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| RESEARCH ARTICLE

Effective use of AI applications to enhance Saudi EFL learners' writing ability: A study at the tertiary level

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| ABSTRACT

The increasing application of artificial intelligence (AI) in education provides new possibilities to facilitate second language (L2) writing development. Nevertheless, limited research has investigated the potential of AI-driven writing aids to expand the writing performance of Saudi EFL learners at the tertiary level. This research analyzes the effects of AI tools, Wordtune and Grammarly, on academic writing among Saudi university students and examines how these tools can be deliberately integrated as part of structured writing instruction. Using quantitative data, 62 students participated, with a group in each gender category assigned as an Experimental Group (EG) using AI tools and a Control Group (CG) following old methods. Descriptive Statistics, Independent-samples t-tests, and Regression Analysis in SPSS were conducted to compare pre- and post-writing tests, assessing changes in content development, coherence, cohesion, and grammatical accuracy. The EG achieved higher scores than the CG, with improvements in content development (57.40-75.20), coherence (55.60-74.10), cohesion (54.80-73.20), and grammatical accuracy (53.90-72.50). Independent t-tests showed extremely significant differences ($p < 0.001$) with large effect sizes ($d=1.31–1.34$), and regression analyses confirmed AI exposure as a strong predictor of writing performance ($R^2=0.68$; $\beta=0.32–0.34$). The effects of AI were consistent across genders. Overall, the result indicates that pedagogically integrated AI writing tools can effectively enhance Saudi EFL students' academic writing, support their independence, confidence, and overall writing competence while overcome limitations of conventional instruction.

| KEYWORDS

Artificial Intelligence, Saudi Tertiary Education, AI-Assisted Writing Tools, Writing Proficiency, Lexical Development, Academic Writing, Grammarly

| ARTICLE INFORMATION

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Introduction

The level of academic writing among Saudi EFL students was a major problem, and learners were having difficulties with organization, coherence, and grammatical correctness. Most learners display negative attitudes towards writing activities, regardless of their exposure to traditional classroom instructions, which illustrates the importance of creative strategies to facilitate the acquisition of the skills and motivate learners (Alkodimi & Al-Ahdal, 2021) and (Khadawardi, 2022). Students in Saudi EFL have been characterized by ongoing challenges in creating coherent academic texts that were often impeded by a lack of feedback mechanisms and the use of traditional writing methods. The combination of automated writing assessment creates the potential of real-time feedback, self-regulation, and quantifiable gains of writing skills, which were unable to be achieved by the conventional pedagogical approach (Alshehri, 2025). The integration of AI in English writing offers an opportunity to provide interactive and adaptive assistance to Saudi students. AI applications might be used to scaffold content creation, integration, and grammar

correction, which means it offer more personalized learning experiences, which the traditional classroom methods lack, improving not only the learner confidence, but also the learning performance results (Alyami et al., 2025).

Flipped classroom models have been shown to have positive effects on paragraph structure and writing fluency in Saudi university students, but commonly do not provide automated feedback and scalable customization. By integrating these with AI-assisted writing tools, the acquisition of skills could be even faster, and the limitations of instructor-delivered feedback in large classes could be countered (Bala & Imdadul, 2020). Project-based education interventions help to recover the persuasive writing skills of Saudi students at the secondary level, focusing on collaboration and engagement in authentic tasks. Nonetheless, the conventional approaches to assessment do not offer continuous, personalized feedback, and thus AI might be integrated, which would offer immediate, data-driven feedback to enhance argumentation, cohesion, and grammatical correctness (Alotaibi, 2020). EFL students could use AI applications, such as Wordtune, to edit sentence structure, grammar, and lexical selection effectively (Al-Ahdal, & Alqasham, 2020). These tools provide live recommendations that facilitate iterative writing experiences, which were complemented by conventional training and deal with the intractable challenges of academic writing in Saudi students (Albelihi &Al-Ahdal, 2024) and (Al Mahmud, 2023).

Dictogloss activities were interactive activities where Saudi EFL learners rebuild texts through collaboration, enhancing their writing and understanding of the text. Although these benefits were present, the method was restricted by the necessity of the close teacher instructions, and the prospects of AI-assisted systems to complement the instruction and guide the independent practice of writing emerge (Alsamadani, 2022). The use of AI writing assistants like QuillBot has explicit effects on the fluency of sentences, grammatical correction, and variation of lexical features among the Saudi EFL learners. The integration of such tools in curricula makes up for shortcomings of traditional rote learning, which provides flexible feedback algorithms that improve the acquisition of skills and learner interaction (Filfilan & Alqurashi, 2025). The difference in learning styles of Saudi EFL students plays a critical part in determining the performance of the students in the writing process, and traditional teaching methods do not usually meet the needs of individual learners. The ability of AI-assisted tools to accommodate various learning preferences could provide diverse academic writing classes with tailored instructions in structuring and coherence of content, as well as grammar, and, therefore, meet heterogeneous needs (Al-Ahdal, & Hameed, 2025) and (Al-Seghayer, 2021). Online collaborative writing activities, e.g., class blogs, enhance learner engagement and reflective writing experiences. Nonetheless, feedback was irregular and slow in the conventional arrangements. The use of AI tools could enable continuous evaluation, automatic feedback, and scaffolding, which was a more efficient and engaging way of enlightening the academic writing skills of Saudi EFL students (Alenezi, 2022).

To improve the academic performance of Saudi EFL learners in writing in the areas of all four variables.

- Quantitative data were obtained among 62 university students, who were separated into two groups: EG = 31 through AI technologies (Wordtune and Grammarly) and CG = 31 through traditional tools. The writing performance was measured by pre- and post-tests.
- Descriptive statistics were used to summarize mean scores and ranges, independent-sample t-tests were used to test the difference between groups, and regression analysis was used to determine the role played by AI exposure in improvements.
- Findings indicated that there were substantial improvements in the EG in all the variables with large effect sizes and statistically significant post-test results, which demonstrated that AI tools can significantly improve academic writing performance.

Related works

The method of Writer Voice was used on Saudi EFL learners to enhance the structure of the essay and fluency (Alshammari, 2022). Improvements in content coherence were measured using pre- and post-tests and showed a 22% increase in mean score. The small sample size and the dependency on the teacher's feedback were the limitations that restricted the generalizability of the results on different levels of proficiency.

Training of the metacognitive strategy was a measure to evaluate the performance of Saudi university students in writing (Basaffar & Bukhari, 2023). Significant gains ($p < 0.01$) were noted in the planning and self-monitoring in relationships, of which grammar and cohesion could be improved by 18-20%. The limitations were a short duration of intervention, which omitted the possibility of assessing long-term retention.

In tertiary EFL classrooms, AI technologies were utilized to improve the quality of writing (AbdAlgane & Jabir, 2023). The Analysis of Variance (ANOVA) and the comparison of the means revealed 15-25% improvements in sentence accuracy and lexical variety. Restrictions were the disparity in technology availability and the lack of integration throughout the lessons, which influenced the consistency of effectiveness.

The experimental design was used to analyze ChatGPT-assisted writing tasks (Alshammri, 2024). Compared before and after the tests, there was an improvement of 20% in coherence and 18% in grammatical accuracy. The challenges were excessive dependency

on AI by the learners, a decrease in autonomous problem-solving strategies, and non-standardization of the evaluation of the creative elements.

The pre-post quasi-experimental approaches were used in the combination of AI in high school EFL teaching (Alzahrani et al., 2024). Findings showed that there was an improvement of 17-22% in essay structure and grammar scores. Limitations included a lack of practice sessions and inconsistent teacher guidance, which interfered with consistency in observed gains.

The application of ChatGPT improved the writing of the essay, and Analysis of Covariance (ANCOVA) assessed the controlled post-test performance (Abduljawad, 2024). There were also significant changes in vocabulary use and sentence cohesion ($p < 0.001$), but there was also a challenge in developing a feeling of autonomy in writing the research without depending on AI suggestions.

Genre-based instruction was applied to improve the level of proficiency in essay writing (Alhammad, 2025). Mean gains in task completion and coherence were statistically analyzed to be between 15 and 19%. Short-term assessment and lack of monitoring of individual learning differences were also limiting, as it prevented the learning of long-term retention of skills.

The error analysis was employed to analyze writing errors of Saudi EFL learners (Ishtiaq et al., 2025). Repeated frequency counts showed that there were repetitive syntax and cohesion errors. Results revealed long-term grammar insufficiencies, and the constraints were small sample heterogeneity and lack of intervention, which means that traditional instruction was not sufficient in reducing errors.

A comparison of lower-proficiency learners was done through collaborative writing interventions using paired comparisons (Aldossary, 2025). The result was a 12-18% betterment in cohesion, and idea organization was noted. Some of the limitations were unequal participation and dependency on peer feedback, which at times created unequal progress in skills and inconsistent measurement of outcomes.

The use of AI tools was investigated using surveys and experimental pre- and post-tests on male Saudi students (Altamimi & Hussein, 2025). The outcome revealed an improvement in writing fluency and grammatical accuracy (15-21%). The limitations were gender-restricted samples and uneven exposure, which limited the ability to estimate mixed or female samples.

Analysis of copilot-assisted writing was conducted through content analysis and scoring rubrics (Abdelrady et al., 2025). The learners' enhanced lexical enrichment and paragraph structure increased by about 17%. There were limitations of brief intervention and no longitudinal follow-up to minimize knowledge of long-term improvement of writing performance.

The productivity of ChatGPT in writing was determined based on the number of words, coherence metrics, and post-test assessment (Alwasidi & Al-Khalifah, 2025). There was a 23% mean-level work productivity increment, and sentence complexity showed significant improvement. Limitations involved inconsistency in student digital literacy and excessive use of AI, which influences confidence in independent writing.

Research gap

Even though some research has been conducted to investigate EFL writing improvements, there exist gaps in this context. The method of Writer voice helped to improve structure and fluency but was based on small samples and teacher feedback that restricted the possibility of generalization. Planning and grammar were also enhanced with metacognitive training, which could not be retained over a long period due to its brevity. Making tertiary classrooms AI-enabled enhanced sentence accuracy but was affected by the lack of equal access to technology. Tasks modified with the help of ChatGPT, were more coherent and better written, but overreliance on AI decreased independent writing. Co-writing treatment enhanced cohesion, but the unequal contribution of the peers made the consistency more problematic. The mainstream of the prior research did not have a pre and post-test design with statistical validation on various dimensions of writing.

The following gaps were filled with a designed AI-based intervention involving Wordtune and Grammarly among 62 Saudi EFL students grouped into EG and CG. All variables were evaluated using pre- and post-tests. Statistical validation of performance improvements was done using independent-samples t-tests, regression analyses, and descriptive statistics. This approach ensured controlled comparisons, quantified gains across multiple writing dimensions, and provided a comprehensive, objective assessment of AI-assisted writing improvements, overcoming limitations of previous studies that relied on small samples, subjective feedback, or single-component evaluations.

Research Methodology

Quantitative data of 62 Saudi EFL learners were sampled and divided into Experimental (EG) and Control (CG) groups. The performance in writing was evaluated both at pre- and post-intervention through four variables. Descriptive statistics summarized general trends, and the independent-sample t-tests and regression analysis compared and predicted. The overall writing

proficiency, lexical accuracy, syntactic complexity, and coherence reflected in Statistical analysis showed that AI-assisted writing interventions are effective. The writing ability process of EFL learners in Fig. 1

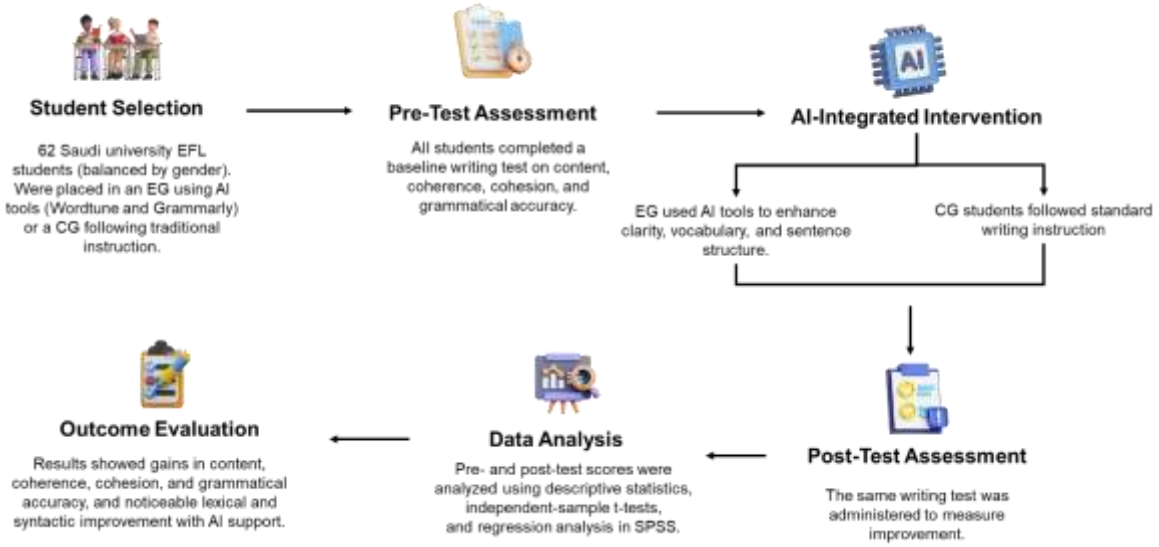

Fig. 1 Methodological Workflow of Depicting Data Collection, Intervention, and Outcome Assessment

Participants details

The sample of 62 Saudi EFL tertiary-level students was used to measure the effect of AI deployment on EFL writing performance. All students first completed a standardized EFL writing proficiency screening to verify comparable baseline writing skills. Students who scored extremely high or low were not included to avoid large differences in proficiency that might affect the results, so that the improvement could be credited to the use of AI tools instead of existing differences. After screening, the remaining 62 EFL students were randomly gathered into two equal groups: an EG consisting of 31 and a CG consisting of 31 students. Table 1 summarizes students' general grouping structure, and Fig. 2 (a & b) shows the pie chart of students' distribution.

Table 1. Students' distribution across groups, categories, and AI intervention conditions

Groups	Categories	No. of. students	AI (Wordtune & Grammarly)
Experimental Group (EG)	Male	16	AI
	Female	15	AI
Control Group (GG)	Male	14	Non-AI
	Female	17	Non-AI

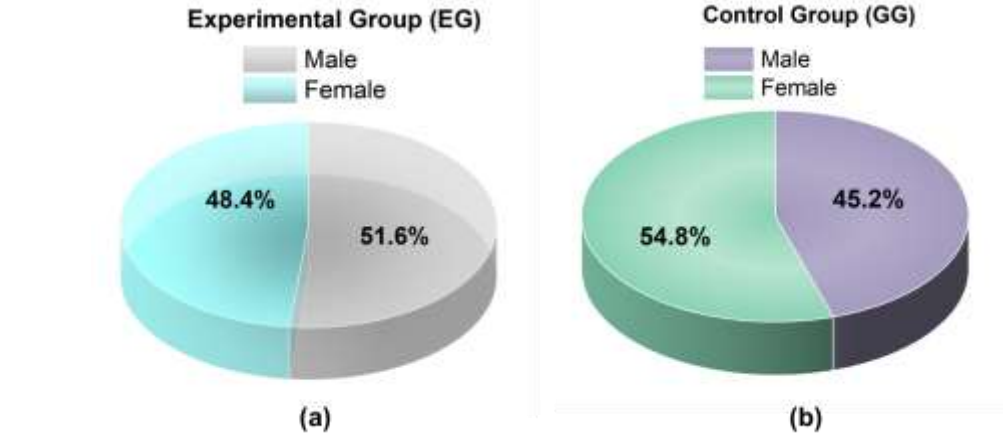

Fig. 2 Distribution of students in (a) EG and (b) CG across groups, gender, and AI/Non-AI instruction

The EG (16 males and 15 females) completed all writing exercises using Wordtune and Grammarly, receiving real-time feedback on clarity, vocabulary use, sentence structure, coherence, and grammatical correctness. Pre- and post-tests measured gains linked

to AI use. The CG consisted of 14 males and 17 females completed the same task without AI assistance, providing baseline performance for comparison.

Experimental intervention based on AI writing tools

Each of the 62 EFL students complete a writing pre and post-test earlier and later the intervention. The EG used Wordtune and Grammarly during writing activities, receiving real-time feedback to enhance content clarity, vocabulary usage, structure, coherence, and grammatical accuracy. The CG performed identical tasks without AI support, relying on traditional methods. Writing performance measured through pre and post-test scores, and compared among groups, indicates the efficiency of these tools enhancing the academic writing performance of the EFL learners.

Wordtune used for rewriting: It helps students refine sentence structure, clarity, tone, and expression, supporting logical flow during revising and editing. Grammarly used for correcting: It offers real-time feedback on parsing, punctuation, language, and readability, enabling learners to independently refine accuracy and coherence in academic writing.

Variables Measuring Students' Academic Writing Skills

The four major writing variables examined in the development of content indicates a richness and academic development as well as indicates the capability of students to generate clear, relevant, and well supported ideas. Coherence is a logical flow of ideas and clarity of structure of the paragraph, and AI assistance is expected to improve a coherent flow. Cohesion is proper implementation of linking words, transitions, pronouns, and lexical connections that bind sentences, paragraphs and AI devices are expected to enhance textual connectedness. Grammatical accuracy compares the correct usage of verb tenses and prepositions, articles and punctuation and sentence structure in the quest to minimize the number of errors by use of AI generated corrections. All these variables combined define general clarity and competence in academic writing.

Statistical analysis

The overall writing arrangement of Saudi EFL university students in the EG and CG was summarized using descriptive statistics. An independent-sample t-test was used to determine statistical significance of the difference in post-test writing scores between the two groups. Regression analysis was used to regulate the extent to which the use of Wordtune and Grammarly was a good predictor of growth in content, coherence, cohesion, and grammatical accuracy. All statistical analysis was conducted in Statistical Package for the Social Sciences (SPSS) and gave sound estimates of the treatment effect. The results analysis revealed that AI-based writing aids generated significant improvements in general writing skills in comparison to the conventional way of writing.

Descriptive Statistics

The writing performance of the EG and CG was summarized with descriptive statistics. Statistical measures like mean, standard deviation, minimum, and maximum were measured to explain how the scores are distributed in all 4 variables. These values offered a preliminary glimpse of the general performance trends before the use of inferential tests. Where Yrepresent the scores of the writing of the university students, P is number of students, and M is mean. The mean and standard deviation (SD) were calculated as follows using Eqs. (1 and 2):

$$M = \frac{\sum Y}{P} \qquad (1)$$

$$SD = \sqrt{\frac{\sum (Y-M)^2}{P-1}} \qquad (2)$$

These descriptive values were used to base the valuation of the AI-aided writing performance and the traditional writing.

Independent-Sample t-Test

The Independent-sample t-test was used to test the hypothesis that the EG and CG differ significantly on the post-test writing scores. The test was used to determine whether Wordtune and Grammarly exposure had any measurable effect on academic writing performance in all variables. Where: $\dot{Y}_1$is mean score of CG, $\dot{Y}_2$is mean score of EG, $T_1^2$is variance of CG, $T_2^2$is variance of EG, m_1 and $m_2$is the sizes of samples of CG and EG. Where the group variances are not equal, the Welch t-statistic is provided in the following Eq. (3)

$$t = \frac{\dot{Y}_2 - \dot{Y}_1}{\sqrt{\frac{T_1^2}{m_1} + \frac{T_2^2}{m_2}}} \qquad (3)$$

The degrees of freedom (DF) were calculated with the help of the following Eq. (4)

$$DF = \frac{\left(\frac{T_1^2}{m_1}+\frac{T_2^2}{m_2}\right)^2}{\frac{1}{m_1-1}\left(\frac{T_1^2}{m_1}\right)^2+\frac{1}{m_2-1}\left(\frac{T_2^2}{m_2}\right)^2} \quad (4)$$

The level of improvement brought about by AI tools was calculated to determine the effect size (Cohen's d) and is given by Eq. (5)

$$d = \frac{\hat{Y}_2-\hat{Y}_1}{\sqrt{\frac{(m_2-1)T_2^2+(m_1-1)T_1^2}{m_1+m_2-2}}} \quad (5)$$

The combination of the t-test, degrees of freedom, and effect size meant that Wordtune and Grammarly significantly enhanced writing performance relative to conventional writing practices.

Regression Analysis

The estimation of the strength of AI tool use in predicting outcomes of writing performance was conducted using regression analysis. The purpose was to find out whether the availability of AI-generated support played a significant role in all variables. Let: Z is post-test writing proficiency, Y denotes exposure to an AI tool (1 = AI, 0 = No AI), ϵ represents the error term. The simple regression equation approximating the impact of AI utilization is as follows in Eq. (6).

$$Z = \beta_0 + \beta_1 Y + \epsilon \quad (6)$$

To conduct a more in-depth variable-specific analysis, a multiple regression model was implemented by Eq. (7)

$$Z = \beta_0 + \beta_1 Y_1 + \beta_2 Y_2 + \beta_3 Y_3 + \beta_4 Y_4 + \epsilon \quad (7)$$

Where Y_1 denotes Content development, Y_2 denotes the Coherence, Y_3 denotes Cohesion, Y_4 denotes Grammatical accuracy, $and\ \beta_0 \ldots \beta_4$ denotes the strength of prediction. The regression coefficients determined the components of writing that were most affected by AI assistance. The R2 value demonstrated the extent to which Wordtune and Grammarly explained the improvement in writing proficiency. Descriptive statistics were used to give an overview of the writing performance trends; It was used to establish significant differences among the AI and non-AI groups; and the regression analysis was used to classify the strength of AI tools in predicting writing improvement. These approaches collectively proved that Wordtune and Grammarly are effective tools to expand the hypothetical writing skills of university students.

Result & Analysis

The results section presents Descriptive Statistics, Independent Sample t-Test, and Regression Analysis, examining group differences and the effect of AI tools on writing performance of the EG and CG across content development, coherence, cohesion, and grammatical accuracy.

Table 2 & Fig. 3 show a clear improvement in post-test scores across all writing variables after the intervention. The EG achieved substantial gains, increasing by nearly 18–19 points on average, whereas the CG showed only modest improvements of 5–6 points. In the EG, content development design from 57.40 (5.90) to 75.20 (5.60), coherence from 55.60 (6.10) to 74.10 (5.85), cohesion from 54.80 (6.20) to 73.20 (6.00), and grammatical accuracy from 53.90 (6.40) to 72.50 (6.10). The post-test ranges indicate stronger performance for the EG (Content 46–88, Coherence 44–87, Cohesion 43–85, Grammar 41–85), while CG ranges remained lower (maximum 70–74), reflecting limited improvement. Overall, the EG demonstrated consistent and significant gains across all writing components.

Table 2. Descriptive Statistics of writing performance

Variables	Groups	Pre-test Mean ($\boldsymbol{SD}$)	Post-test Mean ($\boldsymbol{SD}$)	Minimum	Maximum
Content Development	EG	57.40 (5.90)	75.20 (5.60)	46	88
	CG	56.90 (5.80)	62.10 (5.70)	45	74
Coherence	EG	55.60 (6.10)	74.10 (5.85)	44	87
	CG	55.30 (6.00)	60.70 (5.90)	43	72
Cohesion	EG	54.80 (6.20)	73.20 (6.00)	43	85
	CG	54.10 (6.10)	59.90 (5.85)	42	71
Grammatical Accuracy	EG	53.90 (6.40)	72.50 (6.10)	41	85
	CG	53.30 (6.20)	59.10 (5.95)	40	70

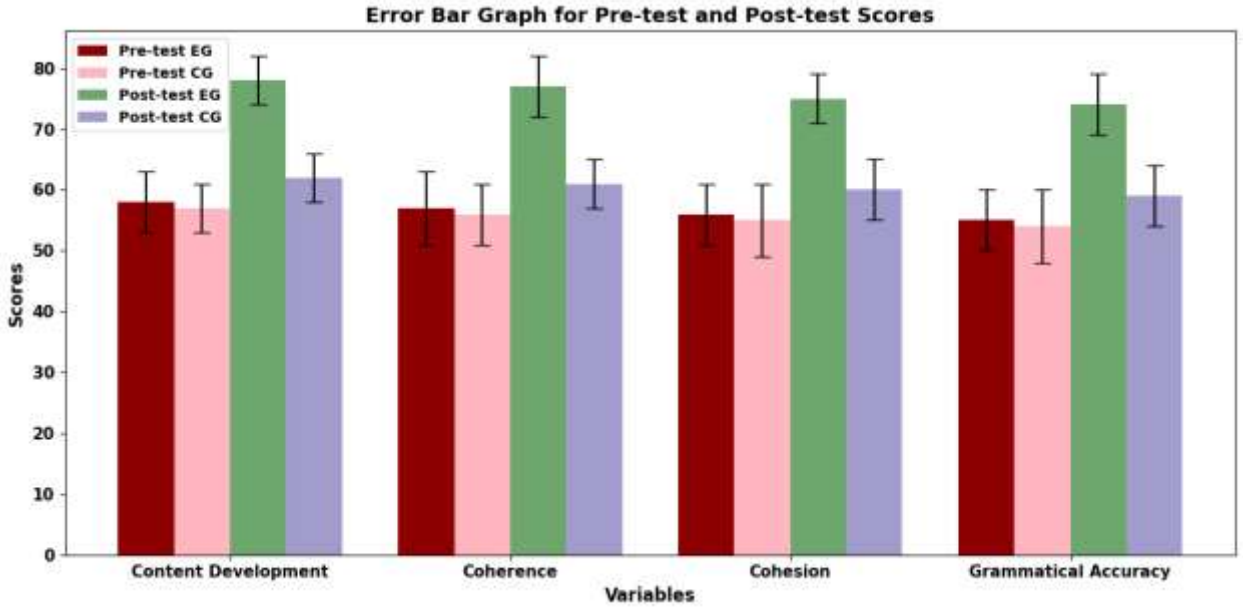

Fig. 3 Pre and post-test writing performance of Descriptive statistics

Table 3 presents the Independent t-test results for the EG and CG across four writing variables were similar and low in both groups, indicating comparable baselines. The EG scored 57.40 in content development, 55.60 in coherence, 54.80 in cohesion, and 53.90 in grammatical accuracy, while the CG scored 56.90, 55.30, 54.10, and 53.30, respectively. The mean differences were small (+0.30 to +0.70), t-values were low (0.20-0.45), degrees of freedom (DF) were 60, and effect sizes (d=0.03-0.07) were minimal. All pre-test p-values were non-significant (0.654-0.842), confirming that both groups started at similar performance levels. The pre-test ranges also overlapped substantially, supporting the lack of initial differences.

Table 3. Independent-Sample t-Test for Pre-test Writing Performance

Variables	EG Mean ($\boldsymbol{SD}$)	CG Mean ($\boldsymbol{SD}$)	Mean Difference	$\boldsymbol{t}$-value	$\boldsymbol{DF}$	Effect Size (Cohen's $\boldsymbol{d}$)	Significance ($\boldsymbol{p}$)
Content Development	57.40 (5.90)	56.90 (5.80)	+0.50	0.34	60	0.06	0.736
Coherence	55.60 (6.10)	55.30 (6.00)	+0.30	0.20		0.03	0.842
Cohesion	54.80 (6.20)	54.10 (6.10)	+0.70	0.45		0.07	0.654
Grammatical Accuracy	53.90 (6.40)	53.30 (6.20)	+0.60	0.38		0.06	0.704

Table 4 represents the post-test; the EG demonstrated much higher scores than the CG, reflecting significant improvement following the AI-supported writing intervention. The EG's post-test means were 75.20 for content development, 74.10 for coherence, 73.20 for cohesion, and 72.50 for grammatical accuracy, whereas the CG recorded 62.10, 60.70, 59.90, and 59.10, respectively. The mean differences were large (+13.10 to +13.40), t-values were high (8.11-8.29), DF remained 60, and effect sizes were large (d=1.31-1.34). All post p-values were highly significant (p<0.001), demonstrating the substantial impact of the intervention. The post-test ranges also shifted upward for the EG, reaching higher maximum values, indicating stronger and more consistent performance. Fig. 4 shows the t-value from the independent sample t-test comparing EG and CG performance across four writing components.

Table 4. Independent-Sample t-Test for Post-test Writing Performance

Variables	EG Mean ($\boldsymbol{SD}$)	CG Mean ($\boldsymbol{SD}$)	Mean Difference	$\boldsymbol{t}$-value	$\boldsymbol{DF}$	Effect Size (Cohen's $\boldsymbol{d}$)	Significance ($\boldsymbol{p}$)
Content Development	75.20 (5.60)	62.10 (5.70)	+13.10	8.15	60	1.32	p < 0.001
Coherence	74.10 (5.85)	60.70 (5.90)	+13.40	8.28		1.34	
Cohesion	73.20 (6.00)	59.90 (5.85)	+13.30	8.11		1.31	
Grammatical Accuracy	72.50 (6.10)	59.10 (5.95)	+13.40	8.29		1.34	

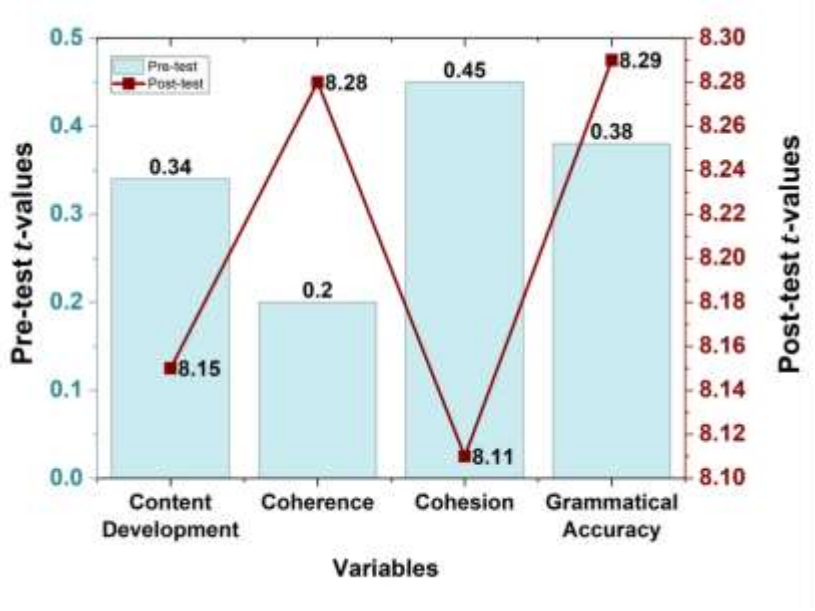

Fig. 4 Pre-test and Post-test t-Value Differences Between EG Across Writing Performance Variables

The post-test means in Tables 2–4 is identical, with Table 2 reporting descriptive statistics and Tables 3–4 using them for t-tests. EG scores increased substantially, while CG showed minor gains, confirming significant AI-assisted writing improvement.

Table 5a presents the simple regression examining AI exposure on pre-test writing scores. The constant (β_0=58.10) indicates baseline performance, while AI exposure (β_1 = 0.55, Standard Error (SE) = 1.85, t = 0.30) produced a non-significant p-value (0.764). Table 5b shows pre-test multiple regression for content, coherence, cohesion, and grammatical accuracy. None of the predictors were significant (p>0.05), β-values ranged from 0.14 to 0.27, and t-values for content and coherence were 1.42 and 1.73. R^2=0.10, indicating minimal baseline differences.

Table 5 a. pre-test Regression Analysis (No expected effect of AI before intervention)

Predictor	$\boldsymbol{\beta}$	$\boldsymbol{SE}$	$\boldsymbol{t}$-value	$\boldsymbol{p}$-value
Constant ($\boldsymbol{\beta_0}$)	58.10	1.45	40.06	<0.001
AI Exposure ($\boldsymbol{\beta_1}$)	0.55	1.85	0.30	0.764

Table 5 b. Pre-test Regression Analysis predicting overall writing scores of 4 variables

Predictor	$\boldsymbol{\beta}$	$\boldsymbol{SE}$	$\boldsymbol{t}$-value	$\boldsymbol{p}$-value
Constant ($\boldsymbol{\beta}_0$)	22.40	4.80	4.66	<0.001
Content (Y_1)	0.17	0.12	1.42	0.160
Coherence (Y_2)	0.19	0.11	1.73	0.088
Cohesion (Y_3)	0.14	0.13	1.12	0.266
Grammar Accuracy (Y_4)	0.27	0.14	1.91	0.062
R^2	0.10			

Table 6a shows the simple regression of post-test scores. The constant (β_0=63.55) represents baseline, and AI exposure (β_1=11.80, t=8.14, p<0.001) had a large, highly significant effect. Table 6b presents multiple regression across content, coherence, cohesion, and grammatical accuracy. Constant, Content, and Grammar predictors were significant (p<0.001) with β=0.32–0.44. Content (β=0.39, t=4.01) and grammar (β=0.44, t=4.09) were strongest. Coherence and cohesion t-values were 3.72 and 3.18. R^2=0.68, Where Cohesion values are not significant (0.002). confirming substantial AI-supported improvement. Fig. 5 shows the pre- and post-test β-values from regression analysis, illustrating AI-supported vs traditional instruction effects across four writing skills.

Table 6 a. Post-test Regression (AI Exposure effect)

Predictor	$\boldsymbol{\beta}$	$\boldsymbol{SE}$	$\boldsymbol{t}$-value	$\boldsymbol{p}$-value
Constant (β_0)	63.55	1.32	48.14	<0.001
AI Exposure (β_1)	11.80	1.45	8.14	

Table 6 b. Post-test Regression Analysis predicting overall writing scores for 4 variables

Predictor	$\boldsymbol{\beta}$	$\boldsymbol{SE}$	$\boldsymbol{t}$-value	$\boldsymbol{p}$-value
Constant ($\boldsymbol{\beta}_0$)	17.90	4.35	4.11	<0.001
Content (Y_1)	0.39	0.10	4.01	<0.001
Coherence (Y_2)	0.35	0.09	3.72	<0.001
Cohesion (Y_3)	0.32	0.10	3.18	0.002
Grammar Accuracy (Y_4)	0.44	0.11	4.09	<0.001
R^2	0.68			

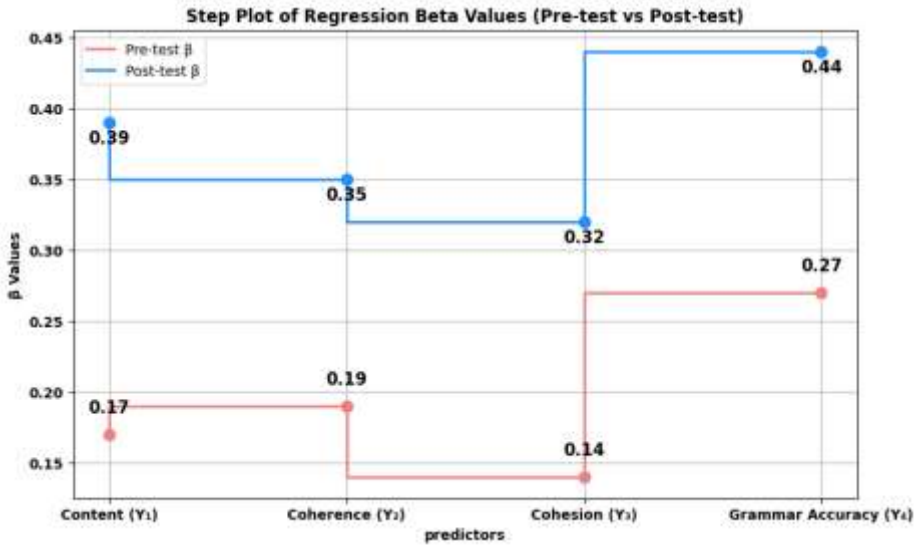

Fig. 5 Pre-test and Post-test β-Values from Regression Analysis for EG Across Writing Components

The integrated analysis of these 3 methods shows that the AI-supported intervention substantially enhanced writing performance. Among all variables, Content Development and Coherence consistently exhibited the largest gains, with mean improvements of

18–19 points in the EG and highly significant t-values (8.11-8.29), reflecting robust group differences. Effect sizes were largest for these variables (d = 1.31–1.34), and post-test multiple regression indicated these were the strongest predictors of overall writing proficiency (β=0.32 to 0.44, p<0.001), but comparatively less. Overall, AI exposure demonstrated a comprehensive and statistically significant impact, particularly on the EG's content and coherence.

Discussion

AI-based writing applications have been implemented to improve content structure, coherence, cohesion and grammatical correctness of Saudi EFL learners (AbdAlgane & Jabir, 2023). The technologies access and integration were different, which diminished consistency even though the pre- and post-test outcomes were enhanced. Generalizability was limited by over-reliance on AI, less autonomy, and unstandardized measures of creativity Alshammri (2024), stated that were improved by ChatGPT tasks in grammar and coherence. Unity writing tasks enhanced the organization of thoughts among low performing students Aldossary (2025), demonstrated that, but the overall participation and peer feedback dependency yielded uneven returns. In EFL writing, content-building and accuracy of grammar are still limited by traditional teacher-centered methodologies.

To address these, the research applied a Quantitative data set of 62 Saudi university students, Wordtune and Grammarly writing assistants, to participate in interventions based on AI-assisted writing tools to overcome the gaps in writing (EG and CG). Writing ability was quantitatively measured with pre and post-tests, and descriptive statistics ensure that there was a significant improvement in the EG (18-19 points) than the CG (5-6 points). Independent-samples t-tests did not indicate any difference at the beginning, but significant post-test improvements (p<0.001, d=1.31-1.34). Regression models demonstrated that AI tools are excellent predictors of writing improvement (R^2 =0.68), especially content development and grammatical accuracy. The results indicate that the systematic implementation of AI contributes to the effective development of the writing proficiency of Saudi EFL students, surmounting the limitations of traditional approaches.

Conclusion

Introducing the concept of AI in educational settings provides a high potential to improve the L2 writing, especially in Saudi EFL learners, who struggle with all writing variables. It was aimed at investigating how the usage of AI-based writing assistance tools, Wordtune & Grammarly, impacts the theoretical writing performance of Saudi university students. Quantitative data were collected with a sample of 62 students, who participated in an EG, using AI tools, and a CG, using old learning. Pre and post-tests remained done to evaluate the gains in all writing variables. Descriptive statistics showed that the EG had significant post-test improvements in all 4 variables, with the content development 57.40 (5.90) to 75.20 (5.60), coherence 55.60 (6.10) to 74.10 (5.85), cohesion 54.80 (6.20) to 73.20 (6.00) and grammatical accuracy 53.90 (6.40) to 72.50 (6.10). Exceedingly significant differences (p<0.001) with large consequence sizes (d=1.31-1.34) were found to confirm strong EG improvements using independent-samples t-tests. Regression analysis found that AI exposure predicts R^2=0.68 with multiple regression. Content (Y_1=0.39) and grammar accuracy (Y_4=0.44) were found to be the strongest predictors. The results reveal that pedagogically combined AI-assisted tools have successfully improved the writing skills of Saudi EFL learners, facilitating the development of content, coherence, cohesion, and grammatical accuracy, and achieving autonomous and confident academic writing behaviors.

Limitations and Future scopes

The research limited in a single institution, short testing, few instruments and self-reported improvements which limits generalization. More AI tools can be incorporated in future work, long-term writing retention can be analyzed, various levels of proficiency can be tested, and multimodal feedback systems could be involved.

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