback mechanisms. This process involves coding the data, identifying recurring themes, and categorizing insights related to how students perceive and apply feedback to improve their writing.

3. RESULTS AND DISCUSSION

This part presents the results and discussion of the gathered data from the pre-test and post-test writing activity of two groups of the engineering department of North Eastern Mindanao State University, Bislig Campus. The data are arranged and displayed following the study's stated objectives.

3.1 How does AI-generated feedback influence various aspects of technical writing

Table-1: How does AI-generated feedback influence various aspects of technical writing?

Indicators	CE4A	CE4B
Clarity	4.63	2.25
Organization	4.37	2.50
Adherence to conventions of grammar	4.20	1.53
Fluency	4.27	2.16
Critical Thinking and Argumentation	4.23	2.72
OVERALL	**4.34** (Excellent)	**2.23** (Needs Improvement)

Table 1 above shows how AI-generated feedback influences various aspects of technical writing in terms of **Clarity**. Results reveal a noticeable contrast in clarity scores between the two groups. CE4A achieved an excellent rating of 4.63, while CE4B received a needs improvement score of 2.25, yielding an overall score of 3.44, which falls under the "Good" category. This disparity suggests that AI-generated feedback significantly enhanced clarity in CE4A's technical writing. Clarity, being a core element of effective technical writing, reflects how well students can express complex ideas in a straightforward and understandable manner. AI-generated feedback influences various aspects of technical writing in terms of **Organization**. CE4A again scored excellent (4.37), while CE4B remained at the needs improvement level (2.50). The overall score of 3.44 still indicates a "Good" quality in structuring written content. This outcome reinforces the earlier observation that AI feedback contributed positively to enhancing CE4A's ability to sequence ideas logically and adhere to structural conventions. In the aspects of technical writing in terms of Adherence to the **Conventions of Grammar**. CE4A earned an excellent score of 4.20, narrowly missing the excellent threshold by a small margin, while CE4B received a poor score of 1.53, with an overall average of 2.87 (Satisfactory). This dramatic gap emphasizes the impact of AI feedback in correcting and reinforcing grammatical rules among students who actively engaged with it. In the aspects of technical writing in terms of **Fluency**. CE4A maintained a strong performance in fluency with an excellent score of 4.27, whereas CE4B again lagged with a needs improvement rating of 2.16. The overall score of 3.22 places the group's fluency under the "Satisfactory" range. Fluency in writing reflects the smoothness and readability of text, incorporating sentence rhythm, transitions, and lexical variety. Lastly in the technical writing in terms of **Critical Thinking and Argumentation**. CE4A earned

a 4.23 (Excellent) while CE4B scored a 2.72 (Satisfactory). The combined average of 3.48 falls into the "Good" category. This metric reflects students' ability to formulate reasoned arguments, support claims with evidence, and display logical reasoning—skills that are fundamental in academic and technical writing.

The summary table presents a clear contrast between the two sections. CE4A consistently scored in the Excellent range across all five indicators, with an overall rating of 4.34, while CE4B was mostly in the Needs Improvement range, averaging 2.23. These findings emphasize the pronounced effect of AI-generated feedback when appropriately engaged with, as seen in CE4A, compared to CE4B, which possibly had lower usage or engagement quality. This stark contrast supports Tran (2025) and Hou et al. (2024), who both concluded that the effectiveness of AI-generated feedback is mediated by user agency, digital literacy, and feedback uptake. AI tools can offer high-quality feedback, but the benefit depends on how students understand, accept, and act upon that feedback. CE4A's exemplary performance indicates a successful alignment of AI tool use and student effort.

3.2 In what ways do well-structured rubrics classify performance expectations and enhance students' technical writing performance based on the identified indicators?

Table-2: Technical writing performance based on the identified indicators.

Indicators	CE4A	CE4B
Clarity	4.47	2.91
Organization	4.37	3.19
Adherence to conventions of grammar	4.27	2.00
Fluency	4.37	2.84
Critical Thinking and Argumentation	4.33	3.34
OVERALL	**4.36** (Excellent)	**2.86** (Satisfactory)

The table 2 shows that CE4A consistently scored in the Excellent range across all indicators, with an overall average of 4.36. In contrast, CE4B averaged 2.86, indicating a Satisfactory level of performance. This consistent trend confirms that well-structured rubrics positively influenced CE4A's technical writing development by making expectations transparent, measurable, and actionable. Meanwhile, CE4B's satisfactory outcomes suggest partial engagement with the rubric, or possibly a need for differentiated instruction and more support in understanding how to use rubrics effectively. The overall findings resonate with Kim et al. (2024) and Wu and Schunn (2023), who observed that the consistent use of rubrics in assessment and revision improves writing performance by offering structured guidance, especially when combined with frequent feedback and reflection opportunities. Rubrics serve not only as assessment tools but also as learning aids, encouraging metacognitive engagement with writing tasks. These results imply that for rubrics to fully benefit all learners, teachers should embed rubric training into their pedagogy. This includes rubric unpacking sessions, reflective writing journals, and feedback loops where students analyze their own work using the rubric before submission. Doing so can maximize the benefits of rubrics and close the performance gap between different groups.

3.3 Significant relationship between AI-generated feedback and the effectiveness of well-structured rubrics in improving technical writing performance.

Table-3: Significant relationship between AI-generated feedback and well-structured rubric

Source	Sum of Squares	df	F	p-value	Decision
Feedback Type	208.23	1	19.51	0.0000	Reject H_0
Pre-test Score	1224.70	1	114.74	0.0000	Reject H_0
Error	608.38	57	—	—	—
Total	2041.31	59			

Note: *p is significant at p < 0.05.*

The Table 3 findings indicate a statistically significant relationship between the type of AI-generated feedback and improvements in technical writing performance, as evidenced by the F-value of 19.51 and a p-value of 0.0000,

which is well below the 0.05 threshold. This suggests that the kind of feedback students receive from AI tools is highly essential in shaping the quality of their writing. This aligns with Rad, Alipour, and Jafarpour (2024), who emphasized that AI tools like Wordtune opt feedback literacy and engagement by offering revision suggestions that directly impact writing outcomes.

Moreover, the pre-test score also significantly predicts improvement, with an F-value of 114.74 and p-value of 0.0000, indicating that baseline writing ability strongly influences how effectively students respond to AI-generated feedback. Students with higher initial proficiency are likely better positioned to critically engage with and apply feedback, a notion echoed in the work of Guo, Zhang, Li, and Yu (2024), who found that learners with a foundational understanding of writing are more adept at revising based on peer or AI suggestions.

This result reinforces the position of Bai and Nordin (2025), who argue that human-AI collaboration is most productive when users possess sufficient writing skills and critical thinking capacity. Well-structured feedback enables students to go beyond surface-level corrections by reinforcing writing conventions, thus promoting deeper learning. As AI tools evolve, the capacity to deliver structured, context-aware feedback will become increasingly important in educational environments.

Importantly, these results suggest that AI-generated feedback cannot function in isolation; it must be aligned with pedagogical frameworks, such as structured rubrics, to support cognitive development in technical writing. According to Tran (2025), the combination of AI and teacher scaffolding results in more effective revision behavior. Therefore, integrating AI tools with clear evaluative criteria, such as rubrics, not only supports technical skill development but also creates students' metacognitive awareness of writing mechanics.

3.4 Significant relationship between the use of well-structured rubrics and students' ability to integrate AI feedback into their revisions?

Table-4: Relationship between the use of well-structured rubrics and students' ability to integrate AI feedback into their revisions.

Source	Sum of Squares	df	F	p-value	Decision
Rubric Use (Group)	154.45	1	9.83	0.0028	Reject H_0
Rubric Score (Post)	1106.67	1	70.48	0.0000	Reject H_0
Error	894.22	57	—	—	—
Total	2155.34	59			

Note: *p is significant at $p < 0.05$.*

The Table 4 analysis also shows a significant relationship between rubric use and students' ability to integrate AI feedback into their writing, with an F-value of 9.83 and a p-value of 0.0028, prompting the rejection of the null hypothesis. This implies that when students are provided with a well-structured rubric, they are more likely to interpret, evaluate, and incorporate AI feedback effectively. This observation is consistent with Guo, Pan, Li, and Lai (2024), who highlighted the value of scaffolding (such as rubrics) in enhancing the quality of feedback and the efficacy of writing revisions. Further, the post-rubric scores show an even stronger relationship, with an F-value of 70.48 and a p-value of 0.0000, indicating that not only does rubric use influence feedback integration, but it also significantly improves writing performance outcomes. Structured rubrics likely function as cognitive guides, helping students discern the relevance of AI-generated suggestions. This aligns with the findings of Wiboolyasarin et al. (2024), who reported that clear evaluative criteria and collaborative tools boost student awareness and accuracy in revisions. This relationship suggests that rubrics act as a necessary interpretive framework, bridging the gap between machine feedback and human learning processes. Alharbi (2023) argues that while AI tools offer sophisticated writing support, their impact is optimized only when students are guided in interpreting and applying the feedback. Rubrics serve this purpose by offering clarity on expectations, thereby enhancing the student's ability to navigate and contextualize AI feedback within their revisions. Finally, these results cap the value of combining automated feedback with teacher-designed assessment tools to strengthen revision practices. Banihashem et al. (2024) found that while AI-generated feedback was helpful, it required instructional support to improve feedback utilization. Instructors can thus leverage well-designed rubrics not just to assess student work, but also to enable students to make informed revisions, cultivating both technical skill and autonomous writing behavior in the process.

4. CONCLUSIONS

Based on the findings, the following conclusions are drawn: AI-generated feedback positively influences clarity, organization, grammar, fluency, and argumentation in technical writing, particularly among students who are guided in its use. Well-structured rubrics clearly define performance standards and significantly enhance students' technical writing across multiple indicators. The combined use of AI-generated feedback and well-structured rubrics yields a statistically significant improvement in writing performance. Rubrics is important in helping students meaningfully integrate AI feedback into their writing revisions. While AI-generated tools offer valuable support for writing development, challenges such as dependency, loss of voice, and inconsistent feedback accuracy remain notable.

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