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The Effectiveness of AI-Generated Feedback in Enhancing Students' Writing Proficiency: A Study of Google Gemini



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Abstract

The integration of Artificial Intelligence (AI) tools in education offers transformative potential for developing student writing proficiency. This study aims to: (1) identify the most prevalent writing deficiencies among Saudi Science and Engineering Track (SET) students, as detected by the Gemini AI model; (2) evaluate the extent to which Gemini's feedback addresses these writing deficiencies; and (3) explore students' perceptions regarding the usefulness of Gemini's feedback for improving their writing proficiency. Adopting a mixed-methods research design, the study first qualitatively analyzed Gemini's feedback on students' writing samples, followed by a quantitative summary of deficiencies across the full dataset. Subsequently, a questionnaire was administered to gauge students' perceptions of Gemini's feedback on improving their writing proficiency. The results indicated that Gemini effectively identified and addressed a range of writing issues, most frequently in sentence structure, followed by orthography (spelling and capitalization), grammar, punctuation, and word choice. Furthermore, the questionnaire and writing samples findings revealed that students held a positive view of Gemini, believing it significantly enhanced their writing proficiency. Consequently, this study recommended that such Gemini's feedback be integrated into writing instruction as a supplement to human teaching, with appropriate oversight to foster critical writing proficiency. A key strength of this study is its use of genuine in-class assignments, Gemini's instant feedback, and data triangulation, which ensure the authenticity of the data and mitigate concerns about plagiarism.

Keywords: artificial intelligence; effectiveness; feedback; Google Gemini; Saudi students; writing proficiency

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Introduction

The development of writing proficiency presents a significant challenge for English as a Foreign Language (EFL) learners, requiring mastery not only of grammar but also of lexical choice, coherence, and stylistic conventions. In this regard, the advent of artificial intelligence (AI) tools has fundamentally transformed the landscape of language pedagogy and acquisition (Chung, 2025; Matthews, 2024; Wu & Xu, 2025). These tools have provided a versatile framework for pedagogical innovation, enabling instructors to address classroom complexities with greater flexibility. Ultimately, they do not merely supplement existing methods but create a dynamic, data-driven environment that accelerates proficiency and reshapes the very nature of how a second language is mastered.

For writing development, they specifically offer a paradigm shift, moving beyond text generation to provide detailed and personalized feedback that addresses students' writing deficiencies. However, students often underutilize this potential, focusing on content creation rather than engaging in deep, iterative learning (Ahmed et al., 2024). While contemporary research suggests AI tools can create adaptive learning materials (Al-Raimi et al., 2024; Wu & Xu, 2025), the specific effectiveness of generative AI feedback in cultivating comprehensive writing skills remains underexplored in the context of the study.

Google Gemini, for example, with its advanced computational techniques and multimodal capabilities, functions as a proofreader, translator, and text generator (Barrot, 2025). Its capacity for real-time, contextually relevant feedback makes it particularly suitable for writing development (Imran & Almusharraf, 2024). Therefore, the present study addresses a critical gap by analyzing Gemini's feedback on Saudi Science and Engineering Track (SET) students' original in-class writing assignments, thereby providing authentic insights into the potential utility of this AI tool. In doing so, this study aims to identify the most frequent writing deficiencies in Saudi SET students' writing, as detected by Gemini, and evaluate the extent to which Gemini's feedback addresses these deficiencies. It also explores students' perceptions regarding the usefulness of Gemini's feedback for improving their writing proficiency.

Three research questions guide this study:

- RQ 1:** What are the most frequent writing deficiencies identified by Gemini in the writing of Saudi SET students?
- RQ 2:** To what extent does Gemini's feedback address the writing deficiencies of Saudi SET students?
- RQ 3:** What are Saudi SET students' perceptions of the usefulness of Gemini's feedback for improving their writing proficiency?

Review of Literature

Artificial Intelligence and Academic Writing

The proliferation of generative AI tools has garnered significant attention from diverse stakeholders in higher education, including educators, researchers, and students. These tools present new opportunities for learning and innovation, particularly in enhancing students' language proficiency and writing quality (Alharbi, 2023; Al-Raimi et al., 2024; Anh, 2024; Barrot, 2025; Godwin-Jones, 2022; Marzuki et al., 2023; Mohammed et al., 2023; Yan, 2023). They provide immediate, individualized feedback by identifying linguistic errors, suggesting alternatives, and offering recommendations to improve readability (Mushthoza et al., 2023).

Research indicates that students generally perceive AI tools as beneficial for developing their language skills. For example, Al-Raimi et al. (2024) found that Omani EFL students held positive attitudes toward AI writing tools, particularly for translation, verifying spelling and grammar, generating ideas, and composing paragraphs. In the Saudi context, Al-Sofi (2024) and Ozfidan et al. (2024) reported positive views among Saudi university students, who highlighted advantages such as idea generation, outline creation, improved grammar and spelling, and increased efficiency.

Recent research highlighted the transformative role of Gemini AI in enhancing the academic writing development and emotional well-being of undergraduate learners across diverse linguistic contexts. For example, students perceive it positively for academic purposes, particularly writing improvement, while also acknowledging limitations that require strategic approaches to mitigate (Anh, 2024; Anandaa & Salmiah, 2024; Hasanein et al., 2024; Utami et al., 2024). In a mixed-method study conducted by Azmi and Fithriani (2025), Indonesian students perceive Gemini as a highly effective pedagogical tool that streamlines the writing process, specifically in idea generation, grammatical refinement, and structural organization, while simultaneously boosting writing confidence and efficiency. Complementing these findings, Derakhshan (2025) employed longitudinal latent growth curve modeling to confirm that AI-assisted instruction leads to significantly higher writing proficiency and a marked reduction in Iranian students' writing anxiety compared to traditional methods. Collectively, these studies suggested that Gemini serves as a powerful, user-friendly resource that not only corrects mechanical errors but also addresses the complex psychological and structural challenges faced by EFL learners.

Regarding the other AI tools, studies on ChatGPT, for example, affirmed its positive reception and effectiveness in educational contexts. For instance, Wang et al. (2024) observed that ChatGPT helped students generate structured drafts, connect personal experiences to their writing, and produce high-quality sentences. Similarly, Karataş et al. (2024) highlighted its role in creating personalized learning experiences for writing, grammar, and vocabulary acquisition. Further supporting this, Mohammed et al. (2023) reported that ChatGPT contributed to the development of academic writing, language proficiency, and overall academic performance by facilitating idea generation, information gathering, and enhancing writing skills.

A significant strand of research compares Gemini's efficacy in language skill development to other tools like ChatGPT, QuillBot, WordTune, Google Docs, Microsoft Copilot, and Llama 2. These studies found that while such tools are effective to varying degrees due to their diverse features, their optimal use depends on addressing inherent limitations through training and responsible practices (Almassaad et al., 2024; Anandaa & Salmiah, 2024; Atox & Clark, 2024; Gond et al., 2024; Hiwa et al., 2024; Jinowat et al., 2024; Kotmungkun et al., 2024; Marzuki et al., 2023; Rane et al., 2024; Utami et al., 2024). Comparative analyses reveal distinct strengths: for instance, Gemini has been noted for its factual accuracy and multimodal capabilities, whereas ChatGPT often excels in conversational fluency and creative expression (Rane et al., 2024). Other studies highlighted specific performance differences, such as ChatGPT's proficiency in grammar correction versus Gemini's aptitude for logical reasoning (Atox & Clark, 2024), or Gemini's superiority in aspects like narrativity and syntactic simplicity (Kotmungkun et al., 2024).

While existing research has explored the use of AI-based tools in language learning, a significant gap remains regarding their role in identifying and addressing students' writing deficiencies and their perspectives on the usefulness of these tools. This study is essential because today's students urgently require advanced writing skills for their studies and future careers, making the role of AI tools in their development highly relevant. This study addresses this gap by analyzing Gemini's feedback on Saudi SET students' original, in-class assignments and utilizing a questionnaire to investigate their perceptions of its effectiveness. It is poised to contribute to a more comprehensive understanding of

how AI-driven tools, such as Gemini, can identify writing issues and address them, thereby enhancing students' writing proficiency. Given Gemini's multimodal capabilities, its outcomes may differ from those of other AI tools.

Methodology

Design and Participants

This study employed a mixed-methods design, integrating qualitative content analysis of the feedback generated by Gemini with quantitative statistical analysis of data from an online questionnaire. This combination allows for a triangulated examination, capturing both the objective characteristics of the AI-generated feedback and the subjective perceptions of the students who received it.

The study was conducted among first-year SET students at the University of Bisha in Saudi Arabia. Participants were recruited from various programs within the College of Computing and Information Technology and the College of Engineering (see Table 1).

Proficiency in English writing is critically important for these students, as it is fundamental to their academic performance and future professional advancement in scientific and technical fields. As Arabic native speakers learning English as a foreign language, developing these skills is a recognized priority. This need aligns with recent Saudi educational initiatives promoting technology integration and AI literacy in curricula, goals central to Saudi Vision 2030, making the study's focus particularly timely.

Table 1 *Frequency and Distribution of Respondents' Enrollment*

College	Program	Frequency	Percentage
College of Computing and Information Technology	Artificial Intelligence	15	15.79%
	Computer Science	12	12.63%
	Cybersecurity	9	9.47%
	Information Systems	9	9.47%
College of Engineering	Civil Engineering	14	14.74%
	Mechanical Engineering	14	14.74%
	Science in Renewable Energy Engineering	11	11.58%
	Electrical Engineering	6	6.32%
	Manufacturing Engineering	5	5.26%
Total		95	100.00%

The participant pool consisted of 95 male students studying the General English-1 course (ENG26111) during the first semester of the 2024/2025 academic year. To control instructional variables, all participants were drawn from two sections that shared the same instructor, weekly class schedule, and unified exams. The course, designed to develop general English proficiency from the A2 level of the Common European Framework of Reference, utilized the New Headway Plus (Special Edition) series, along with interactive Oxford iTools. These materials addressed a range of writing skills, including grammatical accuracy, vocabulary expansion, organizational clarity, logical coherence, and sentence construction. From the initial pool of 95 students, a final sample of 86 participated in the study, as nine students were absent or had withdrawn during the data collection phase.

Table 1 indicates that the largest contingent of respondents was from the AI program (N = 15, 15.79%). Collectively, the College of Engineering had a slightly higher representation in the sample (N = 50, 52.63%) compared to the College of Computing and Information Technology (N = 45, 47.37%). The least represented program was Manufacturing Engineering, with only 5 respondents. Regarding the application of Gemini's feedback, Table 2 indicates that most students (N = 57, 66.3%) reported 'always' or 'often' implementing Gemini's suggestions in their revisions.

Table 2 *Frequency of the Students' Application of Gemini's Feedback*

Item	Options	Frequency	%
How often do you apply Gemini's feedback to revise your writing?	Always	24	27.9
	Often	33	38.4
	Sometimes	24	27.9
	Rarely	4	4.7
	Never	1	1.2
Total		86	100

Research Instruments

Data for this study were collected using two primary instruments: 1) the feedback generated by Gemini on students' in-class writing assignments, and 2) an online questionnaire. Some data were also elicited from the students' writing samples. These tools were selected to triangulate data, providing both an objective analysis of writing skills and the students' subjective perceptions of the feedback's utility.

The first stage involved analyzing feedback generated by Gemini on original, in-class writing samples that served as authentic samples of student writing, ensuring the analysis was based on non-AI-generated work. The Gemini's feedback constituted the primary data source for identifying the most prevalent writing deficiencies and the extent to which Gemini addresses these deficiencies.

In the second stage, an online questionnaire assessed the students' experience to determine how they engaged with and internalized Gemini's feedback, thereby evaluating its impact on writing proficiency. It is comprised of three parts. The first part collected information about students' academic majors (see Table 1) and the frequency of applying Gemini's feedback to revisions (see Table 2). The second part included eight items focusing on specific writing aspects that students believed needed improvement (see Table 8). The third part contained six items measuring students' perceptions of how Gemini's feedback improved their overall writing skills (see Table 9). The second and third parts utilized a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." The questionnaire demonstrated strong internal consistency reliability, with a Cronbach's Alpha (α) of .894. To supplement the questionnaire data, student perspectives on AI tools, as articulated in their writing samples, were treated as qualitative data to address the study's third objective. These qualitative corpora were subjected to a systematic thematic analysis to identify recurring patterns and conceptual themes relevant to the role of Gemini's feedback in enhancing their writing proficiency.

Data Collection and Analysis Procedures

The data collection occurred in two sequential stages at the end of the semester.

Stage 1: Writing sample and Gemini feedback

First, students were given 30 minutes in the classroom to complete a standardized academic writing task on the role of AI in English language learning. This task was conducted without access to any AI tools to ensure the authenticity of the initial writing samples. Students submitted their original tasks via the Blackboard platform. Subsequently, they were instructed to input their tasks into Gemini using the prompt, "Proofread the following text:" to receive automated feedback. Following this, a teacher-facilitated class discussion was held where students compared Gemini's feedback and suggestions with their original work to identify areas for improvement. Finally, students submitted the Gemini-generated feedback to Blackboard, enabling a comparative analysis with their original submissions (see Figure 1). This process was conducted during four-hour class sessions for each section, with one hour allocated for writing the task and three hours dedicated to interaction with Gemini and classroom discussion.

Stage 2: Perception questionnaire

In the second stage, an online questionnaire was administered to gauge student perceptions. A QR code was projected in the classroom, providing students with direct access to the survey. The purpose of the study was reiterated to ensure informed participation. To guarantee anonymity and encourage candid responses, no personally identifiable information was collected.

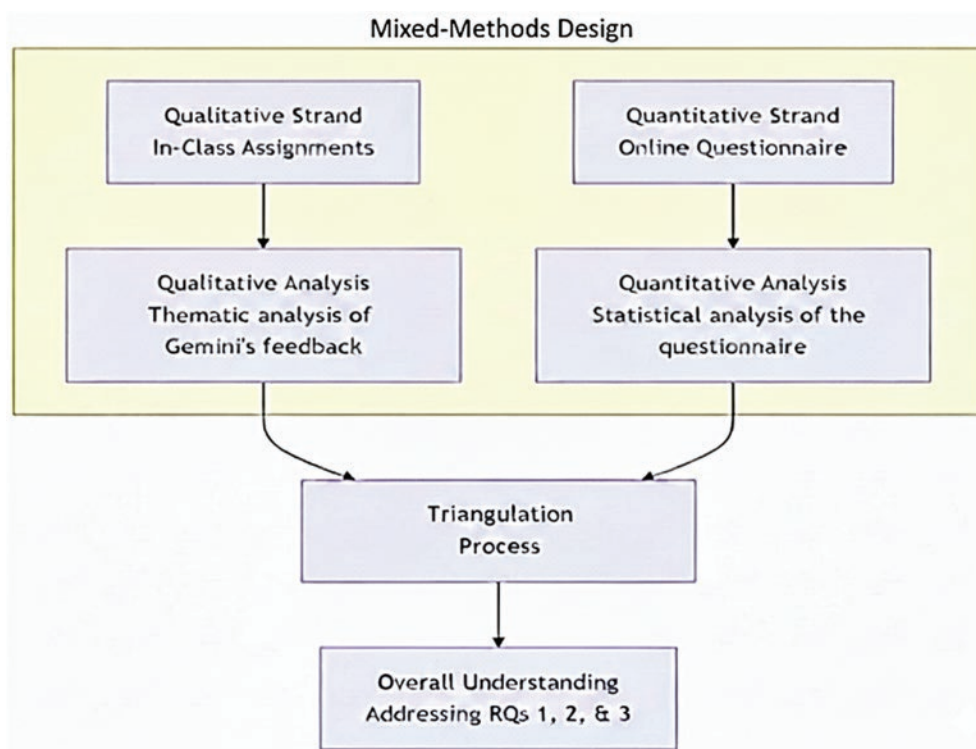


Figure 1 Methodological Framework of the Study

Prior to the analysis process, six tasks were excluded as they contained only student identification details without written responses. To assess Gemini's effectiveness, a qualitative thematic analysis was used on both the Gemini's feedback and student perspectives as reflected in their writing samples. A coding scheme was developed using a blended approach where initial categories were derived to identify writing deficiencies and evaluate proficiency levels. At the same time, additional codes were induced from themes that emerged directly from Gemini's feedback. The final codes encompassed

specific writing aspects, such as spelling, grammar and sentence structure, punctuation, and word choice/clarity. Furthermore, a quantitative summary of deficiencies across the full dataset was used to support qualitative data.

To provide illustrative examples, a purposive writing sample of six selected participants, along with their corresponding Gemini feedback, was selected for in-depth analysis (see Figures 2–7 in the Appendix). The sample was chosen to represent high-performing students from both the College of Engineering and the College of Computing and Information Technology (see Table 1).

The questionnaire data were analyzed using the Statistical Package for the Social Sciences (SPSS), Version 26. Descriptive statistics were calculated to summarize the dataset. To address the mixed-methods design, the qualitative results from Gemini's feedback and students' perceptions were triangulated with the quantitative results to identify the degree of alignment or dissonance between the study results.

Results

This section analyzes Gemini's feedback on the students' in-class writing samples and the results of the questionnaire. Figures 2–7 in the appendix present writing samples of six participants, purposively selected from the total sample ($N = 86$).

Writing Deficiencies Identified by Gemini

***RQ 1:** What are the most frequent writing deficiencies identified by Gemini in the writing of Saudi SET students?*

Spelling Mistakes

The analysis of the writing samples reveals that spelling accuracy is a significant and widespread challenge, even with common words. These errors can alter a message's meaning and undermine the writer's credibility. As shown in Table 3, the analysis identified three main patterns of spelling mistakes:

1. Phonetic and orthographic errors: Students often write words as they sound, leading to misspellings.
2. Word boundary issues: Students combine separate words.
3. Unnecessary apostrophes: Students incorrectly use apostrophes in words like “down's” instead of the correct plural “downs.”

Table 3 Examples of Student Spelling Errors with Gemini's Feedback

Error type	Examples of student's original misspelled words	Gemini's suggested correction	Analysis of feedback accuracy
Phonetic spelling	sholed, bcuse, dayily	should, because, daily.	Accurate identification and correction
Omission/addition of letters	grammer, benafit	grammar, benefit	
Word boundary Issue	Afterall	After all	
Unnecessary apostrophe	down's	downs	

Grammar and Sentence Structure

Students faced persistent challenges with grammar and sentence structure, both of which are essential for effective communication. The writing examples exhibited a range of recurring issues that compromised their quality, including sentence fragments and incoherence, pronoun misuse, informal and imprecise diction, morphosyntactic issues, and run-on sentences (see Table 4). The writing example 1 began with fragments, such as “AI tools have transformed language and...”, which fails to express a whole idea (see Figure 2 in the Appendix). Similarly, the writing example 3 contained structurally flawed phrases, such as “AI it is tool helps,” which violates the rules of pronoun-noun agreement and article usage (“a tool”) (see Figure 4 in the Appendix).

Another common error was the incorrect personification of AI. In the writing example 2, the student used masculine pronouns (“his answers,” “he can write”) to refer to the Gemini AI. In academic English, non-human entities, such as software, should be referenced with the neutral pronoun “it” or by name, “Gemini,” to maintain objectivity. Furthermore, students’ use of colloquial language, such as “not bad,” undermined the academic tone of the writing. Replacing such phrases with more precise and formal alternatives like “satisfactory,” “effective,” or “proficient” would significantly enhance the scholarly quality of his assignment. Moreover, several errors pointed to students’ struggle with the mechanical rules of English grammar. These included the incorrect verb form after a modal (“can helps” instead of “can help”), gerund inconsistency (“review and answering”), and pronoun-antecedent disagreement (using “it” to refer to plural “mistakes”).

A more significant finding was the students’ overwhelming reliance on long, run-on sentences. This issue severely impacted readability across multiple assignments. In the writing example 1, for example, the student presented the entire text as a single, unpunctuated sentence, making it extremely challenging to decipher the student’s ideas. In the writing example 2, clauses were strung together with conjunctions like “but” and “so” without appropriate punctuation, as in: “I’m using Gemini... his answers are not always correct... so I repeat the questions...” While the general meaning was sometimes discernible, the lack of sentence boundaries created a stream-of-consciousness effect, making the text informal and difficult to follow. This tendency may be influenced by L1 interference (e.g., from Arabic, where sentence boundaries can differ), highlighting the need for explicit instruction on English sentence structure.

Table 4 Examples of Grammatical Mistakes with Gemini’s Feedback

Error category	Student’s original sentence/phrase	Specific error	Gemini’s suggested correction	Analysis of feedback
Sentence Fragment	“AI tools have transformed language and”	Incomplete sentence	“AI tools have transformed language learning.”	Accurate. Gemini correctly completed the sentence with a logical object
Wordiness/ Repetition	“learn words and vocabulary and correct errors.”	Repetitive structure	“They help users learn words, expand vocabulary, and correct errors.”	Accurate & improved. Gemini improved sentence flow and clarity.
Pronoun Agreement	“I asked Gemini to explain his answer.”	Incorrect possessive pronoun for AI	“I asked Gemini to explain its answers.”	Accurate. Corrected personification of the AI tool.
Subject–verb Agreement	“AI can helps students.”	Incorrect verb form after modal verb	“AI can help students.”	Accurate. Corrected a common grammatical error.
Article Usage	“It is useful tool.”	Omission of the indefinite article	“It is a useful tool.”	Accurate.

Punctuation Mistakes

Table 5 shows that the analysis of students' writing examples exhibits several recurring and impactful error patterns, such as the absence or misuse of punctuation, commas, and capitalization, which have the greatest impact on readability. Errors in capitalization were widespread, particularly with proper nouns, such as "gemini," "chatgpt," "English," and "Ai." Furthermore, it was found that the students frequently omitted full stops at the end of sentences, leading to the pervasive run-on sentences identified in previous analyses. Students also repeatedly overlooked the correct use of commas to separate items in a list.

Table 5 *Examples of Punctuation Mistakes with Gemini's Feedback*

Error Category	Student's Original Sentence/Phrase	Specific Error	Gemini's Suggested Correction	Analysis of Feedback
Capitalization	"I use gemini and chatgpt ."	Lowercase proper nouns	"I use Gemini and ChatGPT ."	Accurate. Corrected capitalization of brand names.
Capitalization	"I study english ."	Lowercase language name	"I study English ."	Accurate.
Capitalization	" i think that..."	Lowercase first-person pronoun "I"	" I think that..."	Accurate.
Comma Usage	"I have tried it but I prefer..."	Missing a comma before a coordinating conjunction	"I have tried it, but I prefer..."	Accurate. Applied standard comma rule.
Apostrophe Usage	"It has its up and down's ."	Incorrect apostrophe in plural noun	"It has its up and downs ."	Accurate. Corrected a common error.
End Punctuation	"AI is helpful," (when ending a sentence)	Using a comma instead of a period	"AI is helpful."	Accurate.
Comma for Clarity	"...he couldn't solve or an essay he couldn't finish or for anything new..."	Missing commas in a complex series is confusing	"...he couldn't solve, an essay he couldn't finish, or for anything new..."	Accurate & improved. Added commas to clarify the list structure and improve readability.

Word Choice/Clarity Issues

As detailed in Table 6, the analysis of the students' writing samples revealed several specific areas that impeded clarity and stylistics, such as informal and imprecise diction, redundant and vague phrasing, and contextually inappropriate use of language. For example, students frequently relied on conversational language unsuitable for academic contexts. Phrases like "a lot of things," "some are good and some are bad," and "big effect" are vague and lack the specificity required for scholarly analysis. Similarly, evaluative terms such as "not bad" or "normal translation" are overly subjective and informal; they should be replaced with more precise and neutral alternatives, such as "satisfactory," "effective," "conventional machine translation," or "standard lexical placement." Furthermore, students tended to use redundant words and phrases, such as the use of both "words" and "vocabulary" without a clear distinction and the vague phrasing like "make learning easier," "make everything easy." This weakens their arguments and indicates a struggle to articulate specific mechanisms or outcomes, instead falling back on generalities that fail to inform the reader.

Moreover, word choice was sometimes technically correct but contextually awkward. For example, “solve the duties and questions” is an unnatural collocation. Rephrasing it as “help with assignments and tasks” immediately creates a more natural and contextually appropriate sentence, connecting the action directly to the academic setting. This may be attributed to L1 interference, as students attempt to think in Arabic and translate their thoughts into English.

Table 6 *Examples of Word Choice, Clarity, and Style Issues with Gemini's Feedback*

Issue category	Student's original sentence/ phrase	Specific issue	Gemini's suggested correction	Analysis of feedback
Clarity/ Sentence Structure	“AI the future for everything governments AI create int”	Incoherent sentence fragment; unclear meaning.	“AI is the future of everything. Governments also create AI.”	Accurate & Improved. Gemini restructured the fragment into two clear, grammatical sentences, making the intended meaning understandable.
Word Choice (Formality)	“Writing in gemini is not bad.”	Overly informal and negative phrasing.	“Gemini's writing capabilities are good,” or “Gemini can write well.”	Accurate & Improved. Provided more formal, positive, and objective alternatives.
Word Choice (Precision)	“solve the duties and questions that I have”	“Solve” is imprecise for “duties”; “duties” is awkward.	“help with assignments or tasks and questions”	Accurate & Improved. Suggested more natural and precise vocabulary.
Word Choice (Precision)	“AI is a great thing...”	“Thing” is vague and informal.	“AI is a useful tool...”	Accurate & Improved. Replaced with a more specific and academic term.
Word Choice (Precision)	“big effect”	“Big” is informal and imprecise.	“significant effect” or “major impact”	Accurate & Improved. Offered more academic synonyms.
Word Choice (Precision)	“up and down's”	Informal and grammatically incorrect.	“pros and cons” or “advantages and disadvantages”	Accurate & Improved. Corrected the error and provided formal alternatives.
Pronoun Clarity	“...for a homework he couldn't solve.” (Referring to a student)	Unclear pronoun reference.	“...for homework he couldn't do.” or “...for a student who couldn't solve homework.”	Accurate. Improved clarity by adjusting the phrase to define the antecedent.
Style/Formality	“better than normal translating”	Informal and vague.	“offers numerous advantages over traditional translation methods”	Accurate & Improved. Significantly improved formality and specificity.

While the preceding six writing samples offer an in-depth examination of the nature of student errors, a thematic mapping of the complete dataset (N = 86) reveals the broader prevalence of these deficiencies. As illustrated in Table 7, sentence structure emerged as the most frequent area of concern, with Gemini identifying structural issues in 65.1% of the students' assignments. This was followed by orthography (55.8%), where errors in spelling and capitalization remained highly prevalent. Grammar and punctuation

accounted for 45.3% and 36.0% of the feedback instances, respectively. While word choice appeared less frequently (25.6%), it represented a more nuanced level of feedback regarding academic register. Quantifying these patterns demonstrates that the six writing samples selected for qualitative analysis are not anomalous; rather, they constitute representative cases that reflect the systemic challenges experienced by most participants. Consequently, this prevalence supports the validity of the thematic coding process and ensures that the qualitative depth of the study is firmly grounded in the overall linguistic profile of the students' assignments.

Table 7 *Quantitative Summary of Deficiencies across the Full Dataset*

Deficiency category	Frequency	Percentage	Primary Gemini feedback focus
Sentence structure	56	65.10%	Run-on sentences, fragments, complexity
Orthography	48	55.80%	Spelling and capitalization errors
Grammar	39	45.30%	Subject–verb agreement, tense consistency
Punctuation	31	36.00%	Misuse of commas, periods, or apostrophes
Word choice	22	25.60%	Vocabulary precision, academic register

Gemini's Role in Enhancing Student Writing

***RQ 2:** To what extent does Gemini's feedback address the writing deficiencies of Saudi SET students?*

Gemini Feedback: Key Results

The analysis of Gemini's feedback revealed that Saudi SET students face significant challenges in the fundamental mechanics of English writing. A predominant issue was the use of extensive run-on sentences, demonstrating a critical lack of understanding regarding sentence boundaries and punctuation. These structural weaknesses, alongside frequent spelling errors (such as "effect" vs. "affect"), pronoun misuse, and informal language, hindered clarity and professional tone, often making students' writing difficult to comprehend.

Google Gemini addressed these challenges by providing nuanced, context-aware feedback across four dimensions: spelling, grammar, punctuation, and word choice. As detailed in the accompanying tables, the tool successfully identified phonetic misspellings, apostrophe errors, and capitalization issues (e.g., proper nouns and the pronoun "I"). Beyond surface-level corrections, Gemini enhanced higher-order concerns by breaking down complex thoughts into simpler sentences, correcting subject-verb agreement, and removing redundancies. Furthermore, the most compelling evidence of Gemini's sophistication is found in its handling of word choice, clarity, and style (see Table 6). Gemini moved beyond error correction to offer substantive enhancements to the quality of writing. It replaced vague and informal language ("a great thing," "big effect") with more precise and academic alternatives ("a useful tool," "significant effect"). Furthermore, it improved stylistic tone by rephrasing negatively framed statements and resolving unclear pronoun references, thereby enhancing the overall coherence and rhetorical impact of the students' work.

Ultimately, Gemini functions as a comprehensive writing assistant that transforms vague phrasing into logically structured academic prose. However, for optimal skill development, students must actively engage with and apply these suggestions rather than passively copying them. This strategic interaction is essential for internalizing writing conventions and fostering the ability to produce well-written assignments independently.

Triangulating Questionnaires with Gemini's Feedback

The questionnaire results strongly corroborate the qualitative results of Gemini's feedback, creating a robust picture of the tool's effectiveness. Table 8 shows that the students' perceptions aligned directly with the demonstrated capabilities of Gemini's AI tool. Most notably, students ranked the feedback's help in identifying grammatical errors as the highest benefit ($M = 4.24$, Rank = 1), a finding that is empirically supported by Gemini's correction of a wide range of syntactic issues (see Table 4), including subject-verb agreement and pronoun case. Similarly, the high ranking for improving sentence structure ($M = 4.17$, Rank = 2) is validated by the examples in Tables 5 and 7, where Gemini successfully restructured sentence fragments and repetitive phrasing into clearer, more coherent sentences.

Furthermore, the perceived effectiveness in vocabulary and word choice ($M = 4.13$, Rank = 3) is powerfully illustrated by the results in Table 6, where Gemini consistently generated more precise and academic alternatives to students' vague or informal language (e.g., suggesting "significant effect" for "big effect"). While students perceived slightly less impact on punctuation and spelling ($M = 3.86$, Rank = 7), the evidence from Tables 4 and 6 confirms that Gemini's corrections in these areas were, in fact, highly accurate. This slight discrepancy may indicate that students are more confident in their mechanics or that they value higher-order improvements more. Finally, the strong agreement with the overarching statement that Gemini improved their overall proficiency ($M = 4.01$) provided crucial perceptual evidence that the specific, observable improvements documented in the feedback tables translated into a genuine sense of learning and development for the students themselves. This convergence of objective feedback quality and subjective student experience powerfully argues for the real-world utility of Gemini's feedback in the writing tasks.

Table 8 *Specific Usefulness of Gemini's Feedback*

Gemini's feedback helped me ...	Strongly agree (N/%)	Agree (N/%)	Neutral (N/%)	Disagree (N/%)	Strongly disagree (N/%)	Mean	Std. deviation	Rank
identify grammatical errors	35/40.7	39/45.3	11/12.8	0 / 0	1/1.2	4.24	7.66	1
improve vocabulary or word choice	20/23.3	57/66.3	9/10.5	0 / 0	0/0	4.13	5.7	3
identify problems with sentence structure	29/33.7	43/50.0	14/16.3	0 / 0	0/0	4.17	6.89	2
identify issues with organization and flow	24/27.9	38 / 44.2	29/33.7	0 / 0	0/0	4	7.51	5
identify areas where ideas were not clear	34/39.5	30/34.9	11/12.8	8/9.3	3/3.5	3.98	1.106	6
identify errors in punctuation and spelling	25/29.1	35/40.7	15/17.4	11/12.8	0/0	3.86	0.984	7
improve academic tone and style	27/31.4	26/30.2	22/25.6	11/12.8	0/0	3.8	1.027	8
Overall, I believe that using Gemini's feedback has improved my English writing proficiency	22/25.6	45/52.3	18/20.9	0/0	1/1.2	4.01	0.759	4
The overall mean score of the whole scale						4.0247	0.5155	

Student Perceptions of Gemini-Driven Writing Feedback

RQ 3: *What are Saudi SET students' perceptions of the usefulness of Gemini's feedback for improving their writing proficiency?*

Analysis of Student Writing

The content analysis of the following writing samples revealed that Saudi SET students hold positive perceptions of Gemini's role in improving their writing skills. They viewed Gemini as a transformative and versatile tool, highlighting its utility in various aspects, including error correction, skills development, and its convenience. Similarly, many students demonstrated a sophisticated and critical understanding of AI's role. They acknowledged its ethical considerations, complementary function, and its use for a long-term perspective.

In the writing sample 1, the student wrote that "AI the future for evrrrething governmets AI.create im." He clarified that AI is the future in all aspects, and governments are creating AI, despite the mistakes that might hinder their grasp of the intended meaning. He listed several ways AI can assist in language learning and life, such as feedback on grammar, pronunciation, and presentations. The writing sample 2, the student effectively conveyed two main points about using Gemini: its utility for solving problems (though sometimes requiring re-checking) and its ability to generate varied content. He showed a clear understanding of the AI tool's functions. Furthermore, the student's use of the adverb "ethically" denotes that the student is aware of the widespread use of AI tools in various fields. Some might use it unethically, leading to plagiarism, overreliance, and a decline in critical thinking and creativity. Therefore, he highlighted the effective role of AI tools and emphasized the need for *ethical* and responsible use in developing language skills.

One student identified AI as an "amazing tool" for learning and highlighted its versatility in learning "anything you want." He listed AI tools like Gemini, Alexa, and Siri and acknowledged AI's continuous growth, "growing bigger and bigger." He also expressed the ambitious goal of designing his own AI tool (see Figure 5 in the Appendix). Another student had a balanced view, acknowledging AI's positive role in grammar improvement but also its negative potential for cheating. He highlighted that cheating might help in the short term but is detrimental to long-term skills development (i.e., tests, job interviews, etc.), ending with advice against taking shortcuts (see Figure 6 in the Appendix). The student of the writing sample 6 demonstrated a strong conceptual understanding of AI's capabilities in translation, writing, and vocabulary, as well as its limitations, such as the potential for mistakes. He also logically connected ideas, explaining AI's benefits, like handling ambiguity and cost-efficiency. This indicated a level of analytical thinking (see Figure 7 in the Appendix).

Triangulating Student Perceptions

Table 9 illustrates that the quantitative data from the questionnaire on students' perceptions closely align with and enrich the qualitative themes derived from the students' written assignments. The high mean scores for statements like "I find Gemini's feedback easy to understand" ($M = 4.06$, Rank = 1) and "Using Gemini's feedback makes the writing revision process more efficient" ($M = 4.03$, Rank = 2) provided statistical backing for the students' descriptions of Gemini as a convenient, accessible, and transformative tool. This perception of efficiency and clarity is a fundamental reason why students viewed it as a versatile aid for error correction and skills development. Furthermore, the strong agreement with the statement "I recommend integrating AI tools into the classroom" ($M = 4.00$, Rank = 3) directly reflected the positive and future-oriented attitude seen in the assignments, where students advocated for its use as a complementary learning partner.

However, a nuanced picture emerges when considering reliability and confidence. The notably lower mean score for “I believe Gemini’s feedback is reliable” ($M = 3.41$, Rank = 6) and the moderate score for increased confidence (Mean = 3.81, Rank = 5) triangulated perfectly with the students’ sophisticated and critical understanding of AI’s role. This statistical caution reflects the ethical concerns and awareness of limitations expressed in their writing, such as warnings against overreliance and the potential of cheating. Students appeared to value the tool’s utility for identifying errors ($M = 3.97$), but maintained a critical distance, understanding that its feedback must be engaged with thoughtfully. This convergence of data confirmed that while students perceived Gemini as highly useful and recommended its integration, they did so not with naive acceptance but with a balanced awareness of its potential and pitfalls, viewing it as a supplement for long-term growth rather than an infallible authority.

Table 9 *Students’ Perceptions of Gemini’s Feedback*

Section 3: Students’ perceptions of Gemini’s feedback	Strongly agree (N/%)	Agree (N/%)	Neutral (N/%)	Disagree (N/%)	Strongly disagree (N/%)	Mean	Std. deviation	Rank
I find Gemini’s feedback easy to understand.	24/27.9	43/50.0	19/22.1	0/0	0/0	4.06	0.709	1
Using Gemini’s feedback makes the writing revision process more efficient.	24/27.9	43/50.0	18/20.9	0/0	1/1.2	4.03	0.774	2
I recommend integrating AI tools into the classroom to improve my writing skills.	23/26.7	41/47.7	21/24.4	1/1.2	0/0	4	0.751	3
Gemini’s feedback helps identify errors in my writing.	19/22.1	52/60.5	11/12.8	1/1.2	3/3.5	3.97	0.846	4
I am more confident in my writing after incorporating Gemini’s feedback.	26/30.2	25/29.1	28/32.6	7/8.1	0/0	3.81	0.964	5
I believe Gemini’s feedback is reliable.	7/8.1	25/29.1	50/58.1	4/4.7	0/0	3.41	0.709	6
The overall mean score of the whole scale						3.88	0.541	

To sum up, the convergence of these findings is visually synthesized in Table 10, which serves as a triangulation matrix. Primarily, the data reveal a direct alignment between the most frequent writing deficiencies (RQ1) and the perceived usefulness of Gemini’s feedback (RQ2). For instance, while sentence structure was the most prevalent error (65.1%), it was also ranked by students as the area of greatest improvement ($M = 4.17$). Furthermore, the qualitative themes from the writing samples, ranging from “transformative tool” to “ethical concerns”, provide the necessary depth to explain the quantitative results for RQ3. The statistical caution students showed regarding the tool’s reliability ($M = 3.41$) is mirrored in their qualitative warnings against overreliance and plagiarism. Ultimately, this integrated

display confirms that the use of Gemini fostered a sophisticated form of AI-mediated writing, where objective linguistic improvements were matched by a critical and self-aware student perspective.

Table 10 *Triangulation of Quantitative Results, Qualitative Themes, and Gemini Feedback Patterns*

Research focus	Quantitative data (Tables 7, 8, & 9) (RQ1)	Qualitative themes (Writing samples) (RQ1)	Gemini AI feedback integration (RQ2)	Student perception & attitude (RQ3)
Structure & grammar	65.1% prevalence; Ranked 1 & 2 for usefulness (M = 4.24).	Pervasive run-on sentences and fragments.	Restructured incoherent segments into logical, academic sentences.	Viewed as a “transformative tool” for clarifying complex ideas.
Vocabulary & style	25.6% prevalence; Ranked 3 for vocabulary (M = 4.13).	Use of informal/ vague terms.	Replaced colloquialisms with precise academic terms.	Appreciated for enhancing “academic tone” and professional register.
Mechanics & accuracy	55.8% prevalence; Ranked 7 for punctuation (M = 3.86).	Frequent phonetic spelling and lowercase proper nouns.	Provided high-accuracy corrections for branding and basic orthography.	Valued for “convenience” but ranked lower in perceived impact than structure.
Reliability & efficiency	Reliability ranked 6 (M = 3.41); Integration recommended (M = 4.00).	Warnings against “plagiarism” and “overreliance” on the tool.	Functions as a supplement; requires student verification.	Demonstrated “sophisticated understanding”; viewed AI as a partner, not an authority.

Discussion

To address the first research question, the results indicated that Saudi SET students’ writing errors ranged from basic mechanics to complex syntax, which distorted meaning and academic tone. These findings corroborate previous research within the Saudi Arabian context, which consistently identifies foundational skill deficits and L1 interference as the primary drivers of writing deficiencies (Alrabai, 2016; Bukhari, 2022). At the orthographic level, students frequently struggle with phonetic misspellings, omitted letters, and word boundary issues, alongside a failure to capitalize proper nouns such as “English.” These surface-level mistakes are compounded by significant structural obstacles, most notably the omission of sentence-final punctuation and the prevalence of run-on sentences, which together create choppy, difficult-to-follow writing that obscures logical flow. Furthermore, the results highlighted deeper grammatical and syntactic challenges like sentence fragments, faulty subject-verb agreement, and incorrect pronoun cases. These errors are not merely technical slips but are described as structural obstacles that distort meaning and compromise the formal tone necessary for academic writing.

Specifically, the results presented in Tables 4–7 revealed that students can be broadly categorized based on whether their primary challenges are higher-order concerns (such as structure and idea development) or lower-order concerns (such as mechanics and precision). They revealed four key areas of students’ writing skills that require development: proper use of grammar and sentence structure (the most prevalent), spelling, punctuation, and word choice and clarity. This result went in line with the

results of Mushthoza et al. (2023) who demonstrated the role of AI tools in identifying linguistic errors, suggesting alternative vocabulary, and offering recommendations to improve readability.

To answer the second research question, the results revealed that Gemini AI tool proved highly effective as a corrective tool by accurately resolving the above-mentioned mechanical and grammatical issues. Beyond simple correction, it serves as a pedagogical bridge; by providing instant feedback that organizes lists and reinforces linguistic rules. It helps students develop metalinguistic awareness. This finding aligned with Azmi and Fithriani (2025) and Derakhshan (2025), who demonstrated that Gemini enhances EFL learners' writing by improving idea generation and linguistic accuracy. Ultimately, long-term growth is achieved when students move beyond passive acceptance and actively analyze AI-generated revisions to understand underlying linguistic rules.

These results align with previous findings, confirming the positive impact of AI tools' immediate feedback on enhancing the quality of students' writing. They stated that this feedback identified linguistic errors, suggested alternative expressions or vocabulary options, and provided suggestions that led to enhanced readability (Almassaad et al., 2024; Atox & Clark, 2024; Kotmungkun et al., 2024; Mushthoza et al., 2023; Marzuki et al., 2023). Ultimately, the results of the present study aligned with the previous studies (Azmi & Fithriani, 2025; Derakhshan, 2025) in positioning Gemini as a transformative pedagogical tool that advances EFL learners beyond mere grammatical accuracy by fostering their structural proficiency.

Overall, to answer the third research question, the Saudi SET students perceived Gemini as a transformative and future-oriented tool for improving various aspects of language learning and writing, often citing its role as a grammar and error corrector, vocabulary assistant, complementary learning aid, and translator with appropriate efficiency, convenience, and accessibility. They also showed an emerging awareness of its limitations and the ethical considerations surrounding its responsible application. This result corroborated other studies indicating that the students maintained positive perceptions of AI tools for writing enhancement (Al-Raimi et al., 2024; Al-Sofi, 2024; Anandaa & Salmiah, 2024; Anh, 2024; Hasanein et al., 2024; Ozfidan et al., 2024; Rane et al., 2024; Utami et al., 2024).

Conclusion

The findings of the study revealed students' persistent challenges in sentence structure, spelling, grammar, punctuation, and word choice, issues that were systematically flagged by Gemini's feedback. These objective data align with the students' own perceptions, as the questionnaire results indicated strong agreement that Gemini's feedback helped identify errors, particularly in grammatical accuracy and sentence structure. The quantitative summary of deficiencies across the full dataset ensured that the qualitative depth of the study was firmly grounded in the overall linguistic profile of the students' assignments. This convergence of evidence underscores the utility of Gemini in diagnosing foundational writing weaknesses. Furthermore, the findings congruently demonstrate that Google Gemini serves as an effective tool for identifying and addressing specific writing deficiencies among Saudi SET students.

The findings also highlighted a nuanced relationship between feedback utility and student engagement, showing that students were not just receiving feedback but actively using it, a necessary step for improvement. Furthermore, the immediacy and personalized nature of the feedback can be highly motivating. Moreover, the high rate of feedback application and the overall positive perception of writing improvement suggest that despite reliability concerns, students actively used the tool as a scaffold. This integration of quantitative perception data, qualitative feedback examples, and

performance assessment scores solidifies the conclusion that Gemini acts as a valuable complementary tool, enhancing writing proficiency through immediate, actionable feedback while fostering greater learner autonomy and critical engagement.

While students perceived the feedback as highly understandable and efficient for revision, their confidence in its reliability was notably lower, indicating a critical rather than uncritical acceptance of AI suggestions. This cautious trust aligns with the qualitative findings from the assignments, which showed that students often understood the corrective rationale behind Gemini's suggestions, such as replacing informal phrases like "not bad" with "satisfactory," reflecting a developing metalinguistic awareness.

Recommendations

AI tools like Gemini are valuable for proofreading and formative evaluation, helping students develop a reader-oriented perspective where precision, structure, and tone are central to effective communication. Students should be encouraged to actively proofread their work, either independently or with AI support, prior to final submission.

Teachers play a crucial role in this process by guiding students toward constructive AI use. Beyond raising awareness, educators provide an indispensable human element by contextualizing AI-generated feedback. This ensures that automated evaluations remain pedagogically sound and offers the nuanced, discipline-specific guidance that technology alone cannot provide.

Implications

This research offers a practical framework for integrating AI into the curricula of SET students, particularly English language learners. For teachers and policymakers, the findings highlight the need to move beyond viewing AI as a simple fixing tool. Instead, curricula should be revised to include training on the critical application of AI, such as using it for brainstorming and structural refinement rather than full-scale content generation.

Ultimately, this study advocates for a sustainable, human-centric approach to educational technology. By prioritizing intellectual growth over tool-dependency, institutions can ensure that AI assistants like Gemini enhance learning outcomes while remaining aligned with long-term educational values.

Limitations and Future Research

Despite these insights, several limitations must be acknowledged. The study's sample was drawn from a single institution and an all-male cohort, which may limit the generalizability of the findings to more diverse or co-educational settings. Additionally, the data rely on self-reported perceptions, which are subject to participant bias. Finally, the analysis focused primarily on mechanical improvements (grammar and syntax) rather than higher-order concerns such as complex argumentation or genre-specific technical writing.

To build upon this study, future research should move toward longitudinal studies that track student progress over several semesters. While a controlled experimental design (comparing AI-assisted groups against traditional control groups) is a necessary next step, future studies should also benchmark Gemini against other LLMs, such as ChatGPT, or direct human feedback. Such comparative research will help determine which tools are most effective for specific pedagogical goals in the rapidly evolving landscape of educational AI.

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Use of Generative AI

During the preparation of this paper, the author utilized Grammarly to enhance the manuscript's language and readability. The author has critically reviewed and edited the generated suggestions and assumes full responsibility for the integrity and accuracy of the final content.

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Appendix

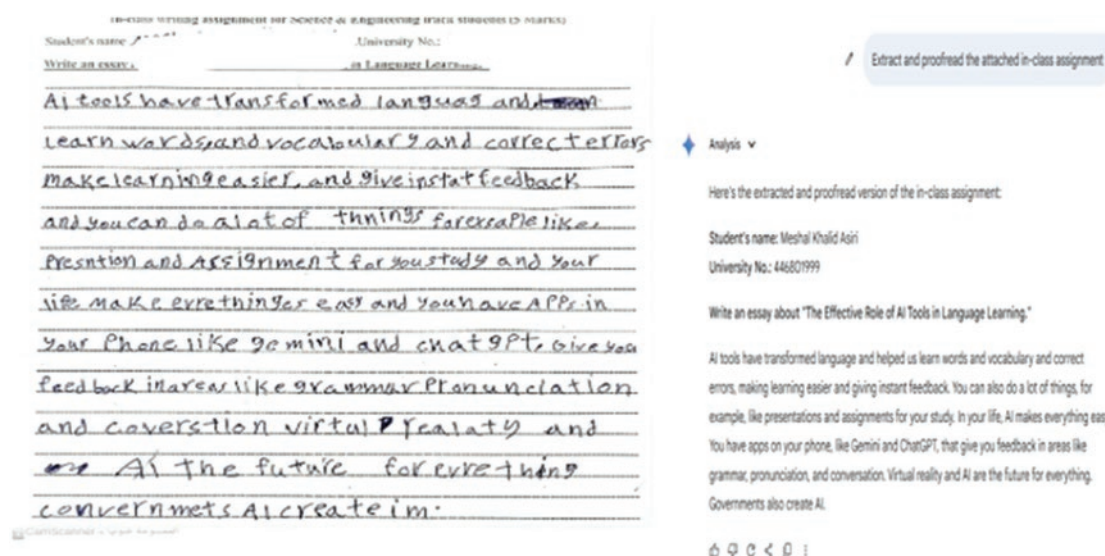


Figure 2 Writing Sample of Selected Participant 1 (left). Gemini's Corresponding Evaluation (right)

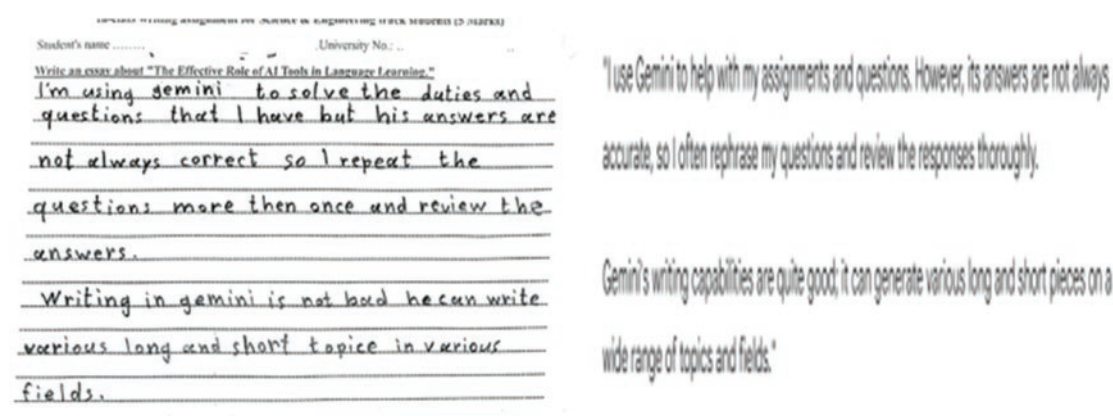


Figure 3 Writing Sample of Selected Participant 2 (left). Gemini's Corresponding Evaluation (right)

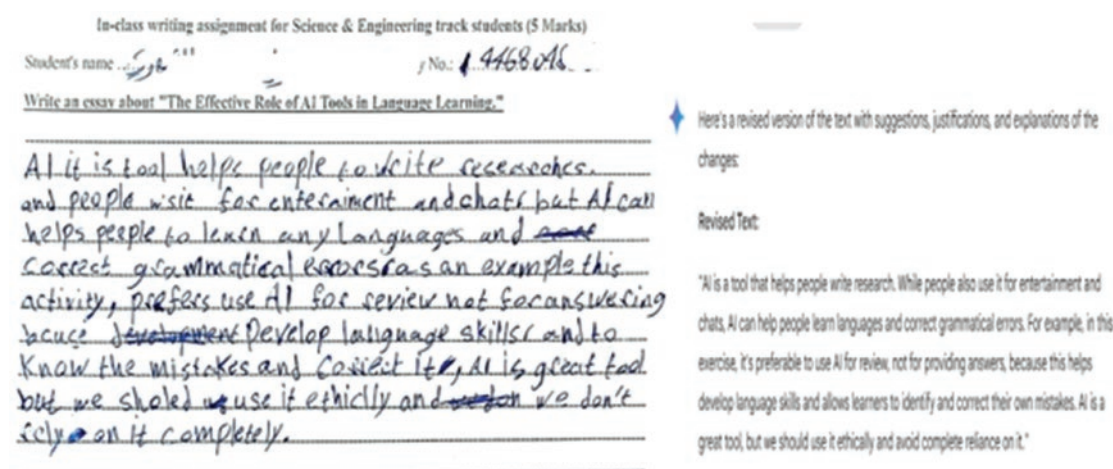


Figure 4 Writing Sample of Selected Participant 3 (left). Gemini's Corresponding Evaluation (right)

In-class writing assignment for Science & Engineering track students (5 Marks)

Student's name: _____ University No. _____

Write an essay about "The Effective Role of AI Tools in Language Learning."

The AI is an amazing tool for learning anything you want to learn. There are so many apps for AI like Gemini and it's the best out of them.

Gemini is a useful app where most of the students use on a daily basis for a homework he couldn't solve or an essay he couldn't finish or for anything new he wants to learn.

The AI is the future and so far it's growing wise and wise now it can talk to you like Alexa from Amazon and Siri from Apple.

AI is a great thing and hope one day I will make one for my own and it will be something big and no one will ever make something better than me.

AI is a remarkable tool for learning virtually anything you want. There are numerous AI-powered applications, such as Gemini, which is arguably one of the best.

Students find Gemini particularly useful for a variety of daily tasks. They use it for homework problems they can't solve on their own, essays they need assistance completing, or simply to explore new topics.

AI is undoubtedly the future, and its capabilities are constantly expanding. Today, AI assistants like Amazon's Alexa and Apple's Siri can engage in conversations with you.

AI has incredible potential, and it's inspiring to imagine creating your own AI one day. While striving for excellence is admirable, remember that innovation often builds upon the work of others.

Figure 5 Writing Sample of Selected Participant 4 (left). Gemini's Corresponding Evaluation (right)

In-class writing assignment for Science & Engineering track students (5 Marks)

Student's name: _____ University No. _____

Write an essay about "The Effective Role of AI Tools in Language Learning."

AI tools have a big effect on students when it comes to learning. It can affect them in numerous ways. Some are good and some are bad. Such as when it comes to grammar some students use it to help them improve their English and some use it to help them cheat. After all, everything has its ups and downs. In my opinion, you don't really benefit when you use it to cheat. Yes, it does help you with your grades but in the long run it doesn't help you when you're in a test or in a job interview.

My advice is use it to help you understand the language not to make shortcuts in your education because it doesn't help you at all in building your future.

"AI tools have a significant effect on students' learning. They can affect them in numerous ways, both positive and negative. For example, regarding grammar, some students use these tools to improve their English, while others use them to cheat. After all, everything has its pros and cons. In my opinion, using these tools to cheat isn't beneficial. While it might temporarily improve grades, it ultimately hinders performance on tests or in job interviews.

My advice is to use these tools to enhance understanding of the language, not to take shortcuts in education. Taking shortcuts doesn't help at all in building a strong future."

Figure 6 Writing Sample of Selected Participant 5 (left). Gemini's Corresponding Evaluation (right)

In-class writing assignment for Science & Engineering track students (5 Marks)

Student's name: _____ University No. _____

Write an essay about "The Effective Role of AI Tools in Language Learning."

The effect of AI tools has many extends including these in language like writing and reading and multiple uses in translation because some words can have more than one meaning in normal translation but with artificial intelligence it can translate using the positioning of the word. AI can learn also new words due to having computer generated systems. AI also can be cheaper and faster than usual learning ways and also cheaper because it doesn't work like employees. Humans need time and salary. Unlike AI where it only needs electricity to run and internet connection. AI can make some mistakes like translating long sentences.

Conclusion: AI is better than normal translating in many ways but it has down sides.

AI tools have a significant effect on students' learning. They can affect them in numerous ways, both positive and negative. For example, regarding grammar, some students use these tools to improve their English, while others use them to cheat. After all, everything has its pros and cons. In my opinion, using these tools to cheat isn't beneficial. While it might temporarily improve grades, it ultimately hinders performance on tests or in job interviews.

My advice is to use these tools to enhance understanding of the language, not to take shortcuts in education. Taking shortcuts doesn't help at all in building a strong future."

Figure 7 Writing Sample of Selected Participant 6 (left). Gemini's Corresponding Evaluation (right)