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Jurnal Penelitian Humaniora

Published by *Muhammadiyah University Press* (MUP)
Universitas Muhammadiyah Surakarta, Indonesia

PRINTED ISSN 1411-5190
ONLINE ISSN 2541-4496
Vol. 26 (1), February 2025
Page 36-48

ENHANCING STUDENTS' ENGLISH ESSAY WRITING PROFICIENCY AI-BASED AUTOMATIC FEEDBACK SYSTEMS

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DOI: 10.23917/jph.v26i1.9041

Received: March 10th, 2025. Revised: March 12th, 2025. Accepted: March 27th, 2025
Available Online: March 27th, 2025. Published Regularly: February 2025

Keywords

Psychology
Humanity
Education
Philosophy
Culture

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Abstract

This study investigates the effectiveness of AI-based automatic feedback systems in enhancing students' English essay writing proficiency. Utilizing a descriptive quantitative research approach, data was collected through pre-test and post-test assessments, surveys, and usage statistics of AI feedback tools. Findings reveal a significant improvement in students' writing proficiency, with an average score increase of 19.8 points. The study identifies grammar and sentence structure as the most frequently revised aspects, with a high rate of AI feedback implementation among students. A strong positive correlation (r = 0.73) was observed between AI feedback usage frequency and writing improvement. The study concludes that AI-based feedback systems are crucial in refining students' writing skills and recommends structured integration of these tools into English writing curricula.
Keywords: AI-based feedback, English essay writing, automated feedback, writing proficiency, AI in education.

INTRODUCTION

Effective communication through writing is one of the most essential skills in both academic and professional settings (Khoo & Kang, 2022). Writing proficiency is indispensable for students pursuing educational excellence and those preparing to enter the professional world. The ability to convey ideas with clarity, to think critically, and to engage in meaningful discourse is vital for success in modern society. Writing enables students to express their thoughts, analyze complex topics, and engage in constructive dialogues, central to their educational and career success. Nevertheless, many learners face significant challenges when writing essays and other academic texts. These challenges can stem from several factors, such as inadequate feedback, a lack of structured guidance, and insufficient practice (Deeva et al., 2021). Writing is a skill that requires continuous development, and students often struggle to refine their writing without the necessary support and resources.

The writing process is not simply about putting words on paper; it involves multiple stages, such as brainstorming, outlining, drafting, revising, and finalizing the content. These stages demand various cognitive and metacognitive skills, including organizing thoughts coherently, developing clear arguments, and ensuring grammatical accuracy.

While many students can express their ideas, translating their thoughts into well-structured, grammatically correct, and logically coherent essays is challenging. This difficulty is exacerbated by the traditional feedback mechanisms available to students in educational settings.

In traditional classroom settings, feedback is typically provided by teachers or peers. Teacher feedback is often delivered through written comments on drafts or during individual consultations. However, in many cases, this feedback is limited by the teacher's time constraints, particularly in large class settings. Teachers are often tasked with reviewing numerous essays quickly, which may result in brief, general, and not personalized feedback to meet each student's unique needs (Gibson & Huang, 2023). Additionally, students may not always fully understand the feedback provided, leading to confusion about how to improve their writing. Consequently, the feedback process becomes ineffective, leaving students with limited guidance for improving their writing skills.

Peer feedback is another traditional method often used in writing classes. Peer feedback can be beneficial in some contexts, allowing students to engage with each other's work and gain new perspectives. However, peer feedback also has its limitations. Students may lack the expertise to provide meaningful, detailed feedback and hesitate to offer constructive criticism. Sometimes, peer feedback may lack the depth and accuracy required to address complex writing issues (Anderson et al., 2023). As a result, students may not receive the guidance they need to improve their writing significantly. This problem is particularly evident in large classrooms where students may not have the opportunity to receive personalized attention or in-depth feedback from either their peers or instructors.

Given these limitations, there is a growing interest in the potential of AI-powered feedback systems as a solution to the challenges associated with traditional feedback methods. AI-based feedback systems have gained popularity in educational settings due to their ability to provide real-time, personalized feedback on students' writing. These systems rely on advanced Natural Language Processing (NLP) algorithms, which are designed to analyze text, detect errors, and suggest revisions based on the individual student's writing level. The primary advantage of AI-based feedback is its immediacy. Unlike traditional feedback methods, which can take days or even weeks to be provided, AI-generated feedback is available instantly, allowing students to revise their work as they go. This feature is particularly beneficial for students who struggle with writing because they can receive immediate suggestions for improvement and apply them to their work without delay.

AI-based systems are not limited to identifying simple grammatical errors. They are equipped to detect a wide range of writing issues, including sentence structure, coherence, cohesion, and even the overall organization of an essay. These systems can also assess the quality of arguments presented in an essay, offering suggestions on strengthening or clarifying points. Moreover, AI-driven feedback systems can provide tailored recommendations considering each student's writing style and proficiency. By analyzing previous drafts and assessing writing patterns, AI systems can identify recurring issues and offer targeted guidance to help students improve specific aspects of their writing. This personalized approach is in stark contrast to the generic feedback often provided by teachers or peers, which may not address the unique challenges faced by individual students.

Furthermore, AI-based feedback systems are not only focused on error correction but also on fostering self-regulated learning. Research suggests that students who engage with automated feedback are likelier to actively participate in their knowledge and become more independent writers (Tayan et al., 2024). By interacting with AI-generated suggestions, students learn to recognize patterns in their writing and develop a deeper understanding of language rules and effective composition strategies. As they revise their

work based on the AI's suggestions, they become more attuned to the nuances of writing, ultimately improving their ability to identify and correct their mistakes in future assignments. This process of self-reflection and autonomous learning is crucial for developing lifelong writing skills, as it empowers students to take ownership of their writing and continue to improve beyond the classroom.

In addition to promoting self-regulation, AI-based feedback systems create a non-judgmental and low-pressure environment for students. Unlike traditional teacher or peer feedback, which may sometimes be perceived as critical or judgmental, AI feedback is neutral and objective. This can help alleviate students' anxiety when receiving feedback, mainly when they fear being judged for their writing mistakes (McAllister & Zhao, 2023). The non-judgmental nature of AI feedback encourages students to experiment with their writing and take risks without fearing harsh criticism. As a result, students are more likely to engage with the feedback process, experiment with different writing strategies, and improve their writing skills.

Given the potential benefits of AI-based feedback systems, examining how these tools influence students' writing performance in more detail is essential. This study aims to investigate the impact of AI-generated feedback on students' writing proficiency, focusing on key areas such as grammar, sentence structure, coherence, and argumentation. More specifically, the study seeks to explore how AI-based feedback contributes to students' improvements in these areas and whether the frequency of feedback usage correlates with gains in writing proficiency. Additionally, the research will examine students' writing's most frequently revised aspects, identifying common areas where AI feedback proves particularly useful. This analysis will help to understand which aspects of writing benefit most from automated feedback and offer insights into how AI tools can be optimized to address students' specific writing challenges.

This research will contribute to the growing body of literature on integrating artificial intelligence in education, particularly in language learning and academic writing. The findings will offer valuable insights for educators seeking to incorporate AI tools into their teaching practices and students who wish to improve their writing skills independently. By exploring the effectiveness of AI-based feedback, the study will inform best practices for using AI in educational settings, providing recommendations for leveraging these tools to enhance writing instruction and promote student success.

Ultimately, this research will contribute to a broader understanding of how AI technologies can be harnessed to support students' academic development, particularly in writing. As AI continues to evolve and play an increasingly significant role in education, exploring how these technologies can be effectively integrated into the learning process to support students' growth and development is crucial. The findings of this study will provide a foundation for further research on the use of AI in education and offer practical insights for educators, policymakers, and learners alike.

LITERATURE REVIEW

AI-Powered Feedback in Education

Integrating artificial intelligence (AI) in education has become a transformative force, revolutionizing the way teaching and learning processes are approached. One of AI's most significant contributions to education is the development of AI-powered feedback systems, drastically changing how students receive feedback on their writing. Traditionally, feedback has been a critical element in the writing process, guiding students toward improving their writing skills. However, delivering timely, detailed, and personalized feedback has often been challenging, particularly in large classrooms where teachers struggle to provide individualized attention to every student. AI-powered feedback systems address this challenge by leveraging advanced technologies such as Natural Language Processing (NLP) to provide real-time, personalized feedback on

students' writing, including grammar, coherence, argumentation, and overall structure (Tayan et al., 2024).

NLP algorithms, the backbone of many AI-powered writing tools, allow these systems to analyze text and identify common errors such as spelling, grammatical, and sentence structure problems. Beyond mere error correction, these systems are also designed to evaluate more complex aspects of writing, such as the clarity of arguments, the logical flow of ideas, and the overall coherence of an essay. AI feedback systems can break down the writing into various components, providing students with targeted suggestions on improving each element of their work. For example, students may receive feedback on the clarity of their thesis statement, the strength of their supporting arguments, or the effectiveness of their transitions between paragraphs. The immediate nature of AI feedback means that students can revise their work more efficiently, making changes in real-time and receiving further suggestions as needed (Gibson & Huang, 2023).

Prior research on the effectiveness of AI-based feedback has consistently demonstrated its positive impact on student writing outcomes. Fleckenstein et al. (2023) studied the effects of AI-driven feedback on writing mechanics and sentence structure. The results indicated that students who used AI-powered tools improved their ability to construct grammatically correct sentences, structure their paragraphs logically, and develop clear, concise arguments. Similarly, Johnson & Lee (2022) conducted a meta-analysis that examined multiple studies on AI-powered feedback and its effects on student writing. The findings revealed that AI-generated feedback significantly enhanced student learning outcomes by improving their writing quality and reducing the time required for revisions. Students who received AI feedback could identify and address writing issues more quickly, leading to improved writing skills over time. The study further emphasized that AI feedback played a crucial role in increasing feedback retention, as students could access feedback on demand and apply it consistently across multiple writing assignments.

Another key advantage of AI feedback is its consistency and objectivity. Unlike traditional methods of feedback, which may be influenced by a teacher’s subjective judgment or biased by time constraints, AI systems provide objective and consistent responses based on predefined algorithms. This allows students to receive feedback based solely on the quality of their writing rather than external factors such as the teacher's workload or personal preferences. Anderson et al. (2023) argue that exposure to consistent, structured recommendations from AI systems fosters greater writing autonomy among students. By receiving feedback that focuses on specific areas of improvement and offering straightforward suggestions for revision, students become more empowered to take ownership of their writing process. This increased autonomy has been shown to positively influence students' motivation and confidence in their writing abilities as they develop more substantial control over their learning (McAllister & Zhao, 2023).

Furthermore, research by Tayan et al. (2024) highlights the role of AI feedback in promoting self-regulated learning. When students interact with AI-generated suggestions, they are encouraged to actively engage with their writing, identify their weaknesses, and decide how to improve their work. Over time, this process helps students develop metacognitive skills, allowing them to assess their writing and apply strategies for improvement independently and critically. This shift towards self-regulated learning is essential for long-term academic success, as it encourages students to take responsibility for their knowledge and continuously strive for improvement without relying on external sources of feedback. In this way, AI feedback enhances writing skills and contributes to the development of lifelong learning habits that extend beyond the classroom.

Writing Proficiency and AI Integration

Writing proficiency encompasses various aspects of writing, including organization, coherence, vocabulary usage, grammar, and the development of logical, persuasive arguments (Sato, 2022). The ability to write clearly and effectively is a crucial skill that

students must develop to succeed academically and professionally. Writing proficiency is often evaluated based on several criteria, such as the structure of an essay, the clarity of the thesis statement, the development of supporting arguments, and the use of appropriate language and style. However, for many students, mastering these elements of writing can be challenging and complex. Writing requires the coordination of multiple cognitive processes, including planning, drafting, revising, and editing. It also requires a deep understanding of language rules and rhetorical strategies, which may not come naturally to all students.

AI-based feedback tools have emerged as powerful aids in helping students develop their writing proficiency by providing immediate, actionable feedback on various aspects of their writing. These systems offer automated suggestions that help students organize their ideas effectively, improve the coherence of their arguments, and refine their sentence structures. Kim et al. (2024) conducted a study that examined the role of AI-based feedback in helping students structure their essays. The researchers found that students using AI feedback tools were likelier to produce well-organized essays with a clear structure and logical flow. The AI systems provided students with real-time suggestions for improving transitions between paragraphs, strengthening thesis statements, and refining the clarity of supporting arguments. This real-time feedback enabled students to make quick adjustments to their writing, improving their essays' overall coherence and structure.

AI tools also provide valuable support in refining the language and style of students' writing. Malik et al. (2023) studied how AI-assisted learning affects vocabulary usage and sentence fluency. The results showed that students who utilized AI-powered writing tools were likelier to use varied vocabulary and construct more complex sentence structures. The AI systems analyzed the students' vocabulary choices and suggested synonyms or more precise terms that could enhance the clarity and impact of their writing. Additionally, the AI feedback encouraged students to experiment with sentence structures, helping them develop more sophisticated and fluent writing styles. These language use and sentence fluency improvements are crucial for students working to elevate their writing to an academic or professional level.

Longitudinal studies have further supported the effectiveness of AI-based feedback in improving writing proficiency. Zhang & Wang (2023) conducted a study that tracked the writing progress of students who used AI feedback tools over a semester. The results showed a 35% improvement in writing fluency and coherence among students who used AI-powered feedback compared to those who relied on traditional peer review methods. The researchers noted that the students who used AI feedback could quickly identify and correct writing issues, leading to greater fluency and coherence in their essays. This improvement was particularly noticeable in students who initially struggled with writing, as they benefited from the personalized, iterative feedback provided by the AI systems. The study also highlighted the importance of consistent use of AI feedback tools, as students who engaged with the input regularly showed the most significant improvement in their writing.

AI feedback tools also significantly increase students' motivation and engagement with the writing process. Writing can often be daunting and frustrating for students, particularly when they struggle with grammar, organization, or argumentation. Revising and editing can be time-consuming and discouraging, especially when students feel uncertain about how to improve their work. However, research by McAllister & Zhao (2023) revealed that students who used AI-generated feedback reported greater satisfaction with their writing progress. This satisfaction was attributed to the detailed, structured, and non-judgmental nature of AI feedback, which provided students with specific suggestions for improvement without the fear of criticism. The non-judgmental aspect of AI feedback creates a more supportive environment for students, allowing them to experiment with their writing without fear of making mistakes. This, in turn, increases students' confidence

in their writing abilities and encourages them to continue engaging with the writing process.

Moreover, AI-powered feedback systems can potentially promote a growth mindset in students. When students receive AI-generated suggestions, they are encouraged to view writing as an iterative process, where mistakes are seen as opportunities for learning and improvement. This growth mindset fosters a positive attitude towards writing and helps students develop resilience in facing challenges. Over time, students become more comfortable with revision and improvement, a crucial aspect of writing. As students engage with AI feedback, they develop a greater sense of agency in their writing, which empowers them to take charge of their learning and continuously strive for improvement.

Integrating AI-powered feedback systems in education has proven to be a valuable tool for enhancing students' writing proficiency. These systems offer real-time, personalized feedback that addresses various writing issues, from grammar and sentence structure to argument development and coherence. By providing objective, consistent feedback, AI tools help students improve their writing more efficiently, fostering greater autonomy and self-regulation in the writing process. Research has shown that students who engage with AI-generated feedback experience significant improvements in their writing skills, particularly in terms of writing fluency, coherence, and vocabulary usage. Furthermore, AI feedback tools have been shown to increase students' motivation and engagement with the writing process, promoting a more positive and supportive environment for learning. As AI technology evolves, these tools will likely become even more sophisticated, offering significant potential for improving writing proficiency and supporting student success in academic and professional writing.

METHOD

This study adopted a descriptive quantitative research design, as outlined by Creswell & Creswell (2018), to investigate the impact of AI-powered feedback systems on students' writing proficiency. The aim was to measure how AI-based feedback influences student essays' quality and explore how students engage with these technologies. The study collected data from various sources, ensuring that quantitative and qualitative aspects of AI feedback were captured for a comprehensive understanding.

Data Sources

The data sources for this study included student essays, writing proficiency assessments, survey responses, and AI usage statistics. These sources allowed for a robust analysis of how AI feedback affects student writing at the macro (essay quality) and micro (individual feedback engagement) levels.

Student Essays and AI Feedback: The primary data for evaluating writing proficiency were student essays submitted through a digital platform integrated with AI-based feedback systems. Essays were analyzed for grammar, sentence structure, coherence, and argumentation improvements. AI tools provided real-time feedback on various aspects of writing, allowing students to revise and refine their work iteratively. Each essay was assessed using an AI platform that generated automated suggestions for improvement and overall performance scores.

Writing Proficiency Assessments: In addition to the essays, students took part in writing proficiency assessments, which included pre-test and post-test evaluations. The pre-test assessed students' initial writing skills, while the post-test measured improvements after students had engaged with the AI-based feedback system over a set period. The results of these assessments allowed for a direct comparison of students' writing abilities before and after using the AI tool.

Survey Responses: To understand students' perceptions of AI-generated feedback, a Likert-scale survey was administered, as suggested by Johnson & Christensen (2020). The

survey consisted of questions that measured students' engagement with AI feedback (ranging from 1 = strongly disagree to 5 = strongly agree). It also explored students' perceived input effectiveness, satisfaction with the revision process, and motivation to improve their writing skills.

AI System Usage Statistics: To complement the qualitative and assessment data, usage statistics were gathered from the AI platform. These statistics provided insights into how often students accessed the feedback, which aspects of the input they engaged with most frequently, and whether higher frequency usage correlated with improved writing performance. This data allowed for a more nuanced understanding of how students interacted with the AI tool and its impact on their progress.

Writing Rubric and Data Analysis

AI comprehensive writing rubric was developed to assess five primary components of student essays: content, organization, vocabulary, language use, and mechanics. Each of these categories was evaluated to understand how the integration of AI feedback contributed to improvements in specific areas of writing. The rubric also ensured that the analysis was systematic, covering all critical aspects of writing proficiency. Statistical methods were employed to analyze the quantitative data. Pre-test and post-test scores were compared using correlation analysis to identify the relationships between AI feedback usage and writing improvements. Regression modeling was applied to examine the extent to which different variables, such as feedback frequency and students' engagement with AI suggestions, predicted improvement in writing performance. This approach allowed for a clear identification of patterns and trends in the data.

In addition to the quantitative analysis, qualitative data was gathered through open-ended survey questions that provided more profound insights into students' experiences with AI feedback systems. Thematic coding was used to analyze these responses and to identify recurring themes, such as students' satisfaction with the AI feedback process, the challenges they faced, and the perceived benefits of the tool. This mixed-method approach provided a holistic view of how AI feedback systems influenced the technical aspects of writing and students' attitudes toward the revision process.

RESULT

The results of this study demonstrate significant improvements in students' writing proficiency after integrating AI-based feedback into their learning process. This chapter presents an in-depth discussion of the findings, analyzing the impact of AI feedback on various writing components, including grammar, sentence structure, organization, coherence, and overall essay quality. Furthermore, it explores students' engagement with AI feedback tools and investigates the correlation between feedback frequency and performance enhancement.

Improvement in Writing Proficiency

A key outcome of this study was the marked improvement in students' writing proficiency, as evidenced by comparing pre-test and post-test results. Table 1 shows the improvements in mean scores and the range of enhancements across individual students.

Table 1. Result of Improvements

Measure	Pre-test	Post-test	Improvement
Mean Score	63.4	83.2	+19.8
Minimum Score	61.0	80.0	+19.0
Maximum Score	70.0	88.0	+18.0
Total Score	2403	3170	+767

The mean score improved from 63.4 to 83.2, which substantially enhances overall writing quality. This improvement was seen across all performance levels, with even the lowest scores increasing by nearly 20 points. The total score for all students in the sample rose by 767 points, further demonstrating the positive effect of AI feedback on writing proficiency. The increased proficiency can be attributed to several factors. First, AI-powered feedback systems offer immediate corrections and explanations, allowing students to learn from their mistakes in real time. Traditional feedback methods, which often involve delays due to manual grading, may not provide the same level of immediacy. By receiving instant suggestions, students could revise their essays iteratively, leading to a deeper understanding of writing mechanics and improved performance over time.

Moreover, the consistency of AI-generated feedback contributed to students' improvements. Unlike human feedback, which may vary depending on an instructor's subjective evaluation, AI provides standardized responses based on predefined linguistic and grammatical rules. This consistency helps students identify recurring errors and develop strategies to address them.

Impact of AI Feedback on Specific Writing Aspects

In addition to overall improvements in writing proficiency, a closer examination of individual writing components reveals that AI feedback significantly impacted grammar, sentence structure, and essay organization.

Grammar Improvement

Grammar emerged as the area with the most significant improvement. Table 2 shows the specific grammatical regions where students showed notable gains, with an error reduction of up to 40%.

Table 2. Grammar Improvement

Grammatical Area	Pre-test Errors	Post-test Errors	Error Reduction (%)
Verb Tense Consistency	150	85	43.3%
Subject-Verb Agreement	120	65	45.8%
Punctuation	180	100	44.4%
Sentence Fragments	130	50	61.5%

The AI system flagged errors related to verb tense consistency, subject-verb agreement, punctuation, and sentence fragments, guiding students toward correct usage through detailed explanations and corrective suggestions. The reduction in errors in these categories can be attributed to the ability of AI feedback tools to provide immediate, targeted advice that students can apply directly to their writing.

Sentence Structure Improvement

Before using AI feedback, many students struggled with constructing complex and coherent sentences. Common issues included run-on sentences, sentence fragments, and improper clause usage. Post-test results indicated a substantial reduction in these errors. Table 3 illustrates the improvement in sentence structure, with students experiencing a notable decrease in errors related to sentence formation.

Table 3. Sentence Structure Improvement

Sentence Structure Issue	Pre-test Errors	Post-test Errors	Error Reduction (%)
Run-on Sentences	110	55	50.0%
Sentence Fragments	90	30	66.7%

Sentence Structure Issue	Pre-test Errors	Post-test Errors	Error Reduction (%)
Improper Clause Usage	95	45	52.6%

The AI system's ability to identify and suggest alternatives for awkward phrasing and sentence structure was crucial in helping students improve the fluency and readability of their essays. By highlighting and correcting errors in sentence construction, students gained a better grasp of sentence composition.

Organization and Coherence Improvement

Students also showed significant improvements in essay organization and coherence. Initially, many students had difficulty ensuring a logical flow of ideas, making it challenging for readers to follow their arguments. AI feedback helped students refine their organizational skills by suggesting improvements in paragraph transitions, topic sentence clarity, and the logical progression of ideas.

Table 4. Organization and Coherence Improvement

Organizational Aspect	Pre-test Errors	Post-test Errors	Error Reduction (%)
Paragraph Transitions	130	75	42.3%
Topic Sentence Clarity	145	90	37.9%
Logical Progression of Ideas	110	60	45.5%

The AI feedback provided valuable suggestions for improving coherence between sentences and paragraphs. This helped students structure their essays more effectively, enhancing the overall quality of their written work.

Student Engagement with AI Feedback

One of the critical factors influencing the improvement in students' writing proficiency was the frequency with which they engaged with AI feedback tools. Data from system usage statistics indicated that students who frequently consulted AI feedback demonstrated the highest levels of improvement. Table 5 shows the distribution of feedback usage across different student groups.

Table 5. Frequency of AI Feedback Usage

Usage Frequency Group	Average Number of Sessions per Essay	Average Score Improvement
Low-frequency users	<3 sessions	8 points
Moderate-frequency users	3-6 sessions	15 points
High-frequency users	>6 sessions	22 points

As shown in Table 5, students who engaged with AI feedback more than six times per essay exhibited the most significant improvements, with an average score gain of 22 points. This finding supports continuous interaction with AI-based feedback fosters sustained learning and skill enhancement. Survey responses revealed that 85% of students found AI suggestions helpful in identifying and correcting their writing mistakes. Many students expressed appreciation for the feedback's immediate and detailed nature, allowing them to revise their work efficiently. Additionally, 78% of students reported that AI feedback helped them become more independent writers, reducing their reliance on instructors for corrections. Despite the overwhelmingly positive feedback, some students noted limitations in AI-generated suggestions. A small percentage (12%) felt that the input was sometimes too generic and did not fully address the context of their writing. Some

students also mentioned that AI struggled with more nuanced aspects of writing, such as tone, argument development, and cultural nuances. These observations suggest that while AI feedback is highly effective for technical and structural writing elements, human feedback remains essential for guiding students in more complex aspects of writing.

Correlation Between AI Feedback Usage and Writing Improvement

Statistical analysis revealed a strong positive correlation between the frequency of AI feedback usage and students' improvement in writing proficiency. Specifically, a Pearson correlation coefficient of **$r = 0.73, p < .001$,** was found, suggesting that students who used AI feedback more frequently showed significant improvements in their writing skills.

Table 6. Correlation Between AI Feedback Usage and Writing Improvement

Group	Pre-test Score	Post-test Score	Improvement (%)
Low-frequency users	63.2	71.5	12.9%
Moderate-frequency users	64.0	79.0	23.4%
High-frequency users	63.4	85.4	34.8%

As illustrated in Table 6, high-frequency users experienced the most significant improvement in writing proficiency, with an average improvement of 34.8%. This highlights the importance of consistent interaction with AI feedback tools in fostering writing development.

Pedagogical Implications

The findings of this study have significant implications for English language instruction and curriculum design. Integrating AI feedback tools into writing courses offers students continuous support and guidance, complementing traditional teaching methods. Educators should encourage students to actively engage with AI feedback actively, as repeated use can help them develop their writing skills over time. It is essential to provide structured opportunities for revision based on AI-generated suggestions, ensuring that students maximize the potential benefits of these tools.

Furthermore, the study highlights the need for a balanced approach to feedback. While AI tools excel at identifying grammatical errors and structural weaknesses, human instructors play a vital role in addressing higher-order writing skills, such as critical thinking, argument development, and creative expression. A blended feedback approach that combines AI's efficiency with human instructors' expertise may offer the most comprehensive support for students.

DISCUSSION

This study aimed to evaluate the impact of AI-based feedback on students' writing proficiency, focusing on improving grammar, sentence structure, organization, coherence, and overall essay quality. The study's results revealed that AI feedback significantly positively influenced the students' writing performance, underscoring the potential benefits of integrating AI tools into educational practices. The findings support that AI-based feedback can enhance students' writing skills by providing timely, consistent, and personalized feedback that traditional methods may lack. One of the most striking outcomes of the study was the significant improvement in students' overall writing scores, which increased from a mean score of 63.4 to 83.2. This substantial gain suggests that AI feedback can play a crucial role in helping students develop their writing proficiency over time. The AI system's ability to offer immediate and specific corrections allowed students to revise their essays iteratively, fostering a deeper understanding of writing mechanics and promoting active learning. This aligns with the principles of constructivist learning

theory (Vygotsky, 1978), which emphasizes the importance of active engagement and social interaction in the learning process. By enabling students to interact with the feedback continuously, AI tools facilitated the construction of knowledge through iterative revision, a core aspect of constructivist theory.

Furthermore, the findings showed that AI feedback had a powerful impact on the technical aspects of writing, such as grammar, sentence structure, and organization. Errors in verb tense consistency, subject-verb agreement, punctuation, and sentence fragments were significantly reduced, highlighting the AI system's effectiveness in providing targeted support for these foundational aspects of writing. These improvements in lower-order writing skills are critical as they form the building blocks for more advanced writing tasks. The AI feedback allowed students to focus on these areas, providing a structured and consistent approach to error correction. This result aligns with behaviorist learning theory (Skinner, 1954), which stresses the importance of reinforcement and repetition in skill acquisition. Through repeated AI feedback, students could correct their mistakes and reinforce correct language usage, enhancing their technical writing proficiency.

However, while AI feedback effectively addressed technical writing issues, the study highlighted limitations in AI-generated suggestions. Specifically, some students pointed out that AI feedback struggled with more nuanced aspects of writing, such as tone, argument development, and cultural context. This suggests that while AI tools effectively provide immediate feedback on technical elements, human instructors are essential for addressing higher-order concerns requiring critical thinking and contextual understanding. This limitation underscores the importance of combining AI feedback with traditional human feedback, as proposed by sociocultural theory (Vygotsky, 1978), which emphasizes the role of social interaction and the guidance of more knowledgeable others (such as teachers) in helping students navigate complex cognitive tasks.

In terms of student engagement, the study found a strong correlation between the frequency of AI feedback usage and the extent of writing improvement. High-frequency users showed the most significant gains, suggesting that students who actively and repeatedly engage with AI feedback are more likely to experience substantial improvements in their writing skills. This supports the idea that sustained practice and active engagement are key to skill development, as highlighted by Bandura's Social Cognitive Theory (1986), which emphasizes the role of self-regulation and self-efficacy in learning. When students take ownership of their education by consistently utilizing AI tools, they are more likely to develop the confidence and skills necessary to become independent writers.

The findings of this study provide valuable insights into the effectiveness of AI-based feedback in enhancing students' writing proficiency. While AI tools deliver immediate, consistent, and targeted feedback on lower-order writing skills, human feedback remains indispensable for addressing higher-order writing concerns. Integrating AI feedback into writing instruction offers a promising approach to improving writing skills, but this must be done in conjunction with traditional pedagogical methods. When implemented strategically, the blended approach of AI and human feedback can offer students the most comprehensive support, helping them develop technical and critical thinking skills essential for successful writing.

CONCLUSION

This study demonstrated the significant impact of AI-based feedback on improving students' writing proficiency, particularly in grammar, sentence structure, and organization. Integrating AI tools into the writing process enabled students to receive immediate, consistent, and personalized feedback, which fostered iterative learning and deeper engagement with writing mechanics. As a result, students showed substantial improvement in their writing scores, with those who engaged frequently with AI feedback

achieving the highest gains. However, while AI feedback proved effective for addressing technical writing issues, it was less effective in tackling more nuanced aspects of writing, such as tone, argument development, and cultural context. This highlights the need for a balanced approach that combines AI feedback's strengths with human instructors' expertise. By blending AI's efficiency in technical corrections with human feedback's ability to address higher-order writing skills, educators can provide students with a more comprehensive and practical learning experience. Overall, the findings suggest that AI-based feedback has excellent potential as a valuable tool in writing instruction, mainly when used alongside traditional methods.

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