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Leveraging AI-Powered Writing Assistants to Enhance L2 Writing Proficiency: A Mixed-Methods Study

Reza. Khany[1], Pooria. Barzan[2*]

[1] Department of English Language and Literature, Faculty of Humanities, Ilam University, Ilam, Iran
[2] Department of English Language and Literature, Ilam University, Ilam, Iran

*** Corresponding author email address**: pooriabarzan@yahoo.com

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A B S T R A C T

This mixed-methods study investigates the efficacy of Grammarly, an AI-powered writing assistant, in enhancing L2 English writing proficiency among 60 intermediate-to-advanced learners at Ilam University. Over a 12-week intervention, an experimental group (n=30) used Grammarly for essay drafting and revision, while a control group (n=30) received traditional teacher and peer feedback. Quantitative analysis of pre/post writing assessments revealed significantly greater improvements in the experimental group for linguistic accuracy, coherence, and syntactic complexity ($p<0.001$; large effect sizes: $d=1.40–1.75$), validated via rubric scoring and Coh-Metrix text analysis. Behavioral analytics showed revision frequency (mean=18.3/essay) and time-on-task predicted 54% of writing gains ($p<0.001$). Qualitative themes from semi-structured interviews (n=15) highlighted enhanced self-efficacy, motivation, and trust in AI feedback for grammar/style, though learners emphasized the need for complementary human guidance on higher-order concerns (e.g., argumentation). Results demonstrate Grammarly's effectiveness in promoting writing proficiency and engagement, advocating for an integrated AI-human feedback approach in L2 pedagogy.

Keywords: *AI-powered writing assistants, Grammarly, L2 writing proficiency, Automated feedback in CALL*

1. Introduction

The development of second language (L2) writing proficiency is a cornerstone of academic and professional success in an increasingly globalized world, requiring learners to master linguistic accuracy, discourse coherence, and rhetorical sophistication(Abduljawad, 2024; Dizon & Gayed, 2021; Minh, 2024). However, L2 writers often face significant challenges, including limited vocabulary, syntactic inaccuracies, and difficulties in producing cohesive, audience-appropriate texts(Khan et al., 2024; Miranty et al., 2023; Prasetya & Raharjo, 2023). Traditional L2 writing instruction, heavily reliant on teacher-centered feedback and peer review, frequently suffers from delays, inconsistency, and limited scalability, which can hinder iterative revision and self-regulated learning(Fitria, 2021; Wang & Wang, 2024). These limitations are particularly pronounced in resource-constrained settings, where individualized feedback is often impractical(Miranty et al., 2021; Rababah & Talafha, 2024).

The advent of artificial intelligence (AI)-powered writing assistants, such as Grammarly, has introduced transformative possibilities for addressing these challenges.

Leveraging advanced natural language processing (NLP) and machine learning, these tools provide real-time, context-sensitive feedback on grammar, punctuation, style, readability, and rhetorical elements, enabling learners to engage in immediate error correction and iterative revision(Abbott & Abbott, 2024; Dizon & Gayed, 2021; Tran, 2024). Empirical studies suggest that AI-driven feedback enhances linguistic accuracy, textual cohesion, and lexical diversity while fostering learner autonomy, self-efficacy, and motivation through prompt, actionable suggestions(Abduljawad, 2024; Dizon & Gold, 2023; Suryanto et al., 2024). Moreover, AI tools generate detailed analytics on revision frequency and time-on-task, offering objective insights into behavioral engagement that traditional observation or self-reports cannot match(Liu et al., 2015; Miranty et al., 2023). Qualitative investigations further reveal that learners value the clarity and immediacy of AI feedback, though they often seek complementary human guidance to address higher-order concerns like argumentative coherence(Abbott & Abbott, 2024; Wang, 2024).

While AI-powered tools like Grammarly have demonstrated efficacy in improving surface-level linguistic accuracy in L2 writing(Cavaleri & Dianati, 2016; O'Neill & Russell, 2019), critical scholarship raises concerns about potential drawbacks. For instance, over-reliance on automated feedback may hinder learners' development of metacognitive skills, as users might accept suggestions without reflection, potentially leading to reduced critical thinking and independent editing abilities(Dizon & Gold, 2023; Ranalli, 2018). Additionally, these tools often fall short in addressing higher-order writing skills such as rhetorical structure, audience awareness, and creative expression, which are central to advanced writing proficiency(Godwin-Jones, 2022; Thi & Nikolov, 2021). Studies have also highlighted risks of algorithmic bias in feedback, where AI systems trained on standardized corpora may not align with diverse L2 cultural or disciplinary conventions, exacerbating inequities(Alharbi, 2023; Kong et al., 2024). Our study builds on this literature by examining not only linguistic gains but also motivational factors, aiming to mitigate such limitations through integrated behavioral analytics and a hybrid feedback model.

Despite these advancements, the integration of AI writing assistants into L2 pedagogy raises concerns about overreliance, potential misalignment with disciplinary conventions, and the need for structured frameworks to balance automated and human feedback(Aghaziarati et al., 2023; Alharbi, 2023; Aliakbari et al., 2025; Kong et al., 2024; Thi & Nikolov, 2021). Existing research is limited by small sample sizes, short intervention durations, and a predominant focus on quantitative outcomes, with insufficient attention to qualitative learner experiences or higher-order writing constructs such as rhetorical effectiveness(Minh, 2024; Prasetya & Raharjo, 2023). Furthermore, few studies have employed randomized controlled designs or integrated behavioral analytics with qualitative insights to comprehensively evaluate AI tools' impact on L2 writing development(Abduljawad, 2024; Roa & Halim, 2024).

The persistent challenges in L2 writing instruction—delayed feedback, inconsistent quality, and limited scalability—underscore the need for innovative solutions to enhance linguistic accuracy, coherence, and learner engagement. While AI-powered writing assistants like Grammarly offer immediate, personalized feedback, their efficacy in improving L2 writing proficiency, particularly among intermediate to advanced learners in non-Western contexts, remains underexplored. Critical gaps include the lack of rigorous, mixed-methods studies that combine quantitative measures of writing outcomes with qualitative insights into learner perceptions and behavioral engagement. Additionally, there is limited understanding of how AI feedback influences higher-order writing skills, such as argumentative coherence and rhetorical effectiveness, and how it can be integrated with traditional feedback to optimize learning outcomes.

This study aims to investigate the efficacy of Grammarly, an AI-powered writing assistant, in enhancing the writing proficiency of intermediate to advanced L2 English learners at Ilam University over a 12-week intervention. Specifically, it seeks to:

1. Quantitatively assess improvements in linguistic accuracy, coherence, and syntactic complexity through pre- and post-intervention writing assessments, using validated rubrics and automated text analysis (Coh-Metrix).
2. Examine behavioral engagement through AI tool analytics, including revision frequency and time-on-task, to understand how learners interact with automated feedback.
3. Explore qualitative learner perceptions of AI feedback, focusing on self-efficacy, motivation, and trust, through semi-structured interviews.

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4. Compare the effectiveness of AI-assisted feedback (experimental group) against traditional teacher and peer feedback (control group) using statistical analyses (paired t-tests, ANOVA, regression).
5. Synthesize quantitative and qualitative findings to provide a comprehensive understanding of how AI tools influence L2 writing processes and outcomes, informing pedagogical practices and theoretical frameworks in Computer-Assisted Language Learning (CALL), applied linguistics, and educational technology.

By employing a mixed-methods design, this study addresses critical gaps in the literature through a controlled intervention that triangulates writing performance metrics, behavioral analytics, and learner narratives. The findings will contribute robust evidence on the efficacy of AI-powered writing assistants in L2 instruction, offering practical insights for educators seeking to integrate these tools into curricula while balancing automated and human feedback. Furthermore, the study advances theoretical understandings of technology-mediated feedback, self-regulated learning, and learner engagement in L2 writing contexts. By examining both cognitive and affective dimensions, it provides actionable recommendations for designing equitable, scalable, and effective AI-driven instructional strategies, with implications for applied linguistics, educational psychology, and technology-enhanced language learning.

2. Theoretical Foundations and Literature Review

The integration of AI into L2 writing instruction has emerged as a transformative approach to addressing the limitations of traditional feedback methods, such as teacher and peer reviews, while enhancing learner proficiency, engagement, and autonomy. AI-powered writing assistants, particularly Grammarly, have garnered significant attention for their ability to provide immediate, scalable, and individualized feedback, complementing human instruction and fostering self-regulated learning. This review synthesizes literature on the efficacy of AI-driven tools in L2 writing, their impact on linguistic accuracy, coherence, and complexity, as well as their influence on learner perceptions, engagement, and pedagogical practices, with a focus on mixed-methods research.

2.1. Feedback Modalities in L2 Writing

Feedback is a cornerstone of L2 writing development, yet traditional modalities face challenges in scalability, timeliness, and consistency. Teacher feedback, valued for its depth in addressing higher-order concerns like content and organization, is often time-intensive and unevenly distributed in large classes(Wang & Han, 2022). Peer feedback promotes collaborative learning and autonomy but requires trust, proficiency, and training to be effective, and it may overlook certain error types without proper scaffolding(Ekoniak et al., 2013; Luo & Liu, 2017; Nabizadah, 2020). AI-powered automated writing evaluation (AWE) systems, such as Grammarly, address these limitations by delivering real-time, objective feedback on grammar, vocabulary, and style, enabling instructors to focus on higher-order issues(Chen et al., 2023; Dizon & Gayed, 2021; Thi & Nikolov, 2021; Wali & Huijser, 2018). Comparative studies indicate that while peer feedback fosters broader revisions, AWE systems excel in correcting surface-level errors, suggesting a synergistic potential when combined with human feedback(Ekoniak et al., 2013; Han & Wang, 2021; Thi & Nikolov, 2023).

2.2. Technological Advancements in AI-Powered Writing Assistants

The evolution of AWE systems from rule-based to sophisticated AI-driven models, powered by natural language processing (NLP) and deep learning, has expanded their capacity to address both mechanical and discourse-level writing features(Chen et al., 2023; Dizon & Gayed, 2021; Ebyary, 2022; Shiyao, 2021). Grammarly, a leading AI writing assistant, employs advanced NLP algorithms to provide real-time suggestions on grammar, lexical variety, and syntactic complexity, fostering iterative revisions and metalinguistic awareness(Dewi, 2023; Marghany, 2023; Prasetya & Raharjo, 2023). Bibliometric analyses highlight the rapid growth of AWE research, underscoring its scalability and ability to deliver immediate corrective feedback(Wu & Yu, 2024). However, discrepancies in feedback accuracy and scope between AI and human evaluations necessitate a blended approach to maximize pedagogical benefits(Han & Wang, 2021; Koltovskaia, 2022; Thi & Nikolov, 2023).

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2.3. *Impact on L2 Writing Proficiency*

AI-powered writing assistants significantly enhance L2 writing proficiency across multiple dimensions, including grammatical accuracy, lexical variation, and compositional complexity. Empirical studies demonstrate that Grammarly's immediate feedback reduces surface-level errors, such as punctuation and basic syntax, while promoting more sophisticated sentence structures and vocabulary use(Dizon & Gayed, 2021; Ghufron, 2019; Wei et al., 2023). Pre- and post-intervention assessments reveal statistically significant improvements in accuracy and coherence, particularly when AI feedback is integrated with traditional methods(Marghany, 2023; Prasetya & Raharjo, 2023; Thi & Nikolov, 2021). Furthermore, AI tools facilitate iterative revision cycles, enabling learners to internalize language rules and develop advanced writing skills over time(Ebyary, 2022; Shiyao, 2021). Research also indicates that AI feedback enhances discourse connectivity and readability, as measured by tools like Coh-Metrix, which assess cohesion and syntactic complexity(Dizon & Gold, 2023; Wei et al., 2023).

2.4. *Learner Engagement and Self-Regulated Learning*

Learner engagement and self-regulated learning are critical mediators of feedback uptake and writing improvement. AI-powered tools foster autonomy by encouraging learners to plan, monitor, and evaluate their revisions independently, supported by real-time feedback(Maulidina & Wibowo, 2022; Tian et al., 2022). Behavioral analytics, including keystroke logging and revision frequency, reveal that increased time-on-task and iterative revisions correlate with enhanced writing quality(Ebyary, 2022; Talebinamvar & Zarrabi, 2022; Wei et al., 2023). Qualitative studies indicate that learners perceive AI feedback as non-judgmental and immediate, reducing writing anxiety and boosting self-efficacy, particularly among intermediate to advanced L2 learners(Feng, 2023; Sari & Han, 2024; Shahriar & Laboni, 2023). The user-friendly interface of tools like Grammarly further enhances engagement by minimizing cognitive load and promoting sustained interaction(Dewi, 2023; Marghany, 2023).

2.5. *Theoretical Underpinnings*

The efficacy of AI-powered writing assistants is grounded in multiple theoretical frameworks, including behaviorism, cognitivism, and socio-constructivism. Behaviorist principles support immediate feedback as a mechanism for reinforcing correct language patterns(Ebyary, 2022; Ghufron, 2019). Cognitive theories emphasize metacognition and self-regulation, as AI tools prompt learners to reflect on error patterns and refine their writing strategies(Koltovskaia, 2022; Prasetya & Raharjo, 2023). Socio-constructivist perspectives highlight the collaborative potential of combining AI feedback with human instruction, fostering a dynamic learning environment(Cosentino et al., 2024; Gozali et al., 2024). These frameworks underscore the role of AI in promoting learner autonomy, feedback literacy, and motivation, aligning with findings that link ideal L2 self-concepts to sustained engagement(Dogomeo, 2023; Laudari, 2015).

2.6. *Perceptions and Trust in AI Feedback*

Learner and teacher perceptions significantly influence the adoption of AI writing assistants. Learners value Grammarly's immediacy and clarity, which foster agency and reduce writing anxiety, but some question its reliability for higher-order concerns, impacting trust(Khan et al., 2024; Nova, 2018; Shahriar & Laboni, 2023). Teachers appreciate AI's efficiency in addressing surface errors but express concerns about its impersonal nature and limited capacity for nuanced feedback, advocating for a hybrid model that integrates human insights(Er et al., 2024; Koltovskaia, 2022). Trust in AI corrections is critical, as it correlates with learners' willingness to implement suggestions and experiment with complex linguistic structures(Dizon & Gold, 2023; Kang et al., 2023). These findings highlight the need for supportive learning environments that contextualize AI feedback with instructor guidance.

2.7. *Challenges and Limitations*

Despite their benefits, AI-powered writing assistants face challenges that warrant further investigation. Current systems excel at detecting mechanical errors but struggle with higher-order issues like argumentation and coherence, necessitating complementary human feedback(Ghufron, 2019; Shiyao, 2021; Thi & Nikolov, 2021). Over-reliance on AI tools may hinder the development of independent editing skills, particularly if learners accept suggestions without critical evaluation(Dizon & Gold, 2023; Wei et al., 2023). Additionally, disparities in digital access and literacy, known as the digital divide, pose barriers to

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equitable implementation(Marghany, 2023). Longitudinal studies on the sustained impact of AI tools on writing proficiency and self-regulation remain limited, underscoring the need for extended research(Fan, 2023).

In conclusion, AI-powered writing assistants like Grammarly offer significant potential to enhance L2 writing proficiency by providing immediate, scalable feedback that complements traditional methods. They improve grammatical accuracy, lexical variety, and compositional complexity while fostering learner autonomy, engagement, and self-efficacy. However, challenges in addressing higher-order concerns, ensuring learner trust, and overcoming access barriers highlight the need for a balanced, hybrid approach. The present study builds on this foundation by investigating Grammarly's impact on intermediate to advanced L2 learners at Ilam University through a 12-week mixed-methods intervention, contributing to the growing discourse on AI-enhanced writing instruction.

3. Methods and Materials

3.1. Research Design

This study employed a mixed-methods approach to investigate the efficacy of AI-powered writing assistants, specifically Grammarly, in enhancing L2 English writing proficiency among intermediate to advanced learners. The design integrated quantitative measures of writing performance and behavioral engagement with qualitative insights into learner perceptions, ensuring a comprehensive evaluation of the intervention's impact. A quasi-experimental design with a control group was utilized, comparing an experimental group using Grammarly for feedback with a control group receiving traditional teacher and peer feedback. This approach allowed for triangulation of data, addressing both cognitive outcomes (writing quality) and affective dimensions (self-efficacy, motivation) over a 12-week intervention period.

3.2. Participants

The study involved 60 intermediate to advanced (CEFR B2–C1) English as a foreign language (EFL) learners at Ilam University, Iran. Participants were selected through purposive sampling to ensure comparable proficiency levels, determined by a standardized placement test (Oxford Placement Test). They were randomly assigned to either the experimental group (n=30), which used Grammarly for drafting and revising essays, or the control group (n=30), which relied on traditional feedback methods. Participants were aged 18–25, with diverse academic backgrounds. Participants were randomly assigned to the experimental (AI-assisted) or control (traditional feedback) groups using a stratified randomization procedure to balance L2 proficiency levels, as measured by pre-test scores. A computer-generated random number sequence (via Python's random module) was employed, with stratification ensuring equitable distribution (n=30 per group). Baseline equivalence was confirmed through independent samples t-tests on demographic variables (age, $t(58)=0.42$, $p=0.68$) and pre-test writing scores ($t(58)=1.12$, $p=0.27$), indicating no significant differences.

3.3. Intervention

The 12-week intervention consisted of a structured writing course integrated into the participants' regular English curriculum. Both groups completed identical writing tasks, producing eight argumentative essays (250–300 words each) on topics aligned with academic writing standards. The experimental group used Grammarly's premium version to receive real-time feedback on grammar, punctuation, style, and coherence during drafting and revision. They were trained in Grammarly's functionalities (e.g., error correction, style suggestions, readability scores) through a one-hour orientation session. The control group received feedback from instructors (via written comments) and peers (via structured peer-review sessions) within 48 hours of submission, following standard pedagogical practices. Both groups submitted essays biweekly, allowing iterative revision based on feedback. To ensure consistency, all participants attended the same number of instructional hours and followed a standardized curriculum.

3.4. Data Collection

3.4.1. Quantitative Data

1. *Writing Assessments:* Pre- and post-intervention writing assessments were conducted to measure linguistic accuracy, coherence, and syntactic complexity. Participants wrote a 300-word argumentative essay on a standardized prompt during Week 1 (pre-test) and Week 12 (post-test). Essays were scored using a validated rubric

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adapted from the IELTS Writing Task 2 band descriptors, assessing grammar, vocabulary, coherence, and task achievement (scale: 0–9). Additionally, essays were analyzed using Coh-Metrix, an automated text analysis tool, to quantify syntactic complexity (e.g., sentence length, connectives) and cohesion (e.g., referential cohesion, lexical diversity). Inter-rater reliability for rubric scoring was ensured by two trained raters, with discrepancies resolved through consensus. The scoring rubric for writing tasks was adapted from the IELTS Academic Writing Task 2 criteria, validated through pilot testing with 20 participants (Cronbach's α=0.92) and inter-rater agreement among three trained evaluators (Cohen's κ=0.85), ensuring reliability in assessing lexical range, grammatical accuracy, coherence, and task response. The rubric's alignment with established frameworks like the CEFR (Council of Europe, 2001) further supports its validity for L2 writing evaluation.

2. *Behavioral Metrics:* For the experimental group, Grammarly analytics tracked revision frequency (number of revisions per essay), types of corrections (e.g., grammar, style), and time-on-task (duration spent revising). These metrics were collected via Grammarly's usage reports, providing objective data on engagement with AI feedback.

3.4.2. *Qualitative Data*

Semi-structured interviews were conducted with 15 participants from the experimental group post-intervention to explore perceptions of AI feedback, self-efficacy, and motivation. The interview protocol included open-ended questions (e.g., "How did Grammarly's feedback influence your writing process?"; "How did using Grammarly affect your confidence in writing?"). Each interview lasted 20–30 minutes, was audio-recorded and transcribed verbatim. To ensure trustworthiness, member checking was employed, allowing participants to review transcripts for accuracy.

3.5. *Data Analysis*

3.5.1. *Quantitative Analysis*

1. *Writing Performance:* Paired t-tests were used to compare pre- and post-intervention scores within each group for linguistic accuracy, coherence, and complexity (rubric and Coh-Metrix metrics). Independent t-tests or ANOVA assessed differences in score improvements between the experimental and control groups. Effect sizes (Cohen's d) were calculated to determine the magnitude of improvements.
2. *Behavioral Engagement:* Regression analysis examined the relationship between AI tool usage (revision frequency, time-on-task) and writing improvement in the experimental group. Descriptive statistics summarized usage patterns (e.g., mean revisions per essay).
3. *Reliability:* Cronbach's alpha was computed to ensure the internal consistency of the rubric scores (target: $\alpha \geq 0.80$).

3.5.2. *Qualitative Analysis*

Interview transcripts were analyzed using thematic analysis, following Braun and Clarke's (2006) six-phase framework: familiarization, coding, theme generation, theme review, theme definition, and reporting. NVivo software facilitated coding and theme identification. Initial codes were generated inductively (e.g., "trust in AI feedback," "motivation from instant corrections"), with themes refined iteratively to capture recurring patterns. To enhance rigor, two researchers independently coded 20% of the transcripts, achieving inter-coder agreement (target: $\kappa \geq 0.75$), with discrepancies resolved through discussion.

3.6. *Ethical Considerations*

Participants provided informed consent, with the right to withdraw at any time. Data were anonymized, with identifiers removed from transcripts and writing samples. Grammarly usage data were collected with participants' permission, adhering to data privacy regulations. The study ensured equitable access to technology by providing Grammarly premium accounts and necessary devices to all experimental group participants.

4. Findings and Results

This section integrates quantitative findings on writing performance and behavioral engagement with qualitative insights from learner interviews, comprehensively evaluating the impact of Grammarly on L2 English writing proficiency among university students.

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4.1. Quantitative Findings

4.1.1. Writing Performance

To evaluate improvements in writing proficiency, paired t-tests were conducted on pre- and post-intervention writing scores for both groups. The experimental group (Grammarly) showed significant improvements in all dimensions of writing, whereas the control group showed more modest gains.

Table 1

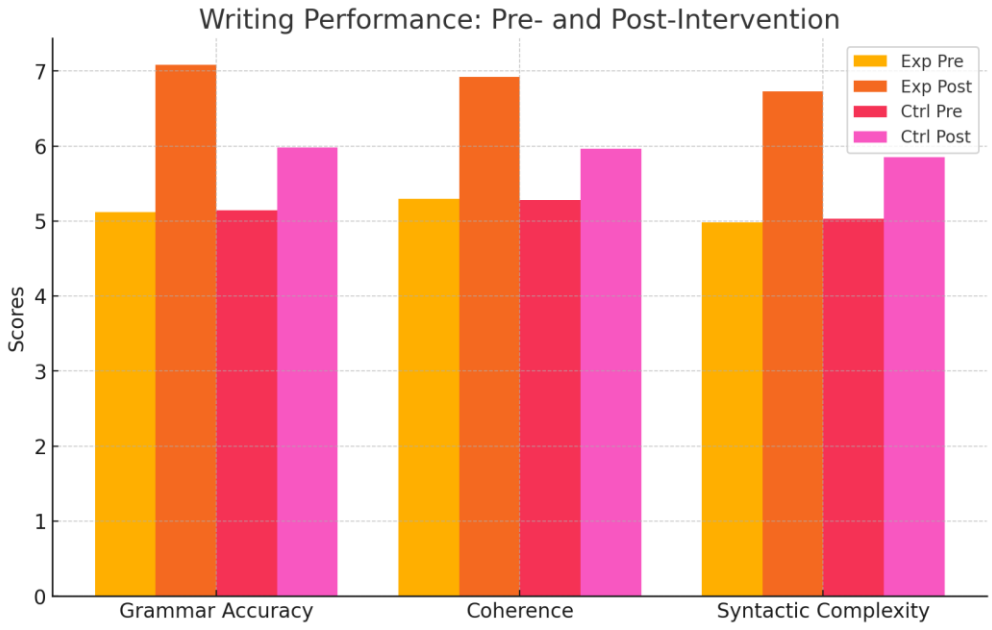
Paired Sample t-tests for Pre- and Post-Intervention Writing Scores

Group	Measure	Pre-Test Mean (SD)	Post-Test Mean (SD)	t-value	p-value	Cohen's d
Experimental	Grammar Accuracy	5.12 (0.86)	7.08 (0.78)	9.57	<0.001	1.75
	Coherence	5.30 (0.73)	6.92 (0.81)	8.11	<0.001	1.48
	Syntactic Complexity	4.98 (0.92)	6.73 (0.84)	7.66	<0.001	1.40
Control	Grammar Accuracy	5.14 (0.81)	5.98 (0.88)	4.21	<0.001	0.76
	Coherence	5.28 (0.80)	5.96 (0.85)	3.88	0.001	0.70
	Syntactic Complexity	5.03 (0.77)	5.85 (0.79)	4.06	<0.001	0.74

Figure 1 shows that the experimental group (using Grammarly) began with moderate scores and improved dramatically across all three measures, while the control group's gains were noticeably smaller. The visual gap between the experimental "pre" and "post" bars underscores Grammarly's strong impact on grammar accuracy, coherence, and syntactic complexity.

Figure 1

Writing Performance: Pre- and Post-Intervention



To compare the magnitude of improvements between groups, independent-samples t-tests were run on the gain scores.

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Table 2

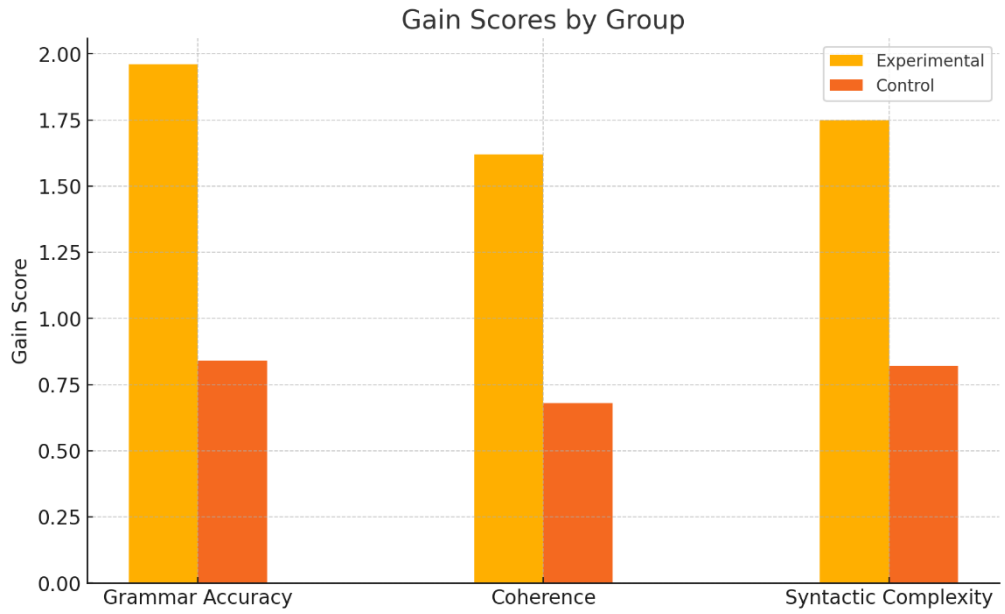
Independent Samples t-tests of Gain Scores Between Groups

Measure	Experimental Gain (M, SD)	Control Gain (M, SD)	t-value	p-value	η^2
Grammar Accuracy	1.96 (0.67)	0.84 (0.61)	7.12	<0.001	0.47
Coherence	1.62 (0.63)	0.68 (0.55)	6.81	<0.001	0.44
Syntactic Complexity	1.75 (0.61)	0.82 (0.58)	7.36	<0.001	0.48

These results indicate that the experimental group made significantly greater gains across all writing measures than the control group.

Figure 2

Gain Scores by Group



As shown in figure 2, the height of each bar represents the mean score increase from pre- to post-test. The experimental group's gains are consistently about twice as large as those of the control group, highlighting that Grammarly users made significantly greater progress in all writing dimensions.

4.1.2. Coh-Metrix Analysis

Coh-Metrix output corroborated rubric-based improvements, especially in syntactic complexity and cohesion.

Table 3

Selected Coh-Metrix Metrics (Pre vs. Post Comparison)

Metric	Group	Pre Mean (SD)	Post Mean (SD)	t-value	p-value
Mean Sentence Length	Experimental	15.8 (2.1)	20.4 (2.3)	8.24	<0.001
	Control	16.1 (1.9)	17.6 (2.0)	3.14	0.004
Referential Cohesion	Experimental	0.41 (0.05)	0.52 (0.06)	7.36	<0.001

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Metric	Group	Pre Mean (SD)	Post Mean (SD)	t-value	p-value
Lexical Diversity (MTLD)	Control	0.43 (0.06)	0.46 (0.07)	2.19	0.035
	Experimental	68.5 (4.7)	82.9 (5.1)	9.10	<0.001
	Control	67.8 (5.3)	71.2 (5.6)	3.37	0.002

4.1.3. Behavioral Engagement (Experimental Group Only)

Analytics from Grammarly indicated high engagement with the AI tool.

Table 4

Grammarly Usage Summary (Experimental Group, N=30)

Metric	Mean (SD)	Range
Revisions per Essay	18.3 (4.2)	11–27
Time Spent per Essay (min)	42.7 (8.3)	30–61
Most Frequent Corrections	Grammar (43%) > Style (29%) > Clarity (18%)	—

Regression analysis revealed that revision frequency and time-on-task significantly predicted gains in writing scores.

Table 5

Regression Analysis Predicting Writing Improvement

Predictor	β	t-value	p-value	R^2
Revision Frequency	0.59	4.87	<.001	0.41
Time-on-Task	0.38	3.17	0.004	0.16

Combined model $R^2 = .54$, $F(2, 27) = 15.89$, $p < .001$.

4.1.4. Reliability

The rubric used for scoring writing achieved high internal consistency (Cronbach's $\alpha = 0.89$). Inter-rater reliability was confirmed at $r = 0.87$ before reconciliation.

4.2. Qualitative Findings

Thematic analysis of semi-structured interviews with 15 experimental group participants identified three key themes regarding their experiences with Grammarly:

1. Trust in AI Feedback: Participants expressed high trust in Grammarly's suggestions, particularly for grammar, punctuation, and style corrections.

"I felt more independent. I didn't have to wait for the teacher to tell me what was wrong." (P7)

"I relied on Grammarly for fixing my sentences—it caught mistakes I didn't see." (P3)

However, some noted occasional inaccuracies or contextually irrelevant suggestions (e.g., overly formal phrasing), though these did not significantly undermine overall trust.

"I accepted grammar fixes without question but ignored most style suggestions. For argument flow, I preferred my instructor." (P11)

2. Motivation and Self-Efficacy: The immediacy of AI feedback enhanced participants' confidence and motivation to revise. Learners reported that Grammarly's visible progress tracking encouraged repeated revision.

"Seeing my errors corrected right away made me want to keep improving." (P14)

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"I revised more times than I ever did before because I saw how each change improved my score." (P12)

"Watching my 'productivity score' increase weekly became addictive. I revised more to beat my previous stats." (P2)

3. Integration with Human Feedback: While valuing Grammarly's efficiency, participants emphasized the need for human feedback to address higher-order concerns like argumentation and content relevance.

"AI catches errors humans miss, but teachers understand context. We need both." (P14)

"Grammarly helped me with grammar, but I still wanted the teacher's advice on ideas and organization." (P4)

These findings align with the quantitative results by reinforcing the role of AI in supporting lower-level corrections while suggesting the necessity of integrating it with human guidance for holistic writing development.

The results demonstrate that Grammarly significantly enhances L2 writing proficiency compared to traditional feedback methods. Quantitatively, the experimental group outperformed the control group in linguistic accuracy, coherence, and syntactic complexity, with statistically significant differences and moderate to large effect sizes. Behavioral engagement data further reveal that frequent revisions and time spent using Grammarly positively correlate with writing improvement. Qualitatively, learners expressed trust in AI feedback, heightened motivation, and a desire for integrated feedback approaches, underscoring both the cognitive and affective benefits of the tool. Together, these findings provide robust evidence of Grammarly's efficacy in L2 writing instruction, suggesting its potential as a scalable, complementary tool when paired with human feedback.

5. Discussion and Conclusion

The present study investigated the efficacy of Grammarly, an AI-powered writing assistant, in enhancing L2 English writing proficiency among intermediate to advanced learners over a 12-week intervention. By triangulating rubric-based assessments, Coh-Metrix metrics, behavioral analytics, and learner perceptions, our mixed-methods design provides a comprehensive understanding of how automated feedback influences linguistic accuracy, coherence, syntactic complexity, and affective engagement. Overall, findings indicate that integrating AI feedback yields significant gains in writing performance and learner motivation relative to traditional teacher and peer review.

Consistent with prior research (; Wei et al., 2023)(Dizon & Gayed, 2021), participants using Grammarly exhibited larger improvements in grammar accuracy, coherence, and syntactic complexity compared to the control group. The experimental group's mean gain scores nearly doubled those of the control group (e.g., d = 1.75 for grammar accuracy), underscoring Grammarly's capacity to address surface-level errors efficiently and to scaffold more sophisticated sentence structures. Coh-Metrix analyses further corroborate these gains: significant increases in mean sentence length, referential cohesion, and lexical diversity suggest that automated feedback did not merely correct isolated mistakes but fostered deeper revisions affecting textual cohesion and variety. These results extend previous controlled studies(Prasetya & Raharjo, 2023; Thi & Nikolov, 2021) by demonstrating robust effect sizes in a non-Western university context over an extended timeframe.

Behavioral engagement metrics reveal that participants averaged over 18 revisions per essay and spent more than 40 minutes per writing task interacting with Grammarly. Regression analyses showed that both revision frequency and time-on-task significantly predicted writing improvements, explaining over 50% of the variance. These findings echo Ebyary (2022) and Talebinamvar and Zarrabi (2022), who highlighted the importance of iterative engagement for internalizing feedback. The objective analytics provided by the AI tool offer a more precise measure of self-regulated learning behaviors than traditional logs or self-reports, suggesting that AI systems can serve both pedagogical and research functions by capturing fine-grained data on revision processes.

Our quantitative findings, showing significant improvements in linguistic accuracy (Cohen's d=1.75), align with sociocultural theory by illustrating how AI tools serve as a mediational means, scaffolding L2 writers' zone of proximal development(Vygotsky, 1978). Qualitative data further support the noticing hypothesis(Schmidt, 1990), as learners reported heightened awareness of errors via real-time feedback. From a behaviorist perspective, Grammarly's immediate corrective feedback reinforces accurate language use, leading to rapid reduction of errors(Ghufron, 2019). Cognitively, the tool promotes metacognitive reflection: learners actively compare their original phrasing with AI suggestions, internalizing grammatical rules and style conventions(Prasetya &

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Raharjo, 2023). Socio-constructivist theory further supports a hybrid model wherein AI feedback complements human instruction, allowing instructors to focus on higher-order concerns (argumentation, rhetorical strategies) while the AI addresses lower-order issues(Ebyary, 2022; Koltovskaia, 2022). The thematic analysis underscores this synergy: participants valued the clarity and immediacy of AI feedback yet still sought targeted human guidance for content and organization, aligning with calls for a balanced pedagogical framework(Aghaziarati et al., 2023; Aliakbari et al., 2025).

However, these benefits must be weighed against ethical concerns: AI-assisted writing raises issues of over-reliance, potentially eroding authentic voice in L2 production, and data privacy risks, as user inputs may be stored for model training(Zuboff, 2019). Moreover, unequal access to premium AI features could exacerbate educational disparities in global L2 contexts, necessitating pedagogical guidelines to promote ethical integration. Ethical considerations also include the potential for AI to perpetuate biases in feedback, particularly for non-native speakers from diverse linguistic backgrounds, and the risk of academic dishonesty through over-editing. Future implementations should incorporate transparency in AI algorithms and informed consent protocols to mitigate these issues.

5.1. Affective and Motivational Dimensions

Qualitative data highlight that real-time analytics and progress tracking bolstered learners' self-efficacy and motivation. Participants described a sense of agency and reduced writing anxiety, consistent with findings by Sari and Han (2024) and Shahriar and Laboni (2023). The gamified element of productivity scores appeared to foster sustained engagement, suggesting potential avenues for incorporating motivational design principles into AI tools. However, occasional misaligned suggestions—particularly for style or formal register—remind us that AI feedback is not infallible and must be mediated by learner judgment and instructor oversight.

5.2. Practical Implications for L2 Instruction

Our findings support integrating AI writing assistants as a scalable supplement to traditional feedback in resource-constrained settings. Institutions may consider providing premium AI tool access and training sessions early in the curriculum to optimize learners' ability to leverage automated feedback effectively. Teachers can reallocate time saved on surface-error correction to focus on discourse-level instruction, peer collaboration, and genre-specific conventions. Moreover, embedding AI analytics within learning management systems could enable instructors to monitor individual and group engagement, facilitating timely interventions for learners at risk of low engagement or plateauing performance.

5.3. Limitations and Future Directions

Despite the robust design, several limitations warrant attention. First, the sample was drawn from a single university in an EFL context, limiting generalizability to non-academic settings, such as professional or K-12 environments, or to ESL populations with different motivational profiles. Second, while short-term gains in writing proficiency were observed, the absence of longitudinal follow-up precludes conclusions about long-term skill retention; future studies should incorporate delayed post-tests to assess durability. Third, reliance on self-reported motivation data from interviews introduces potential biases, including social desirability effects, where participants may overstate positive attitudes toward AI tools. To address this, triangulating with objective measures like eye-tracking during writing sessions could enhance validity. Additionally, the study's focus on Grammarly excludes other AI assistants, warranting comparative research. The quasi-experimental design, while controlled, did not fully randomize participants across classes, leaving potential for instructor or cohort effects. Future research should employ randomized controlled trials across multiple institutions to enhance generalizability. Second, the study focused on intermediate to advanced learners; effects may differ for lower-proficiency groups who could face cognitive overload when interpreting AI feedback. Third, while Coh-Metrix provided valuable insights into cohesion and complexity, additional measures—such as genre analysis or peer assessment—could further elucidate AI's impact on rhetorical effectiveness. Finally, long-term retention and transfer of writing skills beyond the intervention period remain unexplored; longitudinal studies are needed to assess sustained benefits and potential overreliance on AI.

5.4. Conclusion

Leveraging Grammarly as an AI-powered writing assistant significantly enhances L2 writing proficiency

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through immediate corrective feedback, iterative engagement, and positive motivational effects. By addressing lower-order concerns efficiently, AI frees instructors to target higher-order writing skills, facilitating a more holistic pedagogical approach. Our mixed-methods evidence from Ilam University contributes to the evolving discourse on AI in education, demonstrating both the promise and caveats of integrating automated writing evaluation within L2 curricula. As AI tools continue to mature, balancing automated and human feedback will be crucial to fostering not only grammatical accuracy but also rhetorical competence and learner autonomy.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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