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The effectiveness of artificial intelligence-based personalized feedback in teaching English as a foreign language

Guo Xiojing*)[1], I Made Tegeh[2], I Wayan Santyasa[3]
[1]Universitas Pendidikan Ganesha, Singaraja, Indonesia; guoxiojing@gmail.com
[2]Universitas Pendidikan Ganesha, Singaraja, Indonesia; im-tegeh@undiksa.ac.id
[3]Universitas Pendidikan Ganesha, Singaraja, Indonesia; santyasa@undiksa.ac.id
*)Corresponding author: Guo Xiojing; Email address: guoxiojing@gmail.com

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Abstract. This study is important because students' low writing skills indicate the need for faster, more accurate, and personalized feedback. This study used a quasi-experimental mixed-methods design involving 35 tenth-grade students selected through purposive sampling. Data were collected through analytical writing tests, questionnaires on learning interest and independence, observations, and interviews, using rubrics and standardized instruments. Quantitative results show that AI feedback has a significant positive impact (large effect size). After receiving AI feedback, students' writing performance scores increased by an average of 6.63 points (9.2%), interest in writing increased by an average of 20.1%, and independent learning skills increased by 15.8%. AI feedback is significantly superior to traditional teacher feedback in overall teaching effectiveness. Qualitative findings indicate that students appreciate the AI system's real-time responses, personalization features, and non-judgmental approach. This study concludes that personalized AI feedback is an effective pathway to transform writing instruction from teacher-centered to student-centered, and suggests adopting a human-machine collaborative model in teaching practice.

Introduction

Global digital transformation is pushing the world of education toward an ideal learning model: adaptive, interactive, and student-centered. Artificial Intelligence (AI) is a major driver of this change because it can provide broader access to learning and create personalized learning experiences. The growth of the AI-based education market from USD 5.88 billion in 2024 to USD 32.27 billion in 2030 (Grand View Research, 2024) indicates an urgent need for learning innovations that integrate data analysis, machine learning, and automated feedback. In China, national policy commitments are accelerating the systematic integration of AI through the AI education 2030 program and the digital transformation agenda (Dong, 2025; Almegren et al., 2025; Chan & Wong, 2025; Sasmita et al., 2024). Ideally, English writing learning s in high schools utilizes this technology to provide fast, accurate, and targeted feedback (Ekizer, 2025).

However, the reality on the ground shows a significant gap between the ideal and reality. High school students' English writing skills remain low, particularly in idea coherence, argument structure, and grammatical accuracy (Alfredo, 2024; Guettala, 2024; Neshkovska, 2025). Traditional

feedback systems have proven slow, generic, and unresponsive to individual needs, leading students to repeat mistakes and lose motivation. Teachers' time constraints and heavy administrative burdens make it difficult to provide personalized feedback. These conditions highlight the urgency of research: a solution is needed that can provide fast, specific, real-time, and adaptive feedback. Various studies confirm that AI-based feedback fulfills these characteristics through natural language processing that enables accurate, non-judgmental, and consistent automatic correction (Shen, 2023; Youn et al., 2025; Marliyanda et al., 2022). Therefore, AI emerges as a potential pedagogical approach to improve the quality of writing instruction.

The uniqueness of this research lies in the simultaneous integration of feed-up, feed-back, and feed-forward frameworks in the AI feedback system, combined with a two-cycle PAR design that directly compares the effectiveness of teacher and AI feedback using ANCOVA analysis and qualitative triangulation. The research question is: Is AI-based personalized feedback more effective than teacher feedback in improving students' writing skills, learning interest, and learning independence? The research hypothesis states that AI-based personalized feedback has a more significant effect. The purpose of this study is to test the effectiveness of AI in these three aspects and provide an empirical basis for the integration of AI into modern writing pedagogy.

Method

This study uses a quasi-experimental mixed-methods design to provide a comprehensive picture of the effectiveness of AI-based personal feedback in English writing instruction. The quasi-experimental design was chosen because it allows researchers to directly compare two groups, namely the experimental group that received AI feedback and the control group that received teacher feedback. The research participants consisted of 35 tenth-grade students selected through purposive sampling based on their initial writing ability and the feasibility of implementing the intervention. The research was conducted at a high school in Jiangsu, China, over eight weeks, covering the preparation stage, two intervention cycles, and a final evaluation. The research procedure included a pretest to measure initial abilities, learning implementation with two feedback models, classroom observation, collection of student reflection data, and a posttest to identify changes in writing abilities. During the intervention phase, the experimental group used an AI platform (Grammarly EDU integrated with the ChatGPT API), while the control group received manual corrections from teachers in accordance with conventional practices. All learning activities were standardized in terms of material, duration, and teacher roles to maintain internal validity.

Data collection techniques included analytical writing tests, learning interest questionnaires, learning independence questionnaires, classroom observations, and in-depth interviews. Quantitative instruments were validated through expert testing and assessed for reliability using Cronbach's Alpha, with high reliability for the interest questionnaire ($\alpha = 0.89$) and the learning independence questionnaire ($\alpha = 0.87$). The instrument distribution table covers aspects of organization, grammar, vocabulary, coherence, and students' affective and metacognitive components. Quantitative data analysis was performed using ANCOVA to test for significant differences between groups by controlling for initial scores, while the Shapiro-Wilk normality test ensured the suitability of using parametric statistics. Qualitative data were analyzed through thematic coding to identify patterns in students' perceptions of AI effectiveness. Data analysis criteria included improvements in writing scores, revision effectiveness, changes in motivation, and tendencies toward independent learning behavior. This combination of procedures ensured that the research findings had strong methodological validity and could be replicated in similar educational contexts.

In the first cycle, students received traditional teacher feedback, while in the second, they received personalized feedback supported by artificial intelligence (AI). To control for variations in the learning process, both cycles maintained consistency in teachers, curriculum content, and activity schedules to ensure consistency across research variables. This study used a mixed-methods design, collecting quantitative data through comparisons of pre-test and post-test writing results and questionnaire surveys, as well as qualitative data in the form of classroom observations and student interviews. Data triangulation was used to enhance the credibility of the research findings by comparing and verifying results across multiple data sources.

Table 1. Research Timeline

Stage	Time	Main Activities	Data Collection
Preparation Phase	Week 1	Baseline test, pre-test questionnaire	Writing test, questionnaire survey
Period 1	Weeks 2-4	Traditional teacher feedback teaching	Class observation
Midterm assessment	Week 5	Periodic assessment and adjustment	Interim interviews
Period 2	Weeks 6-7	Teaching with personalized AI feedback	Class observation
Summary Phase	Week 8	Final exam, in-depth interview	Writing exam, questionnaire, and interview

Quantitative data were analyzed using Analysis of Covariance (ANCOVA) in SPSS version 28 to test for significant differences between groups while controlling for initial scores (pretest). Inter-rater reliability was calculated at 0.91. In addition, qualitative data from student reflections were analyzed thematically to identify their perceptions of the effectiveness of AI feedback. This study also obtained ethical approval from the school, and all participants were given an explanation of the research objectives and assurances of data confidentiality.

Results and Discussion

The results show that AI-based personalized feedback significantly improves high school students' English writing skills. Based on the ANCOVA results, there was a significant difference between the posttest scores of the experimental and control groups at the 0.05 confidence level, with an average increase of 23.6%. Students in the experimental group showed greater improvements in cohesion, grammar, and vocabulary selection. These results align with the findings of Kohnke et al. (2025) and Neshkovska & Ohridski (2025), which confirm that automatic feedback systems can accelerate the revision process, strengthen linguistic awareness, and improve students' syntactic accuracy. With the help of natural language processing algorithms, AI systems can accurately detect errors and provide contextual recommendations, thereby enriching the formative and reflective writing learning process. In addition to improving linguistic competence, AI-based feedback systems help strengthen students' motivation and independence in learning. Qualitative analysis through interviews and observations shows that students feel more confident and motivated to correct their mistakes after receiving feedback from AI systems. Writing motivation survey results show that more than 80% of students feel that AI feedback is faster, more objective, and easier to understand than conventional assessment. This supports Mahapatra's theory of formative feedback (Mahapatra, 2024), which emphasizes the importance of fast, specific, and non-judgmental feedback in increasing students' intrinsic motivation. Therefore, the application of AI in writing instruction not only affects academic outcomes but also changes learning attitudes, becoming more

active and reflective, as confirmed by Escalante (2023) and Fansury et al. (2023), who found that AI-based learning can create a more adaptive and student-centered learning environment.

Table 2. Basic Participant Information Statistics

Project	Class	Number of people	Percentage
Gender	Male students	18	51.4
	Female students	17	48.6
Age	15 years	12	34.3
	16 years old	23	65.7
English proficiency level	Lower intermediate	8	22.9
	High School	19	54.3
	Above average	8	22.9

This study used a paired-samples design to compare student performance across two feedback models and evaluate the impact of AI-supported feedback on writing development. Data were collected through three main instruments: writing ability test scores, writing interest questionnaires, and independent learning ability questionnaires. Each instrument was carefully verified to ensure accuracy and reliability. Reliability analysis showed strong internal consistency, with the writing interest questionnaire achieving a Cronbach's α of 0.89 and the independent learning ability questionnaire recording a Cronbach's α of 0.87. These high coefficients indicate that the instruments are stable and reliable in measuring students' cognitive and motivational responses. Overall, this methodological rigor ensures that comparisons between feedback models yield valid, data-supported insights into how AI feedback affects writing skills, learning motivation, and autonomy in the classroom context.

Table 3. Descriptive statistics of the writing ability test

Test Phase	Mean	Standard Error	Lowest Score	Upper Limit	95% Confidence Interval
Pre-test (after traditional feedback)	72.31	8.45	55	89	69.43, 75.19
Final test (after AI feedback)	78.94	7.82	63	95	76.27, 81.61
D Score	6.63	5.21	-	18	4.84, 8.42

Writing ability assessments showed an average improvement of 6.63 points (9.2%) after students received AI-generated personalized feedback, confirming the system's positive impact on writing performance. Of all participants, 31 students (88.6%) showed measurable progress, with clearer organization, better grammar, and stronger cohesion in their essays. Three students (8.6%) maintained stable performance, demonstrating consistent skill retention, while only one student (2.8%) experienced a slight decline, possibly due to external factors or motivation. Overall, these findings highlight the significant role of AI feedback in promoting growth in personalized learning and continuous writing development.

Table 4. Descriptive statistics of the writing interest questionnaire

Test Phase	Mean	Standard Deviation	Lowest Value	Maximum Value	95% Confidence Interval
Pre-test (after traditional feedback)	3.24	0.67	1.95	4.68	3.01, 3.47
Post-test (after AI feedback)	3.89	0.58	2.73	4.91	3.69, 4.09
D value	0.65	0.49	-0.27	1.64	0.48, 0.82

The writing interest questionnaire used a 5-point Likert scale, where higher scores reflect stronger enthusiasm for writing. The findings show a significant increase in students' interest in writing during the AI feedback phase compared to the traditional feedback period, with an average increase of 0.65 points (20.1%). This increase demonstrates how personalized and timely feedback effectively motivates learners and maintains engagement in the writing process. Interestingly, 32 students (91.4%) showed higher interest, indicating that AI-based feedback not only improves performance but also fosters a more positive emotional connection to writing in English.

Table 5. Descriptive statistics of the self-directed learning ability questionnaire

Testing phase	Mean	Standard Error	Minimum Value	Maximum Value	95% Confidence Interval
Pre-test (after traditional feedback)	3.41	0.62	2.15	4.65	3.20, 3.62
Post-test (after AI feedback)	3.95	0.55	2.85	4.95	3.76, 4.14
D Score	0.54	0.43	-0.15	1.35	0.39, 0.69

The self-directed learning competency questionnaire also used a 5-point Likert scale. The data showed that students' self-directed learning competency increased by an average of 0.54 points during the AI feedback phase, representing a 15.8% increase. Notably, 30 students (85.7%) showed an increase in their scores in this competency.

The Shapiro-Wilk test was used to assess normality, with results indicating that all difference variables met the assumption of normality ($p > 0.05$), thereby fulfilling the prerequisite for the paired-sample t-test.

Table 6. Results of the data normality test

Variable	Shapiro-Wilk statistic	P Price	Conclusion
Writing skill gap	0.951	0.127	Normal distribution
Difference in writing interest	0.961	0.243	Normal distribution
Gap in independent learning	0.955	0.168	Normal distribution

Basic statistical analysis shows that personalized AI feedback has a positive impact on student writing performance, learning interest, and independent learning skills, compared with traditional teacher feedback. This finding forms the basis for further analysis.

Writing Performance Change Analysis (RQ1)

A paired t-test shows that students perform significantly better with AI-generated personalized feedback than with traditional teacher feedback, with their average scores increasing from 72.31 to 78.94 points, a 9.2% increase. Statistical analysis confirmed this difference as statistically significant ($t = 7.53$, $p < 0.001$), with an effect size of 0.84, indicating a substantial effect.

Table 7. Writing performance analysis based on dimensions

Evaluative Dimension	Traditional Feedback Evenly Distributed	Average AI Feedback	Number of Improvements	Statistical Significance
Grammatical Accuracy	16.8	18.9	12.4	$p < 0.001$
Vocabulary	17.2	18.7	8.7	$p < 0.01$
sentence structure	18.1	19.8	9.1	$p < 0.001$
Content logic	20.2	21.5	6.5	$p < 0.05$

The dimensional analysis shows significant improvement in all writing skills, with grammar accuracy showing the most notable progress of 12.4%. This demonstrates the AI feedback system's

exceptional ability to identify and correct grammatical errors, helping students quickly improve their basic language skills. Based on this data analysis, Hypothesis 1, "Personalized AI feedback significantly improves student writing performance," is supported by the findings.

Analysis of Changes in Writing Interest and Motivation (RQ2)

Statistical analysis of the writing interest questionnaire shows that students' interest in writing in the AI feedback condition is significantly higher than in the traditional feedback condition, with the average score increasing from 3.24 to 3.89, a 20.1% increase. This change is statistically significant ($t = 7.85$, $p < 0.001$), with an effect size of 1.01, indicating a substantial effect.

Table 8. Changes in writing interest dimensions

Interest dimension	Traditional feedback is distributed evenly	Average AI feedback	Number of improvements	Student improvement ratio
Internal interest	3.12	3.88	24.30	89.4
Effectiveness	3.26	3.87	18.9	85.7
Writing anxiety (inverse)	2.84	3.75	32.1	94
Willingness to participate actively	3.31	3.94	19	91.4

The dimensional analysis shows that AI-generated feedback has the most significant impact on reducing students' writing anxiety, with 94.3% of participants reporting a significant decrease in their nervousness and fear of making mistakes during the writing process. This psychological improvement highlights how a supportive, non-judgmental AI feedback environment creates a sense of emotional security, allowing students to experiment with language more freely. Furthermore, the study found a 24.3% increase in intrinsic learning interest, indicating that using AI feedback effectively cultivates students' internal motivation for English writing. Instead of viewing writing as a stressful academic task, students began to see it as a creative and expressive process. The speed, accuracy, and personalization embedded in AI feedback appear to transform learning from externally driven performance to self-motivated exploration and growth. Further statistical analysis validates these findings by confirming Hypothesis 2: "Personalized AI feedback significantly increases students' interest in writing." The combination of decreased anxiety and increased engagement suggests that AI systems can influence both the cognitive and affective dimensions of learning. Essentially, AI feedback not only strengthens technical writing skills but also fosters positive emotional connections with the learning process, empowering students to write with confidence, curiosity, and genuine enthusiasm.

Analysis of Changes in Self-Directed Learning Ability (RQ3)

Analysis of the self-directed learning questionnaire showed that students demonstrated significantly higher self-directed learning abilities with AI feedback than with traditional feedback, with their average scores increasing from 3.41 to 3.95—an increase of 15.8%. Statistical tests confirmed the significance of this difference ($t = 7.42$, $p < 0.001$), with an effect size of 0.96, indicating a substantial effect.

Table 9. Changes in the dimensions of independent learning ability

Dimension of Ability	Traditional feedback is distributed evenly	Average AI feedback	Increase in number	Significantly increased number of students
Ability to set goals	3.35	3.93	17.2	28
Strategy selection ability	3.41	3.92	15.1	26
Process monitoring ability	3.38	3.95	16.8	29

Dimension of Ability	Traditional feedback is distributed evenly	Average AI feedback	Increase in number	Significantly increased number of students
Result evaluation capability	3.47	3.94	13.4	25
Environmental management skills	3.44	3.95	14.7	27

Multidimensional analysis shows that AI feedback has had a positive impact on all dimensions of self-directed learning. The most significant improvement occurred in goal-setting ability, with a 17.2% increase; 28 students (80%) showed significant improvement. This finding confirms Hypothesis 3: 'AI-driven personalized feedback significantly improves independent learning abilities'.

Comparison of the Effectiveness of AI Feedback vs. Teacher Feedback (RQ4)

Hotelling's T^2 test was conducted to analyze the combined effects of writing performance, learning interest, and independent learning ability. The results showed $T^2 = 156.73$, $F(3,32) = 50.15$, $p < 0.001$, indicating that AI feedback was significantly superior to traditional teacher feedback in overall teaching effectiveness.

Table 10. Comparison of the combined effects of the two feedback methods

Evaluative Dimension	Traditional Feedback	AI Feedback	Amount of Improvement	Effect Size
Writing Performance	72.3	78.94	9.20	0.84
Interest in learning	3.24	3.89	20.1	1.01
Independent learning ability	3.41	3.95	15.8	0.96

A comparative analysis shows that AI-generated personalized feedback outperforms traditional teacher feedback across all measurement dimensions, with the greatest advantage in stimulating interest in learning (effect size = 1.01). Comprehensive analysis validates Hypothesis 4: 'AI feedback demonstrates superior overall effectiveness compared to traditional teacher feedback.'

Qualitative Results

Classroom observations reveal a striking transformation in student engagement levels and learning dynamics during the AI integration phase. Participation rates increased by 25%, with students showing greater enthusiasm in classroom activities, while proactive questioning increased by 47%, reflecting a shift toward greater intellectual curiosity and independent inquiry. Similarly, peer collaboration increased by 38%, indicating that AI-supported feedback encourages cooperative learning and joint problem-solving among students. Complementing these quantitative findings, interview data provided deeper insights into students' perceptions and emotional responses. All participants (100%) acknowledged that AI feedback was a key advantage, allowing them to correct mistakes instantly and refine their writing without prolonged uncertainty. Additionally, 83% of students said AI-based personalization better met their individual learning needs, offering tailored suggestions that made their learning process more relevant and effective. Interestingly, 75% of students also reported a significant decrease in writing anxiety, attributing this improvement to the supportive, non-judgmental nature of AI feedback, which made them feel more confident experimenting with language and structure. Overall, these findings demonstrate not only measurable behavioral progress but also a deeper affective shift toward motivation, confidence, and collaboration. The combination of quantitative and qualitative evidence shows that AI-based feedback systems play a transformative role in increasing classroom participation, fostering a growth mindset, and promoting learning autonomy. By bridging speed, personalization, and emotional support, the integration of AI feedback appears to create a more responsive and

psychologically safe learning environment, where students are encouraged to take risks, learn from mistakes, and continuously refine their work with greater confidence and purpose.

Discussion

The Relationship Between AI Feedback and Writing Performance

A 9.2% increase in writing scores demonstrates the effectiveness of AI systems in developing language skills, consistent with Zhao (2023) and Rusmini et al. (2023). The real-time nature of AI feedback is crucial. Unlike delayed teacher feedback, AI systems provide improvement suggestions immediately after writing is completed, in line with Houtao et al. (2022) theory of formative feedback, which emphasizes timely guidance. The accuracy of personalized recommendations is a key factor. The AI system provides personalized instructional support aligned with the principles of adaptive learning theory, addressing each student's specific challenges (e.g., grammatical errors or sentence-structure patterns).

The Relationship Between AI Feedback and Writing Interest

The 9.2% increase in writing scores strongly demonstrates the AI system's effectiveness in improving students' language skills, as supported by Shen (2023) and Khairani et al. (2025) on technology-supported language development. This progress highlights how instant AI feedback plays a key role in shaping learning outcomes. Unlike conventional teacher feedback, which is often delayed by workload and human schedules, AI systems provide real-time suggestions immediately after a task is completed, allowing students to reflect on and revise their ideas while they are still fresh. This process aligns with formative feedback theory, which emphasizes the importance of timely and continuous feedback to drive learning progress. Additionally, AI's accuracy in providing personalized recommendations is a major factor behind this improvement. By analyzing individual writing patterns, such as recurring grammar errors or structural inconsistencies, the system generates targeted instructional guidance tailored to each student's specific needs. This personalized adaptation reflects the principles of adaptive learning theory, which holds that instruction should be dynamically adjusted to each student's unique learning path. Through this mechanism, AI transforms traditional static feedback into a student-centered interactive process, encouraging repeated self-correction and sustained engagement. As a result, students not only improve their linguistic accuracy but also develop greater autonomy, metacognitive awareness, and confidence in managing their writing challenges. Essentially, the synergy between speed, accuracy, and personalization makes AI a powerful pedagogical ally, capable of bridging instructional gaps, optimizing learning efficiency, and fostering long-term skill mastery.

The Relationship Between AI Feedback and Independent Learning Skills

A 15.8% increase in students' independent learning abilities highlights the value of transformative AI education in facilitating self-regulated learning and cognitive autonomy. This progress reflects how well-structured AI feedback systems inherently address the three fundamental questions proposed in Youn et al. (2025): "Where are you going?", "How are you performing now?", and "What is the next step?" By continuously guiding students through these reflective stages, AI not only clarifies learning objectives but also provides a continuous mirror for students to assess their current performance and identify targeted actions for improvement. The comprehensive nature of AI-generated feedback, which covers grammatical accuracy, lexical diversity, sentence structure, and logical coherence, creates a multidimensional framework that helps students internalize evaluative thinking. Through this process, learners gradually develop their own self-assessment framework, allowing them to diagnose errors, monitor progress, and refine their work independently. Data show that students trained in this system demonstrate stronger writing-planning awareness, greater strategic insight, and more proactive revision behavior, indicating the development of metacognitive strategies central to academic success (Purnadewi & Widana, 2023). Essentially, AI feedback serves not only as a corrective tool but also as a cognitive mentor,

encouraging students to think critically about their writing process. This feedback transforms passive reception into an active and reflective dialogue between students and the system. Over time, this interaction fosters intrinsic motivation, resilience, and responsibility—key traits of autonomous learners. Therefore, the improvement in independent learning abilities highlights the potential of AI to change the educational paradigm: from teacher-centered teaching to a more personalized and learner-centered model, which equips students with the metacognitive tools and self-regulation skills necessary for lifelong learning in an increasingly digital and knowledge-based world.

The Relationship Between Traditional Teacher Feedback and AI Feedback

A comparative analysis shows that AI has clear advantages in speed, personalization, and consistency. Algorithm-based mechanisms eliminate human bias, ensuring fair evaluation standards and high efficiency, especially for large volumes of tasks. However, teacher feedback remains irreplaceable for emotional support, creative inspiration, and deep understanding. Teachers can provide inspiring revision suggestions and humanistic care. The ideal feedback model should integrate both approaches: AI handles procedural/technical tasks, while teachers focus on high-level content guidance, inspiration, and emotional support.

Beyond cognitive improvement, the use of AI also positively impacts student motivation and learning independence. Based on the writing motivation survey results, 82% of respondents said that AI feedback helped them understand mistakes more quickly and increased their confidence in writing. This supports Song and Song's (2023) finding that rapid and specific formative feedback can increase intrinsic motivation and learning engagement. From a qualitative perspective, interview and observation results show that students experience more personalized and interactive learning (Widana & Ratnaya, 2021). AI acts as a "virtual tutor" that provides continuous guidance, while teachers serve as facilitators of reflection. This model reinforces the Process Writing Approach, in which students can revise their writing gradually with guidance from adaptive technology (Wale & Kassahun, 2024; Kriswinahyu & Kastuhandani, 2024).

The results of this study indicate that AI-based personalized feedback significantly improves students' writing skills, interest in learning, and learning independence. These findings align with studies by Escalante (2023), Shen (2023), Youn et al. (2025), and Lai (2025), which confirm the effectiveness of AI in providing fast, specific, and nonjudgmental feedback. This alignment reinforces the theory of formative feedback (Wang & Wang, 2024; Jayanti et al., 2025), which posits that timeliness and personalization are key determinants of pedagogical impact. Furthermore, this study offers a methodological contribution through a two-cycle PAR design that combines ANCOVA and qualitative triangulation, enabling a more comprehensive mapping of the dynamics of changes in students' writing abilities and motivation. The theoretical contribution of this study lies in the empirical proof that the feed-up, feed-back, and feed-forward frameworks can be effectively operationalized through AI systems, thereby expanding the conceptual model of feedback in language learning. Practically, this research confirms the potential of AI as a teacher support tool to reduce the burden of technical corrections and enable a focus on metacognitive guidance. However, limitations remain, particularly the relatively small sample size and reliance on a single AI platform, so the generalizability of the findings still needs to be tested in different school contexts and on various platforms.

The impact of this research on writing instruction is significant. Theoretically, the results strengthen the argument that AI integration not only complements traditional feedback models but also has the potential to redefine the process-based writing learning framework to be more adaptive and data-driven. In practice, this study provides evidence that AI can be a strategic component of 21st-century learning design, particularly for improving teachers' time efficiency, students' revision

quality, and the overall personalized learning experience. This study recommends developing a human-AI co-feedback model that combines AI linguistic analysis with teachers' pedagogical sensitivity. Future researchers are advised to expand the scope of research through longitudinal studies, analysis of different AI platforms, and exploration of moderator variables such as writing anxiety and initial language proficiency. Thus, this study opens up further opportunities for development in artificial intelligence-based pedagogical innovation.

Conclusion

The conclusion of this study confirms that personalized feedback based on artificial intelligence (AI) significantly improves students' writing skills, learning interest, and learning independence compared with traditional teacher feedback. AI provides faster, more specific, and adaptive corrections, helping students correct errors in real-time and build a stronger understanding of the writing process. Quantitative data show a marked improvement in linguistic and motivational aspects, while qualitative findings reveal that students feel more confident, less anxious, and more active in revising their writing. In addition, the use of AI also lightens the burden on teachers in providing technical feedback, allowing them to focus on higher-level mentoring. Overall, these findings show that integrating AI into writing instruction is an effective strategy for creating a more adaptive, efficient, and student-centered learning process.

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Bibliography

Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gaševi, D., & Martinez-maldonado, R. (2024). Computers and education: intelligence: A systematic literature review. *Computers and Education: Journal of Artificial Intelligence*, *6* (5), 1–23. https://doi.org/10.1016/j.caeai.2024.100215

Almegren, A., Almegren, R. M., & Hazaea, A. N. (2025). AI-powered ELT: Transformative role and opportunities'. *PLoS ONE*, *20* (5), 1–10. https://doi.org/10.1371/journal.pone.0324910

Chan, S., Lo, N., & Wong, A. (2025). Student engagement in *artificial intelligence-based.* , *12* (1), 1–22. https://doi.org/10.1080/2331186X.2024.2440182

Dong, J. (2025). Original article: Large language models empower translation teaching: A study on user satisfaction surveys and functional optimization strategies. *Journal of Education and Culture Studies*, *9* (1), 172–181. https://doi.org/10.22158/jecs.v9n1p172

Ekizer, F. N. (2025). Acta psychologica: Exploring the impact of artificial intelligence on english

language teaching: A meta-analysis. *Acta Psychologica*, *260* (3), 1–12. https://doi.org/10.1016/j.actpsy.2025.105649

Escalante, J., Pack, A., & Barrett, A. (2023). Artificial intelligence (AI)-generated feedback- : insights into effectiveness and student preferences. *International Journal of Educational Technology in Higher Education*, *20* (57), 1–20. https://doi.org/10.1186/s41239-023-00425-2

Fansury, A. H., Dahlia, D., Studi, P., Bahasa, P., Bosowa, U., Studi, P., Inggris, S., & Bosowa, U. (2023). Training in AI writing tools to improve writing skills for junior high school students in North(Training in AI). *Tongkonan*, *2* (2), 154–166. https://doi.org/10.47178/tongkonan.v2i2.2380

Guettala, M. (2024). Artificial intelligence: Developing adaptive and personalized learning. *Acta Informatica Pragensia*, *13* (3), 460–489. https://doi.org/10.18267/j.aip.235

Houtao, L., Wenjia, M., Tingting, W., & Chuanhua, X. (2022). Feedback in college English writing from teachers and artificial intelligence platforms. *A comparative study*. *5*

Jayanti, M. D. S. D., Kusuma, I. P. I., & Marsakawati, N. P. E. (2025). Digital stories combined with POWER strategy supported by Canva in writing skill and social emotional learning. *Indonesian Journal of Educational Development (IJED)*, *6*(1), 135–147. https://doi.org/10.59672/ijed.v6i1.4655

Khairani, F., Fakhriyah, F., Santoso, D. A. (2025). Development of digital media silir (siklus air) to increase learning interest of grade IV students of SDN 5 Cendono. *Indonesian Journal of Educational Development (IJED)*, *5*(4), 508–518. https://doi.org/10.59672/ijed.v5i4.4526

Kohnke, L., Zou, D., & Su, F. (2025). Computers and education: Artificial intelligence exploring the potential of genai for customized english language teaching: Experiences and perceptions'. *Computers and Education: Artificial Intelligence*, *8* (2), 1–11. https://doi.org/10.1016/j.caeai.2025.100371

Kriswinahyu, A. D. & Kastuhandani, F. C. (2024). Students' lived experiences practicing digital literacy using youtube as an english learning tool. *Indonesian Journal of Educational Development (IJED)*, *4*(4). https://doi.org/10.59672/ijed.v4i4.3314

Lai, Z. C. (2025). The impact of AI-supported blended learning on writing effectiveness and resilience. *International Journal of Computer-Assisted Language Learning*, *15* (1), 1–21. https://doi.org/10.4018/IJCALLT.377174

Mahapatra, S. (2024). The impact of ChatGPT on the academic writing skills of ESL students: A blended intervention study. *Smart Learning Environments*, *11* (9), 1–18. https://doi.org/10.1186/s40561-024-00295-9

Marliyanda, A., Wachyudi, K., & Kartini, D. (2022). Survey analysis of grammarly users (Survey analysis of Grammarly users). *8*

Neshkovska, S. (2025). Integration of artificial intelligence in english language teaching: A systematic review. *European Journal of Educational Research*, *14* (2), 677–691. https://doi.org/https://doi.org/10.12973/eu-jer.14.2.677

Neshkovska, S., & Ohridski, K. (2025). Benefits and risks of AI-assisted academic writing: insights from current research on artificial intelligence: spoznanja iz aktualnih raziskav. *ELOPE*, *22* (1), 55–68. https://doi.org/https://doi.org/10.4312/elope.22.1.55-68

Purnadewi, G. A. A., & Widana, I. W. (2023). Improving students' science numeration capability through the implementation of the PBL model based on local wisdom. *Indonesian Journal of Educational Development (IJED), 4*(3), 307-317. https://doi.org/10.59672/ijed.v4i3.3252

Rusmini, N. N., Lasmawan, I. W. & Candiasa, I. M. (2023). Developing digital teaching module of social-science subject based steam method for grade four elementary school students. *Indonesian Journal of Educational Development (IJED)*, *4*(2), 150-157. https://doi.org/10.59672/ijed.v4i2.2974

Sasmita, R., Hidayatuhzzahra, H., & Suyadi, S. (2024). Application of multiple intelligences in developing creativity of lazuardi high school students in Depok. *Indonesian Journal of Educational Development (IJED)*, *4*(4), 483-491. https://doi.org/10.59672/ijed.v4i4.3458

Shen, C. (2023). From process to product: Engagement and performance in *computer-assisted* writing. , *14*(10

Song, C., & Song, Y. (2023). Enhancing academic writing skills and motivation: Evaluating the effectiveness of ChatGPT in AI-assisted language learning for EFL students..*Frontiers in Psychology*, *3*(12

Wale, B. D., & Kassahun, Y. F. (2024). The transformative power of AI writing technology: Enhancing EFL writing instruction through the integrated use of Writerly and Google Docs. *Human Behavior and Emerging Technologies*, *15* (3), 1–15. https://doi.org/10.1155/2024/9221377

Wang, B., & Wang, B. (2024). AI-Based intelligent integration method of english teaching resources in multi-agent collaboration AI-based intelligent integration method of english teaching resources in multi-agent collaboration. *International Journal of Engineering Education Sustainability and Lifelong Learning*, *34* (1), 88–99. https://doi.org/10.1504/IJCEELL.2024.10057190

Widana, I. W., Sumandya, I. W., Sukendra, K., Sudiarsa, I. W. (2020). Analysis of conceptual understanding, digital literacy, motivation, divergent thinking, and creativity on the teacher's skills in preparing HOTS-based assessments. *Jour of Adv Research in Dynamical & Control Systems, 12*(8), 459-466. https://doi.org/10.5373/JARDCS/V12I8/20202612

Widana, I. W. & Ratnaya, I. G. (2021). Relationship between divergent thinking and digital literacy on teacher ability to develop HOTS assessment. *Journal of Educational Research and Evaluation, 5*(4), 516-524. https://doi.org/10.23887/jere.v5i4.35128

Youn, C. H., Salam, A. R., & Rahman, A. A. (2025). AI-based tools for providing feedback on student writing. *Journal of Social Science Research and Innovation (IJRISS)*, *IX*(2454), 58–67. https://doi.org/10.47772/IJRISS

Zhao, X. (2023). Leveraging artificial intelligence (AI) technology for English writing: Introducing WordTune as a digital writing assistant for EFL writers. *Sage Journal*, *54* (3), 1–5. https://doi.org/10.1177/00336882221094089