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AI-Assisted Error Analysis for Improving EFL Writing Accuracy: A Corpus-Based Quasi-Experimental Study

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تحليل الأخطاء باستخدام الذكاء الاصطناعي لتحسين دقة كتابة الإنجليزية كلغة أجنبية: دراسة شبه تجريبية قائمة على مدونة لغوية

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Abstract

This study investigates the effectiveness of AI-assisted error analysis in improving English as a Foreign Language (EFL) learners' writing accuracy in a Libyan university context. Adopting a quasi-experimental, corpus-based design, the study involved two intact groups of undergraduate EFL students (n = 60). The experimental group received AI-supported corrective feedback using tools such as Grammarly and ChatGPT, while the control group was taught through traditional teacher-centered feedback.

A learner corpus consisting of pre-test and post-test essays was compiled to examine patterns of linguistic errors over time. Quantitative data were analyzed using paired and independent samples t-tests, while corpus-based error analysis was employed to identify and categorize recurring errors.

The results revealed that the experimental group significantly outperformed the control group in post-test writing performance ($p < 0.001$), with a large effect size indicating a strong instructional impact. Corpus findings further demonstrated a substantial reduction in grammatical errors, particularly intense usage, prepositions, and sentence structure. However, improvements in lexical accuracy were comparatively moderate.

The findings suggest that AI-assisted feedback is particularly effective in enhancing rule-based aspects of writing by increasing learners' noticing of linguistic errors and facilitating iterative revision. Nevertheless, the results also indicate that some learners relied on AI feedback

without sufficient critical engagement, highlighting the continued importance of teacher mediation in AI-supported writing instruction.
Overall, the study contributes to the growing field of AI-enhanced language learning by integrating corpus linguistics, error analysis, and experimental methods, offering empirical evidence from an under-researched EFL context.

Keywords: AI-assisted feedback; error analysis; corpus linguistics; EFL writing; learner autonomy.

الملخص
تستكشف هذه الدراسة فعالية تحليل الأخطاء المدعوم بالذكاء الاصطناعي في تحسين دقة كتابة متعلمي اللغة الإنجليزية كلغة أجنبية في سياق جامعي ليبي. وباتباع تصميم شبه تجريبي قائم على مدونة لغوية، شملت الدراسة مجموعتين متكاملتين من طلاب اللغة الإنجليزية كلغة أجنبية في المرحلة الجامعية (ن = 60). تلقت المجموعة التجريبية تغذية راجعة تصحيحية مدعومة بالذكاء الاصطناعي باستخدام أدوات مثل Grammarly وChatGPT، بينما تلقت المجموعة الضابطة تعليمها من خلال التغذية الراجعة التقليدية التي تركز على المعلم.
تم تجميع مدونة لغوية للمتعلمين، تتألف من مقالات قبل وبعد الاختبار، لدراسة أنماط الأخطاء اللغوية بمرور الوقت. وتم تحليل البيانات الكمية t للعينات المزدوجة والمستقلة، بينما استُخدم تحليل الأخطاء القائم على المدونة اللغوية لتحديد الأخطاء المتكررة وتصنيفها.
أظهرت النتائج تفوقًا ملحوظًا للمجموعة التجريبية على المجموعة الضابطة في أداء الكتابة بعد الاختبار (قيمة بي < 0.001)، مع حجم تأثير كبير يشير إلى تأثير تعليمي قوي. أظهرت نتائج تحليل المدونة اللغوية انخفاضًا ملحوظًا في الأخطاء النحوية، لا سيما في استخدام الأزمنة وحروف الجر وبنية الجملة. مع ذلك، كان التحسن في دقة المفردات متوسطًا نسبيًا.
تشير النتائج إلى أن التغذية الراجعة المدعومة بالذكاء الاصطناعي فعّالة بشكل خاص في تعزيز الجوانب القائمة على القواعد في الكتابة، وذلك من خلال زيادة انتباه المتعلمين للأخطاء اللغوية وتسهيل المراجعة المتكررة. ومع ذلك، تُشير النتائج أيضًا إلى أن بعض المتعلمين اعتمدوا على التغذية الراجعة المدعومة بالذكاء الاصطناعي دون تفاعل نقدي كافٍ، مما يُبرز الأهمية المستمرة لتدخل المعلم في تعليم الكتابة المدعوم بالذكاء الاصطناعي.
بشكل عام، تُساهم هذه الدراسة في مجال تعلم اللغة المُعزز بالذكاء الاصطناعي المتنامي، من خلال دمج علم اللغة المدون وتحليل الأخطاء والأساليب التجريبية، مُقدمةً أدلة تجريبية من سياق تعليم اللغة الإنجليزية كلغة أجنبية الذي لم يحظَ بالبحث الكافي.

الكلمات المفتاحية: التغذية الراجعة المدعومة بالذكاء الاصطناعي؛ تحليل الأخطاء؛ علم اللغة المدون؛ كتابة اللغة الإنجليزية كلغة أجنبية؛ استقلالية المتعلم.

1. Introduction

1.1 Background of the Study

In recent years, English as a Foreign Language (EFL) education has been gradually influenced by the rapid development of Artificial Intelligence (AI) technologies. In particular, writing instruction has started to move beyond traditional teacher-centered feedback, as students increasingly gain access to AI-powered tools such as Grammarly and Chat GPT, which provide immediate corrections and suggestions based on large linguistic databases.

From a practical teaching perspective, these tools have changed the way many learners approach writing tasks. Instead of waiting for delayed teacher feedback, students can now revise their work instantly and repeatedly. However, in real classroom contexts, especially in EFL settings, this shift does not always lead to consistent improvement. Some students use these tools effectively, while others rely on them in a very mechanical way without fully understanding the corrections provided.

Despite these technological developments, writing remains a persistent challenge for many EFL learners. In my experience within the Libyan university context, students often struggle with recurring grammatical issues, particularly in tense usage, prepositions, and sentence construction. These problems tend to persist over time, even after repeated instruction, which suggests that traditional feedback methods alone may not be sufficient.

Error Analysis has long been used in second language research to understand the nature of learner difficulties. However, when conducted manually, it becomes time-consuming and limited in scope, especially when dealing with larger sets of student writing. This limitation becomes more noticeable in classroom environments where teachers are responsible for large numbers of students and cannot always provide detailed individualized feedback.

For this reason, combining Error Analysis with corpus-based methods and AI tools may offer a more efficient and systematic approach. Such integration allows for a more detailed examination of learner writing, making it possible to identify recurring patterns of errors across multiple texts rather than relying on isolated examples.

In the Libyan EFL context, particularly at Sebha University, students continue to face noticeable difficulties in writing accuracy despite ongoing instructional efforts. This is not necessarily due to lack of instruction, but rather the limited time available for detailed feedback and the traditional nature of assessment practices, which often focus more on final products than on the writing process itself.

Although AI tools have gained global attention in language education, there is still relatively limited empirical research on how these tools interact with corpus-based error analysis in real classroom environments, especially in developing contexts such as Libya. This study therefore attempts to explore this gap by examining whether AI-assisted error analysis can genuinely contribute to improving EFL writing accuracy in a measurable way.

1.2 Contribution to Knowledge

This study attempts to contribute to the existing body of research on EFL writing by bringing together three areas that are often studied separately: Error Analysis, Corpus Linguistics, and Artificial Intelligence. While each of these areas has been widely discussed in previous literature, their integration within a single classroom-based quasi-experimental design is still relatively limited.

From a practical perspective, the study offers some evidence on how AI-assisted feedback may influence learners' writing accuracy in a real educational setting. Rather than focusing only on perceptions of AI tools, it examines actual changes in student writing performance before and after the intervention.

In addition, the use of learner corpus data provided a more detailed way of observing error patterns over time. This helped in identifying not only whether improvement occurred, but also which types of errors were more responsive to AI-supported feedback.

However, it should be noted that these contributions are based on a relatively small sample from a single institution, so the findings should be interpreted with caution and not overgeneralized beyond the context of the study.

1.3 Novelty of the Study

The main novelty of this study lies in its attempt to move beyond general claims about the usefulness of AI in language learning and instead examine its impact in a more structured, classroom-based experimental setting.

Unlike many previous studies that rely mainly on questionnaires or students' perceptions, this research focuses on actual writing performance and tracks changes through pre-test and post-test data. In this sense, it tries to provide a more direct measure of improvement rather than subjective opinions.

Another aspect that may be considered relatively new is the combination of AI-assisted feedback with corpus-based error analysis in the same framework. This allows for a more detailed examination of learner errors, rather than treating writing improvement as a single overall score.

Finally, the study is situated in the Libyan EFL context, which is still underrepresented in research on AI in language education. While this does not make the findings universally generalizable, it may provide useful insight into how such technologies function in developing educational environments where access to resources and training is still evolving.

1.4 Research Problem

Despite ongoing efforts to improve EFL writing instruction at Sebha University, many students continue to experience persistent difficulties in producing accurate written English. In classroom practice, it is common to observe repeated grammatical problems, especially in areas such as tense usage, prepositions, and sentence structure. These errors often appear even after they have been explicitly explained and corrected in previous assignments.

From a teaching perspective, one of the main challenges is that feedback is usually provided after the writing task is completed. While this type of feedback is useful, it is often delayed and sometimes too general to address each student's individual needs. In large classes, it also becomes difficult for instructors to give detailed corrective feedback to every student consistently.

In addition, students tend to focus mainly on final grades rather than the writing process itself. As a result, they may correct errors superficially without fully understanding the underlying linguistic rules. This pattern often leads to the repetition of the same mistakes over time.

Although AI-based writing tools have recently been introduced into educational environments, their actual pedagogical impact is still not fully understood in this context. Some students appear to benefit from immediate feedback provided by these tools, while others use them in a more mechanical way, simply accepting corrections without critical reflection.

At Sebha University, there is still limited empirical evidence on whether combining AI-assisted feedback with corpus-based error analysis can lead to measurable improvement in students' writing accuracy. Most existing practices still rely on traditional teacher-centered correction methods, which may not fully capture the complexity of learners' writing development.

For these reasons, this study seeks to examine whether AI-assisted error analysis, supported by corpus-based tracking of learner writing, can offer a more effective approach to improving EFL writing accuracy in this specific educational context.

1.5 Significance of the Study

This study may be considered relevant from both theoretical and practical perspectives, particularly in the field of EFL writing instruction. However, its significance should be understood within the limits of its context and design.

From a theoretical perspective, the study brings together three main areas of research—Error Analysis, Corpus Linguistics, and Artificial Intelligence—that are often treated separately in the literature. By examining how these frameworks can interact in a classroom-based setting,

the study may help in understanding how digital tools influence the process of writing development rather than only the final product.

From a practical perspective, the study reflects classroom realities where teachers often face large groups of students and limited time for detailed feedback. In such situations, AI tools may offer additional support by providing immediate correction and suggestions. However, the findings suggest that these tools are most effective when used alongside teacher guidance rather than as a complete replacement.

For EFL instructors at Sebha University and similar contexts, the study may offer some insight into how writing instruction can be supported through a blended approach that combines traditional feedback with AI-assisted tools. At the same time, it highlights the need for students to develop critical awareness when using automated feedback systems.

It is also important to note that the significance of this study is mainly contextual. The findings are based on a relatively small sample and a specific institutional environment, so they should not be generalized without caution. Instead, they may serve as a starting point for further research in similar EFL settings.

1.6 Objectives of the Study

The main aim of this study is to explore the effectiveness of AI-assisted error analysis in improving EFL learners' writing accuracy at Sebha University. More specifically, the study seeks to understand how AI-supported feedback influences students' writing performance when compared to traditional teacher-centered instruction.

In order to achieve this aim, the study focuses on several related objectives. First, it examines the overall impact of AI-assisted feedback on learners' writing accuracy before and after the intervention. Second, it identifies the most frequent types of writing errors produced by students, particularly in areas such as grammar, sentence structure, and prepositional use.

The study also compares the performance of students who used AI-assisted tools with those who received traditional feedback, in order to determine whether any noticeable differences exist between the two approaches. In addition, it pays attention to the role of corpus-based analysis in tracking and classifying recurring linguistic errors over time.

Finally, the study considers, to some extent, how AI tools may influence learners' writing behavior, particularly in relation to self-correction and revision practices, although this aspect is treated as supplementary rather than the main focus of the analysis.

1.7 Research Questions

This study is guided by a set of research questions that aim to explore the impact of AI-assisted error analysis on EFL learners' writing performance at Sebha University.

The main question is concerned with the overall effectiveness of AI-assisted feedback in improving writing accuracy among EFL students. More specifically, the study seeks to understand whether there is a noticeable difference in writing performance between students who use AI-supported tools and those who rely on traditional teacher feedback.

In addition, the study looks at the types of writing errors commonly produced by learners, particularly in grammatical structures, sentence formation, and prepositional usage, as these areas tend to be persistent challenges in EFL writing.

It also investigates whether the integration of AI-assisted feedback leads to statistically significant differences in performance when compared with conventional instructional methods.

Finally, the study considers how corpus-based error analysis can help in identifying recurring patterns in learner writing and whether this contributes in any meaningful way to reducing repeated errors over time.

2. Literature Review

2.1 Introduction

Artificial intelligence has increasingly influenced EFL writing instruction by introducing new forms of automated feedback and revision support. AI-powered tools such as Grammarly and ChatGPT allow learners to receive immediate corrections during the writing process, reducing dependence on delayed teacher feedback.

As AI technologies become more common in language education, researchers have shown growing interest in their effects on writing accuracy, learner autonomy, and revision practices (Kasneci et al., 2023; Godwin-Jones, 2024). At the same time, concerns remain regarding the pedagogical limitations of AI systems and their role in supporting deeper aspects of writing development.

This literature review examines previous studies on AI-assisted feedback, Error Analysis, corpus-based approaches, generative AI, and learner autonomy in EFL writing contexts.

2.2 AI-Assisted Writing Feedback in EFL Learning

The use of AI-assisted feedback in EFL writing has gained increasing attention in recent years. Tools such as Grammarly and ChatGPT provide immediate corrective feedback, allowing learners to revise their writing continuously during the writing process.

Previous research suggests that corrective feedback plays an important role in improving grammatical accuracy and increasing learners' awareness of language errors (Ferris, 2003; Lee, 2017). More recent studies indicate that AI-supported environments may also encourage learner autonomy by enabling students to review and edit their writing independently (Godwin-Jones, 2024).

Kasneci et al. (2023) argue that generative AI systems can support writing development through interactive language assistance and revision support. However, researchers also note that AI tools are generally more effective in detecting surface-level grammatical problems than in addressing higher-order writing skills such as coherence and argumentation (Godwin-Jones, 2024).

For this reason, many scholars emphasize that AI-assisted feedback should complement teacher guidance rather than replace it entirely.

2.3 AI and Error Analysis Integration

The integration of artificial intelligence into Error Analysis has expanded opportunities for analyzing learner language more efficiently. Traditionally, Error Analysis relied on manual identification and classification of learner errors, which can be time-consuming when processing large amounts of learner data (Corder, 1967; Ellis, 1994).

Recent developments in Natural Language Processing (NLP) have enabled AI systems to detect common grammatical problems such as tense errors, subject–verb agreement, and prepositional misuse with increasing accuracy (Dahlmeier et al., 2012; Hochreiter & Schmidhuber, 2015).

Despite these developments, AI systems remain limited in interpreting discourse-level meaning and context-dependent language use. Therefore, researchers argue that automated error detection should support rather than replace human linguistic analysis (Ellis, 2008; Bitchener & Ferris, 2012)

2.4 Corpus-Based Approaches in EFL Writing

Corpus-based approaches have become increasingly important in second language writing research because they allow researchers to examine authentic learner language systematically. Unlike traditional approaches that rely on isolated examples, corpus linguistics enables the analysis of recurring linguistic patterns and common learner errors across large sets of written data.

Granger (2002) emphasizes that learner corpora provide valuable insights into interlanguage development by revealing systematic patterns in learners' writing. Similarly, Boulton and Cobb (2023) argue that corpus-based instruction can increase learners' awareness of frequent language problems and support more data-driven learning practices.

Recent technological developments have also improved the efficiency of corpus analysis through automated annotation and error tagging tools (McEnery & Hardie, 2012). However, researchers note that human interpretation remains essential, particularly when analyzing context-dependent or discourse-level language use.

2.5 Generative AI and Academic Writing Development

Generative AI has recently become an influential tool in academic writing instruction, particularly in EFL contexts. Applications such as ChatGPT support learners during different stages of writing by assisting with grammar correction, paraphrasing, idea generation, and text revision.

Kasneci et al. (2023) suggest that generative AI systems can function as interactive learning assistants that provide continuous linguistic support during writing tasks. Similarly, OECD (2024) reports that AI-supported environments may increase learner engagement and improve revision practices.

Despite these benefits, concerns have been raised regarding overreliance on AI-generated content. UNESCO (2024) warns that excessive dependence on generative AI may reduce learners' critical thinking and originality if these tools are used without proper guidance. Therefore, effective use of generative AI requires careful pedagogical supervision.

2.6 Learner Autonomy and AI Feedback

AI-assisted feedback has important implications for learner autonomy in language learning. By providing immediate feedback, AI tools allow learners to revise and monitor their writing independently without relying entirely on teacher correction.

Ranalli (2024) argues that automated feedback systems can encourage self-directed learning by supporting repeated revision and self-monitoring practices. Likewise, Godwin-Jones (2024) suggests that AI-supported learning environments may increase learners' confidence and engagement during writing tasks.

However, learner autonomy does not automatically develop through technology use alone. Some learners may accept AI-generated corrections passively without critically evaluating them. For this reason, teachers continue to play an important role in guiding students to use AI feedback critically and effectively.

2.7 Research Gap

Although interest in AI-assisted writing instruction has increased considerably, several gaps remain in the existing literature.

First, many previous studies have focused mainly on learners' perceptions and attitudes toward AI tools rather than measuring actual improvement in writing performance. Second, relatively few studies have adopted experimental or quasi-experimental designs to examine the long-term impact of AI-assisted feedback on writing accuracy.

In addition, limited research has combined AI-assisted feedback with corpus-based error analysis within a single framework, despite the potential relationship between these approaches. Finally, there is still a lack of empirical studies conducted in Libyan EFL contexts, where technological and educational conditions may differ from those in more widely researched environments.

Therefore, this study addresses these gaps by investigating the effectiveness of AI-assisted error analysis through a corpus-based quasi-experimental design in the context of EFL writing at Sebha University.

3. Research Methodology

3.1 Research Design

This study adopts a quasi-experimental research design with a pre-test and post-test control group approach. The main purpose of this design is to examine the effectiveness of AI-assisted error analysis in improving EFL learners' writing accuracy.

A quasi-experimental design was selected because it allows the researcher to investigate causal relationships in real classroom settings where full randomization is not always possible. The study includes two groups: an experimental group and a control group. The experimental group was exposed to AI-assisted feedback, while the control group received traditional teacher-centered instruction.

In addition to the experimental design, a corpus-based approach was integrated to analyze learners' written output in a systematic and data-driven way.

3.2 Context of the Study

The study was conducted in the Department of English at Sebha University, Libya. The context is characterized by EFL learners who face persistent challenges in writing accuracy, particularly in grammar, sentence structure, and prepositional usage.

This setting was considered suitable for the study because students have limited exposure to advanced writing support tools, and traditional feedback methods are still widely used. Therefore, introducing AI-assisted feedback provides a relevant opportunity to examine its pedagogical impact in a developing EFL environment

3.3 Participants

The participants of the study were 60 undergraduate EFL students enrolled in academic writing courses at Sebha University.

They were selected using purposive sampling based on their enrollment in writing classes and intermediate level of English proficiency. The participants were then divided into two equal groups:

- Experimental Group (n = 30)
- Control Group (n = 30)

Both groups were considered relatively homogeneous in terms of language proficiency prior to the intervention, which was confirmed through the pre-test results.

3.4 Research Instrument

3.4.1 Writing Tests (Pre-test and Post-test)

Two writing tests were used in this study: a pre-test and a post-test. In both tests, students were asked to write an argumentative essay of approximately 250–300 words.

The writing tasks were designed to measure students' ability in:

- Grammatical accuracy
- Sentence structure
- Vocabulary use
- Cohesion and coherence

An analytic scoring rubric was used to ensure consistency in assessment.

3.4.2 AI Tools

The experimental group used two AI-assisted writing tools:

- Grammarly Premium
- Chat GPT

These tools were used to provide:

- Immediate grammatical correction
- Suggestions for sentence improvement
- Support for rewriting and revision

Students were encouraged to revise their drafts based on AI feedback before submitting final versions.

3.4.3 Learner Corpus

A learner corpus was developed from students' written essays collected during both pre-test and post-test stages.

The corpus included approximately 120 writing samples in total. These texts were compiled for the purpose of error analysis and comparison across the two groups.

The corpus allowed the researcher to:

- Identify recurring linguistic errors
- Compare error frequency before and after the intervention
- Track changes in writing accuracy over time
- The study was conducted over an eight-week period and employed a controlled quasi-experimental design with a pre-test and post-test structure.
- The use of AI tools in the experimental group was strictly regulated. Students were allowed to use Grammarly and ChatGPT only during in-class writing sessions under the supervision of the researcher. Unsupervised use outside the classroom was not permitted in order to ensure consistency of exposure and comparability between groups.
- Prior to the intervention, the experimental group received a structured training session on the effective use of AI-assisted feedback. This training focused on interpreting grammatical suggestions, revising drafts based on feedback, and avoiding direct copying of AI-generated output. Students were instructed to use AI tools as revision support rather than content generators.
- During the intervention phase, students in both groups completed two writing tasks per week. In each session, students in the experimental group first produced a draft independently, after which they revised their work using AI tools before submitting the final version. The control group completed the same writing tasks but received only traditional teacher-based corrective feedback.

The procedure of the study was carried out as follows:

 Both groups were administered a pre-test to assess initial writing ability.
 A learner corpus was compiled from pre-test essays.
 The experimental group received training on AI writing tools.
 The experimental group used AI-assisted feedback during writing tasks, while the control group received traditional feedback.
 Both groups completed regular writing tasks over the eight-week intervention period.
 A post-test was administered under identical conditions to the pre-test.
 A second learner corpus was compiled from post-test essays for comparative analysis

3.6 Data Collection

Data were collected from three main sources:

- Pre-test essays
- Post-test essays
- Classroom writing tasks during the intervention

All writing tasks were completed under controlled classroom conditions to ensure consistency across participants.

The collected data were then organized into a learner corpus for further analysis.

3.7 Data Analysis

This study employed a quantitative-dominant analytical approach complemented by corpus-based error analysis in order to examine both overall writing improvement and specific linguistic changes.

3.7.1 Quantitative Analysis

Quantitative data obtained from pre-test and post-test writing scores were analyzed using SPSS. Prior to inferential testing, assumptions of normality and homogeneity of variance were checked to ensure the appropriateness of parametric tests.

The following statistical procedures were applied:

- **Paired Samples t-test** to examine within-group differences (pre-test vs post-test) for both experimental and control groups.
- **Independent Samples t-test** to compare post-test performance between the two groups.
- **Levene's Test for Equality of Variances** was used to verify homogeneity of variance.
- Statistical significance was set at **$p < 0.05$**.
- **Effect size (Cohen's d)** was calculated to determine the magnitude of the intervention effect.
    - Small (0.2), Medium (0.5), Large (0.8 and above).
- **95% Confidence Intervals (CI)** were reported alongside mean differences to improve interpretability and robustness of findings.

In addition, **gain scores (post-test minus pre-test)** were computed for each participant to provide a clearer measure of individual improvement across time

3.7.2 Corpus-Based Error Analysis

A learner corpus was constructed from students' written essays collected during both pre-test and post-test stages, comprising approximately 120 essays in total.

Error analysis followed a structured framework adapted from Error Analysis theory (Corder, 1967; Ellis, 1994). Errors were manually identified and coded according to predefined linguistic categories:

- Grammatical errors (general rule violations)
- Tense-related errors
- Prepositional errors
- Sentence structure errors
- Lexical (vocabulary) errors

To ensure reliability of coding, **inter-rater reliability** was established. A second trained rater independently analyzed 25% of the corpus, and agreement was measured using **Cohen's Kappa coefficient**.

Error frequency was normalized per 100 words to allow fair comparison across texts of varying lengths. This normalization enabled accurate comparison between groups and across testing phases.

Additionally, **percentage change analysis** was conducted to measure the reduction rate of each error type from pre-test to post-test.

3.8 Validity and Reliability

To ensure the validity of the research instruments, the writing tests and rubric were reviewed by three specialists in applied linguistics. Their feedback helped ensure that the tasks were appropriate and aligned with academic writing standards.

Reliability was ensured through inter-rater scoring. Two raters independently assessed the students' writing, and the level of agreement was calculated using statistical measures such as Cohen's Kappa.

In addition, a pilot study was conducted before the main data collection to refine the instruments and ensure clarity of instructions.

3.9 Ethical Considerations

Ethical approval was considered throughout the study. Participants were informed about the purpose of the research and their voluntary participation.

They were assured that:

- Their participation was voluntary
- Their identities would remain confidential
- Their academic grades would not be affected
- They could withdraw at any time

All collected data were used strictly for research purposes.

A. 4. Results and Discussion

B. 4.1 Introduction

This section presents the results of the study in relation to the research questions. The analysis integrates quantitative statistical findings with corpus-based error analysis to provide a comprehensive account of the impact of AI-assisted error analysis on EFL learners' writing accuracy.

4.2 Pre-Test Results

An independent samples t-test was conducted to determine whether both groups were comparable before the intervention.

The results indicated no significant difference between the experimental group (M = 58.40, SD = 6.12) and the control group (M = 57.85, SD = 6.45), confirming baseline homogeneity. This equivalence strengthens the internal validity of the study.

Table 4.1 Pre-Test Results.

Group	N	Mean	Std. Deviation
Experimental	30	58.40	6.12
Control	30	57.85	6.45

Interpretation:

Both groups performed almost equally at the beginning of the study, indicating that they were comparable prior to the intervention.

4.3 Post-Test Results

Post-test results revealed a marked improvement in favor of the experimental group.

The experimental group (M = 78.60, SD = 5.30) significantly outperformed the control group (M = 65.10, SD = 6.00). The difference was statistically significant ($t = 7.42$, $p < 0.001$), indicating a strong effect of AI-assisted feedback.

Table 4.2 Post-Test Results.

Group	N	Mean	Std. Deviation
Experimental	30	78.60	5.30
Control	30	65.10	6.00

Interpretation:
The experimental group showed significantly higher writing performance after the intervention compared to the control group.

4.4 Within-Group Improvement

Both groups showed improvement over time; however, the magnitude of change differed considerably.

- Experimental group gain: **+20.20**
- Control group gain: **+7.25**

Table 4.3 Within-Group Gains.

Group	Pre-Test Mean	Post-Test Mean	Gain
Experimental	58.40	78.60	+20.20
Control	57.85	65.10	+7.25

Interpretation:
The experimental group demonstrated substantially greater improvement, indicating the effectiveness of AI-assisted feedback.

4.5 Post-Test Statistical Comparison

An independent samples t-test was conducted on post-test scores.

Table 4.4 Post-Test Comparison.

Group	Mean	t-value	p-value	Result
Experimental	78.60	7.42	< 0.001	Significant
Control	65.10	—	—	—

Interpretation:
The difference between groups was statistically significant, providing evidence supporting the potential positive effect of AI-assisted error analysis

4.6 Corpus-Based Error Analysis

A learner corpus was analyzed to examine changes in error frequency. Error counts were normalized per 100 words.

Table 4.5 Error Reduction in Experimental Group.

Error Type	Pre-Test	Post-Test	Reduction
Grammar Errors	4.8	2.1	56%
Tense Usage	3.5	1.2	65%
Prepositions	2.9	1.1	62%
Sentence Structure	3.8	1.6	58%
Vocabulary Errors	2.4	1.3	46%

Interpretation:
The results indicate a clear reduction in all categories of linguistic errors. The most significant improvements were observed in tense usage and prepositions, while vocabulary errors showed the least improvement.

4.7 Interpretation of Findings

4.7.1 Effectiveness of AI-Assisted Feedback

The findings provide strong evidence that AI-assisted error analysis significantly improves EFL writing accuracy. The immediacy of AI feedback facilitated continuous revision and error correction during writing.

4.7.2 Cognitive Noticing

The results The results are generally consistent with Schmidt's Noticing Hypothesis, as AI tools increased learners' awareness of linguistic errors through real-time feedback, enhancing grammatical sensitivity.

4.7.3 Limitations of AI Feedback

AI tools appear to be particularly effective in grammatical correction but less effective in improving discourse-level writing skills such as coherence and argument development.

4.7.4 Learner Autonomy

Although AI tools encouraged independence, some learners relied on automatic corrections without critical reflection. This indicates that autonomy requires pedagogical guidance.

4.7.5 Teacher Role

Teacher mediation remains essential, particularly for higher-order writing skills. The most effective approach is a blended model combining AI feedback with teacher instruction.

4.8 Summary of Findings

- Both groups were equivalent at baseline
- The experimental group significantly outperformed the control group
- AI-assisted feedback improved writing accuracy significantly
- Corpus analysis showed strong reduction in grammatical errors
- Improvement was strongest in rule-based language areas
- Learner autonomy improved but remained partially dependent on teachers

C. 5. Discussion

5.1 Interpretation of the Findings: From Effectiveness to Mechanism

The results of this study should not be interpreted merely as evidence that "AI may contribute to improvements in writing accuracy under certain instructional conditions," but rather as an indication of how feedback ecology within the writing process is reconfigured when AI is introduced.

From a sociocognitive perspective, AI-assisted feedback changes the temporal structure of writing. Traditional feedback is delayed and product-oriented, whereas AI feedback is immediate and process-oriented. This shift increases the density of corrective episodes during writing, which in turn enhances what Schmidt (1990) conceptualizes as noticing. However, the data suggest that noticing alone is not sufficient; rather, it is the frequency of revision cycles triggered by AI that contributes more strongly to improvement.

In this sense, AI functions less as a "teacher replacement" and more as a cognitive amplifier that intensifies interaction between learner output and linguistic input.

5.2 Why Grammar Improved More Than Vocabulary: A Theoretical Explanation

The results may indicate that grammatical features were more responsive to AI-assisted feedback than lexical feature; it reflects a fundamental asymmetry in how linguistic systems respond to corrective feedback.

From a **Skill Acquisition Theory** perspective (DeKeyser), grammatical structures such as tense, agreement, and prepositions belong to rule-based declarative knowledge that can be proceduralized through repeated feedback and correction. AI systems are particularly effective here because they provide:

- explicit rule violations

- immediate correction
- high salience of error location

This creates optimal conditions for procedural learning.

In contrast, vocabulary development operates under a **usage-based and probabilistic model of language acquisition** (Ellis, Bybee). Lexical competence involves:

- collocational strength
- register sensitivity
- semantic prosody
- discourse appropriateness

These dimensions are not strictly rule-governed and therefore cannot be reliably captured by surface-level correction systems.

In other words, AI can easily answer: *"Is this word wrong?"* but struggles with: *"Is this word natural in this discourse context?"*

This explains why learners improved more in grammar: the feedback aligns structurally with how grammatical knowledge is acquired, but only partially overlaps with how vocabulary knowledge develops.

5.3 Corpus Evidence and Interlanguage Restructuring

The corpus findings should be interpreted as evidence of **interlanguage stabilization and restructuring**, rather than simple error reduction.

Following Selinker's interlanguage theory, learner language is not a defective system but a dynamic system governed by internal rules. The reduction of recurring errors suggests that AI feedback contributed to:

- weakening of fossilized error patterns
- increased alignment with target language norms
- partial restructuring of rule representation

However, the persistence of lexical errors indicates that interlanguage development is not uniform across linguistic domains. Grammar shows higher sensitivity to corrective input, while vocabulary remains more resistant due to its distributed and context-dependent nature.

Therefore, the corpus does not only show "improvement," but reveals *differential developmental trajectories* within the interlanguage system.

5.4 Limitations of AI Feedback: Technical, Cognitive, and Pedagogical Boundaries

The limitations of AI observed in this study are not merely practical issues but reflect deeper structural constraints in current NLP-based writing systems.

1. Structural (Technical) Limitation

Most AI writing tools rely on token-level or sentence-level modeling. This makes them highly effective at:

- grammar correction
- surface syntax detection

However, they remain weak in:

- discourse coherence
- argument structure
- rhetorical progression

This is because discourse-level meaning requires global text modeling, which current systems approximate rather than truly interpret.

2. Cognitive Limitation (Learning Depth)

AI feedback tends to produce what can be described as **"corrective transparency without explanation."**
Learners see the correct form but not the underlying grammatical principle.
This creates a risk of:

- shallow processing
- rule imitation without understanding
- dependency on external correction systems

From a depth-of-processing perspective (Craik & Lockhart), this may limit long-term retention unless combined with reflective instruction.

3. Pedagogical Limitation (Agency Shift)

A further issue is the redistribution of cognitive responsibility. Some learners shift from:
"Why is this wrong?" → to → "AI will fix it"
This reduces productive struggle, which is essential for durable learning. In Vygotskian terms, AI may sometimes *collapse the Zone of Proximal Development* by providing answers rather than scaffolding reasoning.

5.5 Grammar vs Vocabulary: A Systemic Linguistic Distinction

Beyond pedagogy, the difference between grammar and vocabulary improvement reflects a deeper linguistic distinction between **closed systems** and **open systems**.
Grammar behaves as a relatively closed system:

- finite rules
- predictable patterns
- binary correctness

Vocabulary behaves as an open system:

- expanding lexicon
- context-dependent meaning
- fuzzy boundaries of correctness

AI systems are inherently better at modeling closed systems because they optimize for pattern regularity. This structural alignment explains the differential impact observed in the data.
Therefore, the findings should not be read as a hierarchy of improvement but as a reflection of system compatibility between linguistic domain and AI architecture.

5.6 Pedagogical Model: Toward a Triadic Mediation Framework

The results support a **triadic model of writing development**, consisting of:

1. **AI as feedback accelerator** (speed + correction)
2. **Teacher as interpretive mediator** (depth + explanation)
3. **Learner as active negotiator** (reflection + uptake)

Without teacher mediation, AI risks becoming a correction machine. Without AI, feedback becomes delayed and limited. Without learner engagement, neither system leads to acquisition. Thus, effective writing instruction emerges not from technology alone, but from the interaction between these three agents.

5.7 Summary of Analytical Insight

The central finding is not simply that AI improves writing, but that it reshapes the conditions under which writing improvement becomes possible.
Grammar improves more because it aligns with rule-based feedback mechanisms, while vocabulary remains resistant due to its contextual and probabilistic nature. AI limitations further highlight those current systems operate at the level of surface form rather than discourse meaning.

Ultimately, the study suggests that AI is most powerful not as an autonomous teacher, but as a structural enhancer of feedback density within a mediated learning environment.

6.Conclusion, and Recommendations

6.1 Introduction

This chapter presents the conclusion of the study based on the findings discussed in Chapter Four. It summarizes the main results regarding the effectiveness of AI-assisted error analysis in improving EFL learners' writing accuracy at Sebha University. It also provides pedagogical recommendations and suggestions for future research.

6.2 Conclusion

This study investigated the impact of AI-assisted error analysis on the writing accuracy of EFL learners using a quasi-experimental, corpus-based design. The main purpose was to determine whether the integration of AI tools such as Grammarly and Chat GPT could enhance learners' writing performance compared to traditional teacher-centered instruction.

The findings suggest that AI-assisted feedback may have a positive effect on students' writing development. The experimental group outperformed the control group in the post-test, showing a noticeable improvement in overall writing accuracy.

The results also revealed that learners benefited from the immediacy and continuity of AI-generated feedback. This allowed them to revise their writing more frequently and become more aware of their linguistic errors during the writing process rather than after submission.

In addition, the corpus-based analysis confirmed a clear reduction in recurring grammatical errors, particularly in tense usage, prepositions, and sentence structure. These findings suggest that AI tools are especially effective in addressing rule-based aspects of language learning.

However, the study also highlighted important limitations. While AI-assisted feedback improved grammatical accuracy, its impact on higher-order writing skills such as coherence, organization, and argument development was less pronounced. This indicates that AI tools alone are not sufficient for complete writing development.

Another important finding relates to learner autonomy. Although students became more engaged in self-correction and revision, some tended to rely on AI suggestions without critical evaluation. This shows that autonomy in AI-supported environments is still developing and requires pedagogical guidance.

Overall, the study suggests that AI-assisted error analysis may be an effective pedagogical approach for improving EFL writing accuracy, but its effectiveness is maximized when combined with teacher mediation rather than used as a standalone instructional tool.

6.3 Recommendations

Based on the findings of the study, the following recommendations are proposed:

6.3.1 Integration of AI Tools in EFL Writing Instruction

EFL instructors are encouraged to integrate AI writing tools such as Grammarly and Chat GPT into writing courses. These tools provide immediate feedback that helps students identify and correct errors during the writing process, leading to more effective learning.

6.3.2 Adoption of Blended Feedback Models

The study recommends a blended instructional approach that combines AI-assisted feedback with teacher feedback. While AI tools are effective for grammatical correction, teachers are essential for addressing higher-level writing skills such as coherence, organization, and argument development.

6.3.3 Development of Learner Critical Awareness

Students should be trained to critically evaluate AI-generated feedback rather than accepting it automatically. Developing this critical awareness is essential for ensuring meaningful learning and preventing over-reliance on technology.

6.3.4 Use of Corpus-Based Instruction

Teachers and curriculum designers are encouraged to adopt corpus-based approaches in writing instruction. Learner corpora can help identify recurring error patterns and guide more targeted and effective teaching strategies.

6.3.5 Teacher Professional Development

Training programs should be provided to help EFL teachers effectively integrate AI tools into their teaching practice. Teachers need both technical skills and pedagogical knowledge to guide students in using AI responsibly and effectively.

6.3.6 Institutional Support for AI Integration

Universities and educational institutions should support the integration of AI technologies by providing access to digital tools, improving infrastructure, and developing clear policies for ethical and effective use of AI in academic writing.

6.4 Suggestions for Further Research

Future research is recommended to explore the following areas:

- Long-term effects of AI-assisted feedback on writing development
- Comparison between different AI writing tools and their effectiveness
- Impact of AI-assisted learning across different proficiency levels (beginner, intermediate, advanced)
- Qualitative studies focusing on learners' perceptions and cognitive processes when using AI feedback
- Larger-scale studies across multiple institutions to improve generalizability

6.5 Final Remark

While this study provides evidence of the effectiveness of AI-assisted error analysis in improving EFL writing accuracy, it also emphasizes that technology should be viewed as a supportive tool rather than a replacement for human instruction. The most effective learning environment is one in which AI and teachers work together to support learners' development in a balanced and pedagogically meaningful way.

6.6 Limitations of the Study

Despite the positive findings, several limitations should be acknowledged.

First, the study did not fully control the extent and nature of students' interaction with AI tools. Although participants in the experimental group were instructed to use Grammarly and ChatGPT for revision purposes, the exact frequency, depth, and quality of usage were not strictly monitored. This introduces a potential variability in exposure, which may have influenced the consistency of the results.

Second, the study relied on self-reported and classroom-observed use of AI tools, which may not accurately reflect the actual cognitive processes students engaged in while interacting with automated feedback.

Third, the relatively small sample size (n = 60) and single-institution context limit the generalizability of the findings to broader EFL populations.

Finally, the study focused primarily on short-term writing improvement over an eight-week period, which does not allow conclusions about long-term retention or sustained development of writing accuracy.

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Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.