Impact of Meta AI-Generated Corrective Feedback in the Writing Classroom: Effects on L2 Writing Linguistic Errors

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Abstract

Previous research has explored the impact of corrective feedback provided by human instructors on the writing skills development of ESL/EFL (English as a second/foreign language) learners. There also has been a growing trend towards employing corrective feedback generated by Meta AI for the same pedagogical purposes. However, no studies to date have examined the effect of such feedback on reducing grammatical errors in English writing among language learners., Therefore, the present study aims to examine the effects of three distinct types of corrective feedback, direct, indirect, and metalinguistic generated by Meta AI in conjunction with the WhatsApp mobile application, on grammatical errors in the written English of first-year undergraduate university students. The study employed random sampling to select four sections of undergraduates, comprising a total of 227 students. Three sections were assigned as the experimental group and one as the control group. Section A (N=59) received direct corrective feedback, Section B (N=53) received indirect corrective feedback, Section C (N=58) received metalinguistic corrective feedback, and Section D acted as the control group (N=57). Pictures were given to the students to compose a story in English, totalling 300 words, to collect data from them through a pretest and post-test. The data were analysed in terms of morphological, syntactic, and orthographic errors, employing the theoretical framework of Corder's (1974) and Dulay's (1982) taxonomies. The frequency of errors was recorded, and a repeated-measures ANOVA (analysis of variance) was used to analyse the data in SPSS (version 26). The statistical analysis revealed that the mean of errors decreased in the post-test writings of each section. Significantly, the metalinguistic corrective feedback produced by Meta AI proved effective in reducing errors compared to both direct and indirect feedback methods, in addition to the control group. This study suggests that integrating AI-generated metalinguistic feedback into English learning and teaching curricula could enhance error correction and learning outcomes in higher education.

Keywords: Meta-AI, linguistics errors, quality education, e-learning, self-efficacy, educational technology, corrective feedback, grammatical errors, metalinguistic feedback, sustainable development goals

1. Introduction

Corrective feedback in language learning is a crucial instructional strategy aimed at improving learners' writing skills by enhancing their linguistic accuracy and fostering a deeper understanding of the language (Barrot, 2023; Kim & Emeliyanova, 2021; Brown et al., 2023; Mujtaba et al., 2021; Sarr éet al., 2021; Usama et al., 2024a). Traditionally, this feedback has been provided by teachers who meticulously analyze learners' errors in both speaking and writing, guiding them to recognize and correct these mistakes (Amir et al., 2025b). This process addresses not only immediate inaccuracies but also reinforces learners' comprehension of language rules, helping them build a solid foundation for future language use (Mujtaba et al., 2021; Lyster & Saito, 2020). Numerous studies (Wondim et al., 2024; Bagheri, 2024) (Mao et al., 2024; Liu & Hwang, 2024; Rahimi, 2021; Fan & Ma, 2018; Chong, 2019; Tanveer et al., 2018; Mao & Lee, 2020; Hashemifardnia et al., 2019; Alam et al., 2024; Chanchalor et al., 2019) have highlighted the effectiveness of corrective feedback, particularly in the context of teaching English as a Second/Foreign Language (ESL/EFL), where it plays a pivotal role in helping learners in learning complex language structures. Corrective feedback also promotes active engagement, encouraging learners to reflect on their errors and think critically about language usage (Kartchava et al., 2020; Zhang & Hyland, 2022; Zheng, et al., 2023; Al-Imamy, 2024). Corrective feedback in language learning is categorized into three primary types: direct, indirect, and metalinguistic. Direct corrective feedback explicitly corrects the learner's mistakes, providing the accurate linguistic form immediately. Indirect corrective feedback signals that an error has been made, leaving the learner to identify and correct it themselves, which encourages the development of independent problem-solving skills. Metalinguistic corrective feedback involves providing comments or questions about the nature of the error,

prompting learners to analyse and understand the underlying language rules, thus deepening their engagement and learning. By incorporating various feedback methods, such as direct corrections, indirect suggestions, and metalinguistic clues, teachers create an interactive and supportive learning environment that motivates students to persist in their language learning process (Shams et al., 2025a). Additionally, corrective feedback provides an opportunity for personalized instruction, catering to the unique needs of each learner and addressing diverse error patterns. This personalised approach not only improves grammatical accuracy but also instils confidence among learners, enabling them to tackle the challenges of learning English and achieve more excellent proficiency over time (Alam, 2025b).

However, providing corrective feedback poses several challenges for teachers (Kobylarek, Madej, & Roubalová, 2022). These include the high demand on time to provide personalized feedback, the difficulty in addressing all learner errors within large class settings, and the variability in how different students receive and apply feedback (Adachi et al., 2018; Henderson et al., 2019; Hyland & Hyland, 2019). Despite the proven benefits, the labour-intensive nature of personalised feedback can limit its practicality and effectiveness in classroom contexts (Beg et al., 2024). Additionally, teachers should strike a balance between correcting errors and avoiding excessive criticism, which could discourage students (Alam, 2024c; Alam & Usama, 2023). There is also the challenge of ensuring consistency and fairness in feedback across different students, which can be particularly tough in classrooms with students of varying language proficiency levels (Tierney, 2012). Furthermore, the rapid pace of classroom activities often leaves little time for thorough, in-depth feedback, which can potentially lead to missed learning opportunities and inadequate support for individual student development (Kormos & Smith, 2023).

2. Literature Review

In light of ongoing technological advancements, contemporary research has increasingly focused on investigating the efficacy of AI-generated corrective feedback in improving the writing skills of English learners. These AI systems can potentially offer immediate, personalized, and consistent feedback without the logistical constraints faced by human teachers (Rane et al., 2023). Although several such studies have reported promising results (Alam, 2025c; Hayati et al., 2024; Üstünbaş, 2024; Wang, 2022; Zeevy-Solovey, 2024; Marghany, 2023; Kaharuddin, 2021; Wang, 2024), a notable gap persists in the existing scholarly discourse concerning the impact of distinct feedback modalities namely, direct, indirect, and metalinguistic on the reduction of grammatical errors in English writing when delivered through Meta AI integrated with the WhatsApp mobile platform. Furthermore, the integration of artificial intelligence into language acquisition underscores its potential to personalize learning experiences based on individual learner profiles, thereby delivering feedback tailored to the specific needs and developmental trajectories of each student. This personalised approach can significantly improve language learning efficiency based on different motivation (Kobylarek, Alaverdov, & Jakubowska, 2021). Additionally, AI can track progress over time, providing learners and educators with valuable insights into development trends and areas that require more attention, thus facilitating a more focused and effective learning process (Alam et al., 2023).

The current study explores the unexplored ground by hypothesising that AI-generated metalinguistic corrective feedback, which provides explicit references to the nature of errors without directly correcting them, may be more effective than other types of feedback (direct and indirect) in reducing grammatical errors in the written English of first-year university English learners. Based on this, the study aims to evaluate how different forms of corrective feedback direct, indirect, and metalinguistic affect error rates in English learners' writing, thereby laying the groundwork for innovative pedagogical models that seamlessly integrate artificial intelligence technologies within language learning frameworks. By distinguishing between the effects of these feedback types, the research aims to identify which method most effectively reduces errors, thereby enhancing the efficiency and effectiveness of language instruction in minimising grammatical errors in written English. This investigation not only promises to advance our understanding of how AI can be personalised to support diverse learning needs in real-time but also aims to revolutionise traditional approaches to language education. The aims of the study were investigated based on the following research questions:

- Are there any significant variations among the three experimental groups and one control group in minimising grammatical errors in written English?
- In which group was the intervention proven effective, indicated by improvements in posttest results compared to pretest, in minimising grammatical errors in written English?

2.1 Meta-AI within WhatsApp Application

Meta AI, formerly known as Facebook AI, represents a significant evolution in the application of artificial intelligence technologies by Meta Platforms, particularly the platforms like WhatsApp. This integration aims to transform WhatsApp from a basic messaging platform into a versatile tool that enhances user engagement through sophisticated AI features, especially for educational and developmental purposes such as language learning (Alam, 2025c; Usama et al., 2024b). Within WhatsApp, Meta AI plays a crucial role by generating responses, enriching user interactions, and providing real-time language support. A key functionality includes its ability to deliver AI-Generated corrective feedback, which is particularly valuable for English learners (Wang, 2024). The AI evaluates texts sent by users, pinpoints grammatical, syntactic, or spelling errors, and offers immediate, contextually relevant corrective feedback (Rehman & Khalil, 2024). This mechanism enables learners to promptly recognize and rectify their mistakes, promoting a continuous, interaction-driven learning process aligned with real-world communication needs (Buana et al., 2024). Over time, such AI integration not only helps identify and correct linguistic inaccuracies but also enhances users' understanding of language rules, progressively improving their writing skills (Fathi & Rahimi, 2024). This may significantly improve learners' overall linguistic proficiency, converting everyday interactions into practical learning sessions. Thus, embedding Meta AI within WhatsApp could mark a substantial step forward in utilizing popular

communication platforms for educational purposes, providing English learners with a convenient, accessible, and highly effective tool to enhance their English abilities, seamlessly integrated into their daily digital interactions. This innovative strategy not only makes language learning accessible but also integrates it into users' regular communication practices, enhancing language skills as part of their everyday activities, which is also crucial for the motivation (Kobylarek, 2025).

2.2 Artificial Intelligence on English Writing Skills

Artificial Intelligence (AI) is increasingly pivotal in shaping English writing skills across various academic disciplines. Notably, Hidayatullah's (2024) study reveals a worrying trend where university students excessively rely on AI tools like ChatGPT to complete assignments, potentially impairing critical thinking and independent writing abilities due to AI's limitations and the inability of plagiarism detectors to identify AI-generated content effectively. Lalingkar et al., (2022) demonstrate how AI can positively influence writing skills in academic forums by enhancing clarity of discussion and facilitating consensus, thus enriching educational discourse in online settings. Further, Stojanov et al., (2024) categorize university students into distinct profiles based on their reliance on AI for academic activities, ranging from minimal use to dependence for completing assignments. Chellappa & Luximon (2024) discuss AI's role in helping design students with writing clarity and project feedback, noting that the effectiveness of the tool varies among users. Similarly, Pratama & Pratama Hastuti (2024) confirmed that AI tools, such as *Gencraft* and *ChatGPT*, can substantially improve the writing performance of high school students, particularly after interventions that included AI-generated feedback. Moreover, Amir et al., (2025a) find that AI-driven feedback specifically enhances grammatical accuracy and overall writing proficiency in English learners when compared to traditional teacher feedback.

Al-Mahmoud's study (2023) further reinforces the effectiveness of AI in academic writing, as it indicated a significant improvement in the writing skills of Saudi EFL learners after using the AI-powered application *Wordtune*. This tool helped students achieve better lexical usage and more complex sentence structures, regardless of gender. Similarly, Fadli, Wahyudi & Ahmad (2024) report that *Wordtune* significantly boosts university students' sentence construction and vocabulary use in Southeast Sulawesi, Indonesia. Alam, Ahmad & Biryukova (2024) highlighted the positive attitudes and widespread use of AI technologies among EFL learners, particularly in the context of the classroom pedagogy. Similarly, Li et al., (2024) demonstrated the effectiveness of ChatGPT as a pedagogical tool in medical education, significantly enhancing the coherence, logical structure, and linguistic quality of academic writing produced by non-native English speakers.

2.3 Effects of AI-Generated Corrective Feedback on English Writing Skills

Artificial intelligence applications such as ChatGPT, Grammarly, and Wordtune have demonstrated substantial efficacy in enhancing English writing skills by delivering instantaneous, accurate, and personalized feedback. Empirical studies suggest that these tools contribute to improvements across multiple dimensions of writing including grammar, vocabulary, organization, and conciseness thereby establishing their value for learners at diverse proficiency levels. Erisyerico & Fauzan (2024) examined the impact of AI-generated corrective feedback on English writing skills among eleventh graders in Palangka Raya, Indonesia. The study highlighted a strong preference for AI feedback on grammar and mechanics due to its precision and effectiveness. However, it also found that students viewed AI and human feedback as similarly effective in terms of personalisation and learning alignment. This suggests that while AI-generated feedback can effectively improve specific aspects of writing, human feedback remains indispensable for comprehensive educational support. Therefore, adopting an integrated approach that combines both types of feedback is essential to achieve the best results in enhancing students' learning process. Zhu et al., (2024) investigated the impact of AI-generated corrective feedback, specifically from ChatGPT, on the English writing skills of college students. The study found that ChatGPT significantly improves grammar, punctuation, style, and content coherence, providing immediate and detailed corrections that enhance writing fluency and structural organisation. This makes it particularly useful for primary edits and intermediate drafts. However, the study also emphasised the essential role of teacher feedback in addressing more complex aspects of writing, such as higher-level nuances and the personalization required for comprehensive writing development. This suggests that while AI tools like ChatGPT may be useful for assisting with initial and intermediate stages of writing they cannot replace the in-depth, personalized guidance provided by human teachers, which is crucial for advancing students' writing skills to higher levels. Moreover, Viantika & Dangin (2024) investigated the impact of AI-generated corrective feedback through the Virtual Writing Tutor on the English writing skills of high school students in Yogyakarta, Indonesia. The study involved 32 eleventh-grade students and noted significant improvements in their writing abilities across grammar, vocabulary, content, and organization from pre-tests to post-tests. The Virtual Writing Tutor provided instant, precise feedback, enabling students to revise their drafts effectively. While the tool primarily enhanced the mechanical aspects of writing, it also facilitated the learning of writing conventions. This study highlights the potential of AI-generated feedback to significantly enhance writing skills through ongoing, real-time guidance. However, it also highlights the need to integrate AI tools with traditional educational methods to ensure comprehensive development in students' writing.

Mun (2024) examined the impact of AI-generated corrective feedback significantly through ChatGPT, on the English writing proficiency of Korean EFL college students. The findings indicated that students who received feedback via ChatGPT showed significant improvements in grammar and vocabulary, as evidenced by their higher post-test scores compared to peers who received traditional peer feedback. Additionally, student feedback was generally positive, appreciating the immediate and precise corrections provided by ChatGPT. However, there were concerns about potential over-reliance on AI, underscoring the need for a balanced approach to education. Mun's research indicates that while AI-generated feedback can enhance writing proficiency, it should be carefully integrated with traditional

teaching methods to ensure holistic educational development and prevent dependency (Mun, 2024).

Berglund & Barmen (2024) examined the effects of AI-generated corrective feedback using the Essay Assessment Tool (EAT) in Norwegian lower-secondary education. The findings reveal that EAT enhances the peer review process by efficiently identifying and categorising writing errors, enabling focused discussions and improving student engagement with writing mechanics. However, the study highlights the challenges of integrating EAT into routine classroom practices and emphasises the need to balance AI feedback with human interaction to achieve comprehensive learning outcomes. Additionally, Chang et al., (2021) evaluated the effectiveness of AI-generated corrective feedback, as provided by Grammarly, on the English writing skills of EFL students in China. The study found that Grammarly significantly improved grammar and writing structure, with the experimental group showing notable gains compared to the control group, as reflected by a medium effect size (Cohen's $d = 0.603$). Students appreciated Grammarly's instant and precise corrections, although its limitations in addressing logical development errors between sentences and occasional inaccuracies were noted. These findings highlight Grammarly's utility in enhancing EFL writing instruction while emphasising the importance of integrating AI tools with traditional teaching methods for holistic language development. Similarly, Escalante et al., (2023) investigated the effectiveness of AI-generated corrective feedback in improving English writing skills among English as a New Language (ENL) learners through two longitudinal studies. The first study found no significant differences in learning outcomes between students who received AI feedback (via ChatGPT) and those who received human feedback, while the second study revealed a nearly even preference split between AI and human feedback. Both approaches demonstrated clear strengths, suggesting that AI-generated feedback can complement human feedback effectively without compromising educational outcomes. This research highlights the potential of AI tools in automating feedback and enhancing writing skills, particularly when combined with traditional methods to optimize learning quality.

Polakova & Ivenz (2024) investigated the effects of AI-generated corrective feedback via ChatGPT on the English writing skills of university EFL students. The study revealed significant improvements in conciseness, grammar, inclusion of key information, and reduction of passive voice usage following ChatGPT interventions. These empirical findings were further supported by qualitative data, wherein learners expressed positive perceptions of ChatGPT's role in improving their writing skills. This reinforces the potential of AI-based tools, such as ChatGPT, to address the evolving needs of contemporary learners and to enhance their overall writing proficiency. Furthermore, Song & Song (2023) studied the impact of AI-generated corrective feedback, utilising the AI application, on English as a foreign language (EFL) students. Their findings demonstrated marked improvements in the experimental group's writing outcomes, including grammatical accuracy, vocabulary usage, and content structure. The AI tool provided precise, real-time suggestions that helped students refine their drafts and improve engagement and feedback literacy. These studies collectively emphasize the ability of AI tools to provide immediate and effective feedback, significantly contributing to the development of proficient writing skills in educational contexts. Buana et al., (2024) found that integrating Meta AI within WhatsApp improved user satisfaction in providing corrective feedback, particularly in terms of content relevance and accuracy, although navigation challenges were noted. Rehman & Khalil (2024) reported a 25% improvement in grammatical proficiency among students who used Meta AI for conjunction instruction, highlighting the tool's personalized feedback and interactive exercises. Similarly, Soriano et al., (2024) demonstrated that Meta AI-enhanced Filipino English learners' writing efficiency, coherence, and grammatical accuracy, with students showing positive attitudes toward its dynamic feedback. Alam (2025a) explored feedback role in improving English learners' speaking and writing skills, revealing significant gains in grammar and error reduction; however, teacher feedback remained superior for more complex aspects, such as comparative forms. Collectively, these findings underscore the transformative role of AI in English instruction, while highlighting the need to address usability challenges and integrate AI with traditional teaching methods to achieve comprehensive learning outcomes.

3. Method

3.1 Participants and Sampling

The study employed a random sampling method to select participants, involving 227 English students aged 20 to 23 from a university in India. Random sampling was chosen to ensure that the sample accurately represented the broader student population, enhancing the generalizability of the findings (Etikan et al., 2017). These first-year undergraduate non-majors in English were divided into four sections, with purposeful sampling used to assign them to two groups. Purposeful sampling was employed to ensure that specific variables aligned with the study's objectives, a common practice in experimental research that balances control and treatment conditions (Creswell & Creswell, 2017). Among the four sections, three were assigned as experimental groups: Section A, with 59 students; Section B, with 53 students; and Section C, with 58 students. The remaining section, Section D, with 57 students, was designated as the control group. All participants were proficient in using Android devices and navigating the internet, ensuring their familiarity with the tools required for the study. The students, whose first language was Hindi, had been learning English through English-medium instruction for over a decade. To ensure consistency in the learning process and minimize variability, the researcher acted as the instructor for all groups, facilitating uniform training and addressing any differences that arose. Prior to participation, students were provided with detailed background information, and they gave informed consent.

3.2 Treatment of the Experimental and Control Groups

The participants in the experimental groups received treatment five days a week for 12 weeks, with each session lasting 55 minutes. All students in the experimental groups utilized Android smartphones with 5G internet connectivity to ensure smooth operation. Similarly, the same session duration was maintained for the control group.

In the classroom setting, participants from all four sections were required to write a 100-word composition each day, based on a picture provided by the instructor to ensure variety and sustained engagement. Students composed and submitted their initial drafts via WhatsApp, engaging with the digital platform to seamlessly integrate technology into the learning process. After submitting their compositions, students used specific prompts tailored to their assigned feedback type to interact with Meta AI. Once feedback was received from Meta AI, students were instructed to revise their initial drafts in accordance with the corrections provided. This revision process also occurred through WhatsApp, where students submitted their revised compositions to the instructor to ensure they were following the correct steps. Additionally, after receiving feedback from Meta AI, students were asked to rewrite their initial drafts on paper, incorporating the corrections suggested by Meta AI. This step was designed to reinforce the changes by physically rewriting the corrected text, enhancing retention and understanding of the corrections.

The specific processes for each section are detailed below:

- **Section A (Direct Corrective Feedback):** Students in this section added the prompt, *"Give direct corrective feedback to the written composition,"* to their submissions. Meta AI identified specific grammatical errors, providing precise corrections directly within the text. Students were then instructed to revise their original work by incorporating these corrections, allowing them to observe and learn from the explicit improvements made to their compositions.

  Example: If a student wrote "She go to school every day," Meta AI directly corrected the error to "She goes to school every day." The corrected form was inserted into the text, showing students exactly what the right structure should look like. This explicit correction allowed learners to clearly see the difference between the incorrect and correct usage.

- **Section B (Indirect Corrective Feedback):** Participants in this group used the prompt, *"Give indirect corrective feedback to the written composition."* Instead of providing explicit corrections, Meta AI highlighted the errors in the text without fixing them, leaving the responsibility of making revisions to the students. This process required students to critically analyze the flagged areas and independently apply appropriate corrections, fostering their problem-solving and language proficiency.

  Example: For the same sentence, "She go to school every day," Meta AI would underline or highlight "go" and mark it as an error, but no correction would be given. The student had to recognize that the verb form was incorrect and independently revise it to "goes." This encouraged learners to take ownership of the editing process.

- **Section C (Metalinguistic Corrective Feedback):** Students in this group were instructed to include the prompt, *"Give metalinguistic corrective feedback to the written composition."* Meta AI provided explanations and grammatical rules related to the identified errors, helping students understand the underlying language principles. Students revised their work by applying these insights, ensuring not only the correction of errors but also the reinforcement of their understanding of grammatical concepts.

  Example: For the sentence "She go to school every day," Meta AI explained: "The verb must agree with the third-person singular subject 'she.' In the present tense, verbs take an –es ending with third-person singular subjects. Therefore, 'go' should be changed to 'goes.'" The student then revised the sentence to "She goes to school every day." This approach provided both correction and a grammar lesson, deepening conceptual understanding.

- **Section D (Control Group):** In this section, students received feedback directly from the instructor rather than using AI. Teachers reviewed the compositions, marked errors, and provided detailed comments or suggestions for improvement. Students then revised their texts based on the teacher's guidance, following a traditional feedback model.

  Example: If a student wrote "She go to school every day," the teacher circles the verb "go" and writes a margin comment such as "Check subject–verb agreement: third-person singular requires -es." The student would then revise the sentence to "She goes to school every day." Unlike AI-based methods, this approach involved personalized feedback influenced by the teacher's judgment and instructional style, reflecting conventional classroom practices.

3.3 Data Collection Procedure

The data collection procedure involved administering both a pretest and a posttest to all participants across various groups, with a 300-word limit set for the responses produced by the participants. For this purpose, two distinct pictures were employed: one picture served as the material for the pretest, and another for the posttest. Utilizing different pictures for these tests was essential to eliminate any potential bias that could arise from memory effects. Suppose the same picture had been used for both tests. In that case, participants might have performed better on the posttest simply due to familiarity with the image, rather than as a result of any intervention or change in their capability or understanding. Thus, to ensure the accuracy and integrity of the data regarding the true impact of the intervention, different pictures were necessary.

3.4 Error Analysis Procedure

Two doctoral research scholars analyzed the morphological, syntactic, and orthographic errors present in the written English submissions produced by participants from each group across various assessments, including both pretests and posttests. Morphological syntactical and orthographical errors (see Table 1) were identified employing Corder's (1974) framework for Error Analysis (EA) comprises three distinct phases: the accumulation of data (identification of errors), the characterization of those errors (analyzing the errors), and subsequently elucidating the learners' errors (detailed description of errors). Subsequently, the procedure incorporated Dulay's (1982)

classification of general linguistic production errors, and the research further investigated three specific categories of errors: omissions, additions, and misformations. A systematic checklist was utilized to document the errors committed along with their respective frequencies within the written essays.

To ensure consistency in the coding process, inter-rater reliability was assessed. The two raters demonstrated strong agreement, Cohen's $\kappa = .87$, $p < .001$, confirming that the categorization of morphological, syntactic, and orthographic errors was reliable.

Table 1. This table categorizes the various error types, providing a clear overview of common errors in written English across different linguistic levels. Each category encompasses specific types of errors that are relevant to the analysis and improvement of language proficiency

Category	Types of Errors
Morphological	Inflectional, Derivational, Word Formation, Overgeneralization, and Misapplication of Rules.
Syntactic	Subject-verb agreement, Word Order, Misuse of Prepositions, Run-on Sentences and Comma Splices, Fragmented Sentences, Improper Use of Conjunctions, Incorrect Auxiliary Verbs, Passive Voice Misuse, Relative Clause, Lack of Parallel Structure, Incorrect Tense Usage, Improper Question Formation.
Orthographical	Spelling, Capitalization, Punctuation, Homophones and Homonyms, Typographical Errors, Sentence Boundary, Improper Hyphenation, Misuse of Quotation Marks.

3.5 Statistical Analysis Procedure

In the study examining the impact of interventions on four different groups with data collected through pretests and posttests, a repeated measures ANOVA (RM-ANOVA) is the chosen statistical analysis procedure. RM-ANOVA assesses the changes in group performance across multiple time points, providing insights into the effectiveness of the intervention. This technique analyzes the variability within subjects over time, considering both the time effects and the interaction between time and group differences. RM-ANOVA is suitable for this research due to its ability to handle the intricacies of repeated measures within the same subjects, allowing for a more accurate interpretation of the intervention's impact across different groups. This method is particularly effective in educational settings where interventions are tested over time, as it provides a comprehensive analysis of how each group's performance evolves in response to the intervention.

4. Results

A repeated-measures ANOVA was conducted to assess the main effects of linguistic errors, encompassing morphological, syntactic, and orthographic aspects, on four groups (three experimental and one control) across two testing phases (pretest and posttest). The analysis revealed a significant main effect for the type of linguistic errors, $F (2, 452) = 18.671$, $p < 0.001$, $\eta^2p = 0.41$. Additionally, a main effect was found to be significant for the groups, $F (3, 223) = 12.532$, $P < 0.001$, $\eta^2p = 0.424$. Specifically, Section A received Direct Feedback, Section B received Indirect Feedback, Section C was provided with Meta-Linguistic Feedback, and Section D received Teacher's Feedback. Moreover, the analysis of the testing phases, encompassing both the pretest and posttest, also yielded significant results. The ANOVA revealed a significant main effect for the test phase, $F (1, 226) = 21.891$, $p < 0.001$, $\eta^2p = 0.292$. These results suggest that both the instructional feedback and the duration of the intervention had a notable impact on improving the linguistic accuracy of the learners' written English.

Table 2. Metalinguistic feedback showed greatest reduction in errors

		Morphological		Syntactical		Orthographical	
		Mean	SE	Mean	SE	Mean	SE
Section (A) Direct Feedback							
	Pretest	8.83	0.40	5.85	0.23	6.50	0.39
	Posttest	8.20	0.27	5.81	0.53	4.85	0.48
Section (B) Indirect Feedback							
	Pretest	6.96	0.29	6.81	0.47	8.83	0.40
	Posttest	6.94	0.34	6.19	0.46	8.20	0.27
Section (C) Meta-Linguistic Feedback							
	Pretest	6.19	0.45	8.72	0.33	6.96	0.29
	Posttest	5.01	0.42	5.72	0.46	5.14	0.34
(Section D) Teacher's Feedback							
	Pretest	7.54	0.42	5.70	0.24	6.19	0.45
	Posttest	6.93	0.43	4.96	0.41	5.93	0.42

Table 2 presents a comparison of the effects of four different feedback modalities: Direct Feedback, Indirect Feedback, Meta-Linguistic Feedback, and Teacher's Feedback on morphological, syntactic, and orthographical errors in English learners.In addition, the interaction between linguistic errors and the group was found to vary significantly, evidenced by the ANOVA results ($F (6, 48) = 24.788$, $p < 0.001$, η^2p

= 0.756). Among the groups, Section C, which received Meta-Linguistic Feedback, showed the most significant reduction in errors. This was followed by Section A, which employed Direct Feedback, showing a consistent reduction across error types. The control group, Section D, which received the teacher's Feedback, demonstrated moderate improvements. In contrast, Section B, which used Indirect Feedback, had the least change, particularly in orthographical errors. This ordering from most to least effective in reducing errors underscores the differential impact of feedback types on improving English writing skills among English learners. Furthermore, the interaction between linguistic errors and the testing phases (pretest and posttest) showed a statistically marginal effect, with $F(2, 52) = 3.090$, $p = 0.054$, $\eta^2p = 0.106$. This outcome highlights that while there are detectable differences in error correction from pretest to posttest, the impact of testing alone on linguistic accuracy was not as pronounced.

The three-way interaction among linguistic errors, group types, and test phases was statistically significant, as evidenced by $F(6, 48) = 2.532$, $p = 0.033$, $\eta^2p = 0.240$. This significant interaction highlights the differential impact of feedback modalities on various linguistic errors across different time points, illustrating how each feedback type influenced error reduction differently from pretest to posttest (Table 1).

In Section A, which utilised Direct Feedback, there was a notable improvement in morphological errors, with a decrease from 8.83 to 8.20. Syntactical errors also slightly improved, from 5.85 to 5.81, and orthographical errors decreased from 6.50 to 4.85. This indicates that Direct Feedback was effective, particularly in refining morphological and orthographical aspects of writing.

Section B, receiving Indirect Feedback, showed remarkable stability in morphological errors, maintaining scores from 6.96 to 6.94, and a moderate improvement in syntactical errors from 6.81 to 6.19. Orthographical errors slightly decreased from 8.83 to 8.20, suggesting that Indirect Feedback helps sustain existing knowledge and fosters gradual improvements.

Section C, which received Meta-Linguistic Feedback, showed significant reductions across all error categories, with syntactical errors decreasing from 8.72 to 5.72, morphological errors from 6.19 to 5.01, and orthographical errors from 6.96 to 5.14. This highlights the effectiveness of Meta-Linguistic Feedback in addressing complex error types by providing a deeper understanding of linguistic structures.

Lastly, Section D, which received traditional Teacher's Feedback, demonstrated moderate reductions in all error types: morphological errors decreased from 7.54 to 6.93, syntactical errors from 5.70 to 4.96, and orthographical errors from 6.19 to 5.93. The interaction between the groups and the testing phases (pretest and posttest) did not reach statistical significance, with $F(3, 51) = 1.831$, $P = 0.153$, $\eta^2p = 0.097$.

5. Discussion

In a study examining the effects of different feedback modalities on linguistic errors in written English, significant variations were observed in how each type of feedback impacted morphological, syntactic, and orthographical errors. Direct Feedback and Meta-Linguistic Feedback were notably more effective in reducing linguistic errors across all categories, demonstrating their potent role in enhancing writing accuracy. Conversely, Indirect Feedback and Teacher's Feedback, while still beneficial, showed fewer substantial reductions in errors, suggesting that the effectiveness of feedback can vary significantly depending on its nature and the linguistic aspects it targets. The study's investigation into the effects of various feedback modalities on the English writing skills of learners reveals substantial differences in the efficacy of each approach. Direct and Meta-Linguistic Feedback notably excelled in reducing linguistic errors across morphological, syntactic, and orthographical categories. Mainly, Meta-Linguistic Feedback was highly effective, a finding that resonates with the research by Nassaji (2016), who highlights the superior impact of feedback that not only corrects errors but also explicates the underlying rules, thereby fostering a deeper understanding and retention of language governed rules. The effectiveness of Meta-Linguistic Feedback can be attributed to its dual focus on error correction and educational enrichment. This form of feedback provides explanations that clarify why certain forms are erroneous, which engages learners cognitively to a greater extent than merely indicating an error (Bitchener & Knoch, 2015). The capacity of AI to analyze text thoroughly and provide feedback that is not only immediate but also detailed adds an extra layer of learning support that traditional methods might lack.

Recent studies have underscored the impact of different feedback modalities on the English writing proficiency of English learners, highlighting the particular efficacy of AI-generated meta-linguistic feedback. These enhancements are attributed to the non-threatening, immediate nature of AI feedback, which fosters a more conducive learning environment. Additionally, Escalante, Pack, and Barrett (2023) provide further context by showing no significant difference in writing proficiency between students who received AI-generated and human tutor feedback, suggesting that AI-generated feedback can adequately complement traditional methods without compromising educational quality. This indicates that the intelligent deployment of AI in feedback provision can match the effectiveness of human tutors, particularly when integrated thoughtfully alongside traditional teaching methods. This strategic use of AI-generated feedback enables teachers to focus on addressing deeper content issues and providing personalised coaching.

Meta-linguistic feedback (MF) is distinctly beneficial because it not only indicates errors but also provides explanations and comments about their nature, often incorporating grammar rules and error codes (Mujtaba et al., 2021). This type of feedback contrasts sharply with direct feedback, where corrections are made explicitly, and indirect feedback, which merely highlights errors without correction (Boggs, 2019). The strength of MF lies in its capacity to engage learners cognitively, prompting them to understand why an expression is incorrect and how to amend it. Such engagement is crucial for the internalization of grammatical rules, enabling learners to actively diagnose and rectify their errors, which in turn fosters more profound learning and long-term retention of correct usage (Mujtaba et al., 2021; Shams et al., 2025b). Research supports the efficacy of MF, particularly for treatable, rule-governed errors. By explicating the reasons behind errors such as verb tense inconsistencies or article omissions MF enables learners to apply these rules more broadly in their future writing. Studies

indicate that learners benefit more from meta-linguistic explanations for rule-based grammatical features, whereas direct corrections may be more suitable for idiosyncratic errors (Guo & Barrot, 2019). Rule-based errors, such as issues with regular past tense or subject-verb agreement, are generally corrected effectively through learning from the feedback provided, which minimizes recurrence (Hashemian & Farhang, 2018). However, the effectiveness of feedback may vary based on the context and the type of error. While MF generally promotes better long-term learning, direct feedback may yield better immediate results for simple corrections or situations where learners lack sufficient background knowledge to benefit from explanations (Karim & Nassaji, 2018; Guo & Barrot, 2019). Such findings underscore the complexity of corrective feedback and the importance of tailoring feedback methods to specific learning contexts and needs. Subsequently, this will be a great help for learners to learn the pragmatics of professional communication inside and outside the classroom (Alam et al., 2025)

The integration of AI-driven meta-linguistic feedback in ESL/EFL education not only supports immediate error correction but also enhances traditional teaching by allowing a more focused approach to complex writing instruction. The adoption of such technology in educational settings promises to significantly enhance learning outcomes by providing both immediate corrections and deeper, personalised instructional feedback. This approach aligns with the broader educational trend towards personalised, technology-enhanced learning environments where AI tools support and extends the capabilities of human instructors.

6. Conclusion

This study investigated the effectiveness of various AI-generated feedback modalities direct, indirect, and metalinguistic on reducing grammatical errors in the writing of English as a Second/Foreign Language (ESL/EFL) learners. The findings demonstrate that Meta AI-generated metalinguistic feedback, integrated with WhatsApp, significantly enhances learners' grammatical accuracy, outperforming direct and indirect feedback. This suggests that while all feedback types are beneficial, metalinguistic feedback, which offers deeper insights into errors, is most effective in promoting understanding and long-term retention of language rules. The use of Meta AI within WhatsApp for providing feedback enables immediate, personalized, and contextually relevant corrections, fostering a dynamic and continuous learning environment.

While these findings highlight important pedagogical implications, the study has certain limitations, including a relatively small, context-specific sample drawn from a single institution, the short intervention period, its exclusive focus on written performance without examining other language skills such as speaking, listening, and reading, and possible external influences related to students' digital literacy and internet access. Furthermore, the reliance on WhatsApp as a platform and learners' prior familiarity with this technology may limit the generalizability of results to other digital tools or classroom contexts.

Future research should therefore employ larger and more diverse samples, extend the duration of interventions, and examine multiple language skills across different platforms and classroom contexts. In particular, researchers should investigate the application of AI-generated feedback in different cultural and educational settings to assess its effectiveness across varied EFL contexts. Such studies could explore whether AI-enhanced feedback is equally beneficial for learners at different proficiency levels, age groups, and institutional backgrounds.

Overall, this study not only contributes to the existing literature by confirming the benefits of AI-enhanced feedback but also underscores the transformative potential of integrating such technologies into language education, thereby supporting a more nuanced and compelling learning process while offering insights into scalable strategies for EFL instruction in diverse educational contexts. The findings suggest that AI-integrated feedback can enhance learner autonomy, enable personalized scaffolding, and provide sustained improvements in writing proficiency, which are applicable to broader EFL curricula beyond the immediate study setting.

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Authors Contributions

Dr. SA and Dr. A were responsible for study design and revising. Dr. RK, Dr. TTS, TR, Dr. FA was responsible for revising and drafting the manuscript. All authors read and approved the final manuscript. All authors equally contributed in the manuscript with their insights and regular discussions. All authors contributed equally to writing, editing, and proofreading the manuscript.

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Competing Interests

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