

DeepSeek-Assisted EFL Writing: A Longitudinal Case Study of a Chinese High School Learner's Writing Accuracy, Complexity, and Motivation

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Abstract—This longitudinal single-case study investigates the impact of DeepSeek, a Chinese-developed Large Language Model (LLM), on the English writing development and motivation of a Chinese EFL learner aged 15. Given the increasing importance of written communication in international professional contexts, particularly through email, improving writing proficiency has become a key objective for many Chinese EFL (English as a Foreign Language) students. With AI tools readily accessible to Chinese learners, they offer interactive feedback and writing assistance that may enhance both writing performance and learner engagement. This study examines changes in the learner's writing complexity and accuracy through quantitative analysis, as well as shifts in motivation through qualitative data. The findings indicate that sustained use of DeepSeek contributed to improvements in written accuracy and linguistic complexity. In addition, the learner reported increased motivation, confidence, and engagement in the writing process due to the immediate feedback and collaborative interaction provided by the AI tool.

Keywords—DeepSeek, Large Language Models (LLMs); EFL writing; motivation

I. INTRODUCTION

For most Chinese EFL students, developing English writing skills for professional contexts is more essential skill than acquiring a natural spoken language, as email communication is the primary mode of interaction in the international workplace [1]. As with aspects of language learning, the outcome of language skills development is often shaped by both factors, such as motivation, instruction style, interaction, and exposure. For example, Rasteiro & Limpo [2] examined the links between writing motivation and writing quality, and Chan *et al.* [3] also investigated the effects of motivation in Second Language Acquisition (SLA).

AI-powered Education (AIEd) has been a popular research topic in the past ten years [4]. Many language-related systems or software have been developed recently. For example, researchers have developed a context-aware vocabulary learning system and a conversational agent to foster communication [4]. Other applications like Duolingo (2012) in learning communication, DeepL (2017) in transcription and translation, Grammarly (2009) in writing editing, etc., are keeping adapting to new trends. Right after ChatGPT, DeepSeek is a widely used Large Language Model (LLM) developed by a Chinese team. Those AI tools have been used largely in English education, where the dynamic interaction encourages students to engage more with language learning tasks, as they can discuss ideas, revise their work, and receive support instantly. Such

heightened engagement fosters a sense of achievement and progress, which in turn enhances learners' motivation to continue developing their language skills.

This study adopted a case study longitudinal design. It aims to investigate how DeepSeek would affect a student's writing complexity and accuracy (quantitatively) and their attitudes towards it (qualitatively). The findings provided valuable insights into an intra-individual learner's writing development and future pedagogy. The outcomes of this research bear paramount significance for both EFL educators and learners alike. Furthermore, by endorsing collaborative writing endeavors facilitated by DeepSeek, Chinese high school teachers can cultivate and sustain students' enthusiasm and vested interest in the writing process, thus nurturing their overall growth and proficiency in writing [5].

II. LITERATURE REVIEW

This study first draws on Vygotsky's theory of social constructivism, which emphasizes the central role of social interaction in learning. According to Vygotsky, learning occurs through active engagement with one's social environment, particularly in collaboration with more knowledgeable peers. A key concept in this framework is the Zone of Proximal Development (ZPD), which refers to the gap between what a learner can accomplish independently and what they can achieve with guidance and support. Collaborative language learning and seeking help from others allow learners to progress within their ZPD, and their growing ability to work independently reflects the development and mastery fostered through this process [6].

While Vygotsky's theory provides a foundation for understanding collaborative learning, it is essential to acknowledge the substantial body of research that emphasizes the role of feedback in shaping writing proficiency and motivation. Feedback, whether from human instructors or AI systems, plays a central role in guiding learners toward improvement [7, 8]. Some studies have already examined the use of AI's feedback in language learning. For example, Song and Song [5] pointed out that by employing AI-assisted language learning tools, learners not only partake in social interactions but also engage in dynamic exchanges with AI, effectively treating it as a knowledgeable and adaptive virtual peer. Gao *et al.* [9] statistically compared the essay scores given by the DeepSeek-R1 and four human teacher rater providing profound different qualitative feedback. Other previous studies have shown that AI-assisted writing works on

academic tasks, increasing both efficiency and accuracy. For instances, Barrot [10] examined that ChatGPT can be effectively utilized in diverse language learning courses to enhance learners' writing abilities. And based on a study of 20 Saudi EFL teachers, DeepSeek is perceived as a user-friendly, cost-free, and accurate generative AI tool that supports English language teaching [11]. These recent studies indicate that there is a trend for exploration regarding the application of AI in enhancing writing skills and motivation. This heightened engagement, facilitated by the AI tool's responsiveness, contributes to the observed improvements in writing skills and motivation [12, 13]. However, the studies on the investigation of DeepSeek's support in writing is still underdeveloped.

The second grounding theory supporting this study is Complex Dynamic Systems Theory (CDST), which explores the evolution through a learner's SLA. According to CDST, complex phenomena like language learning are dynamic systems that are nonlinear, completely interconnected, iterative, and co-adaptive [14]. For instance, it is well recognized that within this scope, motivation is a great factor that may lead to a proportional increase in learning achievements. According to Zoltán Dörnyei [15], who proposed the most common research design - the social sciences tend to examine variables in relative isolation rather than as part of a system. Its potential usefulness has already been recognized in several discussions. Gu [16] explains that CDST aims to explore how cognitive, affective or behavioral patterns that are complex and attractor-governed appear in dynamic, self-organized developmental process. This approach is called Retrodictive Qualitative Modelling (RQM), and it does so by looking backward, which can give more tangible explanations with respect to the real-time experiences of language learners in their classroom ecology [16]. Thus, if a system outcome is taken and examined retrospectively to determine how it emerged, as in RQM, prediction is no longer required since retrodiction is employed. This approach also makes it possible to consider the outcome in its totality and to work backwards without losing too much of the system's complexity.

III. PROJECT

A. Research Questions

Considering the changing landscape of language education, this study aims to bridge this complex knowledge gap by investigating the effects of AI-assisted language learning on EFL learners' writing skills, motivation, and perceptions. By doing so, it aims to provide valuable insights into the role of AI in improving language proficiency and informing effective teaching practices within the context of Chinese high school EFL education. To address these research objectives, the following research questions guided this study:

RQ1: Does DeepSeek-assisted writing improve written accuracy and complexity in English compositions by a Chinese high school EFL student, compared to traditional writing over time?

RQ2: How does a Chinese high school EFL student's motivation to write in English evolve through engagement with DeepSeek-assisted writing tasks?

B. Tasks

1) Writing skills assessment

The complexity, accuracy, and fluency (CAF) as measures of language proficiency have been widely used in assessing second language production in English language studies related to task-based language teaching [17]. To assess writing skill, complexity and accuracy were selected as variables to measure individual learning evolution. In this study, the participant's language accuracy and complexity were assessed using three successive writing tasks. In this longitudinal study, the participant completed Tasks 1, 2, and 3 (see Appendix A) at three time points within three months. At each, she produced two writing samples without a time limit: one traditional and one AI-assisted.

2) Semi-structured interview

A semi-structured interview was conducted in the participant's native language to ensure clear expression of ideas and attitudes toward the study. Out of respect for the participant's wish, we refrained from making audio recordings. The interview was documented in written form, with both the questions and the responses recorded on paper and later translated into English (see Appendix B). The interviews included 7 questions to gain in-depth insights into the influence of AI-assisted efficacy on her writing skills and motivation to write. She was encouraged to articulate her views on AI-assisted instruction, contrast it with traditional methods, and highlight the benefits, drawbacks, and challenges she encountered.

C. Participant and Procedure

This longitudinal case study involved a 15-year-old female Chinese high school student learning English as a foreign language (EFL). Her English proficiency was approximately at the A2–B1 level according to the Common European Framework of Reference for Languages (CEFR). She had no experience of studying or traveling abroad and had received English input primarily through school instruction since the age of nine. To protect her privacy, the participant was assigned the pseudonym "Student Y." Informed consent was obtained from both the participant and her parents before data collection commenced.

Prior to the study, the participant received training on the appropriate use of DeepSeek. She was instructed to use the AI tool only for revising text structure, improving word choice, and editing sentences, while generating an entire composition through AI was strictly prohibited. At each data collection point, the participant first completed a writing task independently. After finishing the initial draft, she interacted with DeepSeek to seek feedback and suggestions for revision, and subsequently produced a revised version of the composition. All interactions with DeepSeek were recorded for analysis.

Data were collected at three time points between June and August 2025. At each session, the participant completed an email-writing task under slightly different prompts. Following the final session, a semi-structured interview was conducted to explore changes in her writing motivation and perceptions of traditional versus AI-assisted writing. The final dataset consisted of six compositions (three original drafts and three revised versions), interview data, and

records of all DeepSeek interactions.

D. Methodology

1) Quantitative method

Skehan [18] defined accuracy as “freedom from error”, which includes sub-constructs such as percentage of error-free clauses, errors per AS unit, errors per 100 words, target-like use of verbs, plural, and tenses. In this study, in order to calculate the accuracy of each composition, first, Grammarly was used to detect errors in spelling, grammar, tense, verb usage, and plural forms, with the number of suggested corrections counted as the error metric. Then, a manual judgment was applied to remove non-grammatical suggestions, such as rephrasing recommendations indicated by Grammarly in yellow or blue underlines. Second, an R script was used to calculate the “total AS-units”, “total words”, “total errors”, “error-free AS-units”, “errors per 100 words”, “average errors per AS-unit”, and “percentage of error-free AS-units”.

Complexity is “the extent to which learners produce elaborated language” [19]. In measuring complexity, both syntactical complexity and lexical variety are considered the most germane sub-components of language complexity [20]. The most common way of assessing lexical variety was by finding the type-token ratio (TTR), which was influenced by text length and has now been improved by moving average type-token ratio) (MATTR). Syntactic complexity as a

multidimensional measure includes “sentential, clausal, and phrasal complexity” [21]. There are generalized and specialized measures of complexity, and previous research believed that general measures are better for measuring the complexity of language since they allow for comparisons between studies.

In the present study, several indices reported from TAASSC were used as measures of complexity. For instance, MATTR is a measure of lexical diversity (vocabulary variety). The original standard TTR is the number of unique words divided by the total words, but it decreases as text gets longer. While MATTR fixes this by calculating TTR within a moving “window” of words (e.g., every 50 words) and then averaging these scores. This provides a stable measure of vocabulary richness, regardless of text length. To measure syntactical complexity, DC/C (Dependent Clause per Clause Ratio), MLC (Mean Length of Clause), and MLTU (Mean Length of T-unit) are widely used metrics. At the sentence level, these three indices provide a means of assessing the density of dependent clauses as well as the diversity of syntactic structures. All the accuracy and complexity data results were visualized using R packages, including: (a) ggplot2 for visualization, (b) tidyr for data reshaping, (c) dplyr for data manipulation, and (d) gridExtra for combining multiple plots.

An overall description of the adopted indices in this study to measure complexity is provided in Table 1.

Table 1. An overview of indices in measuring language complexity

mattr	Moving Average Type-Token Ratio	A measure of lexical diversity that calculates the TTR (ratio of unique words to total words) within a moving window, avoiding the downside of decreased TTR in longer texts.
np	Number of Noun Phrases	The count of noun phrases in a text. A higher number often indicates higher informational density .
mlc	Mean Length of Clause	The average number of words per clause (a unit containing a subject and a verb). It measures the complexity at the sub-sentential level .
mltu	Mean Length of T-unit	The average number of words per T-unit (one main clause plus any attached subordinate clauses). It is a classic measure of syntactic complexity at the sentence level.
dc_c	Dependent Clause per Clause ratio	The ratio of dependent clauses (e.g., adverb, adjective, noun clauses) to the total number of clauses. It measures the use of subordination for creating complex sentences.

2) Qualitative method

RQM was employed following a three-step procedure. First, the collected data were examined to identify salient patterns in the participant’s motivational trajectory. Second, these patterns were traced back to the interview responses, which documented the participant’s learning and writing experiences over the three months. Finally, the underlying reasons for the fluctuations in the participant’s motivation were analyzed. RQM thus served as the key qualitative method for uncovering the positive and negative emotions underlying motivational change (Chan *et al.*, 2014) [3].

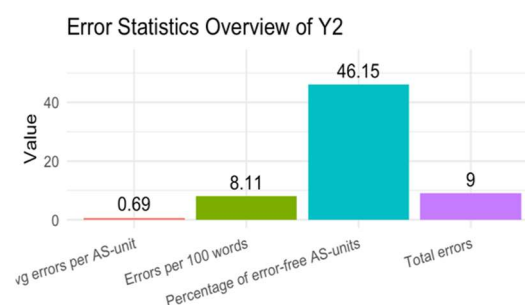
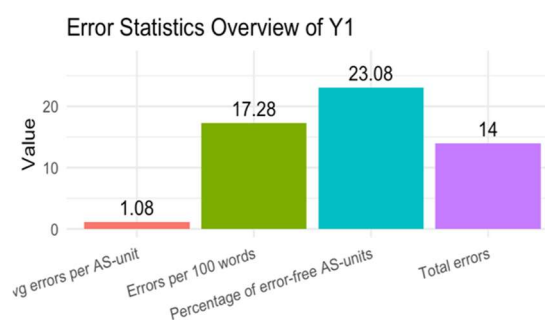
E. Results and Analysis

1) Quantitative results

a) Accuracy

In Fig. 1, data from Student Y’s six writings showed that the DeepSeek-assisted versions had fewer errors per AS-unit and per 100 words, along with higher percentages of error-free AS-units. The most significant change appeared in the first task, where S2’s errors fell from 14 to 9, errors per AS-unit declined from 1.08 to 0.69, errors per 100 words from 17.28 to 8.11, and error-free AS-units rose from 23.08% to 46.15%. These results indicated that in all three writing tasks done by Student Y, AI provided support in her writing

performance, helping her to produce essays with enhanced overall quality.



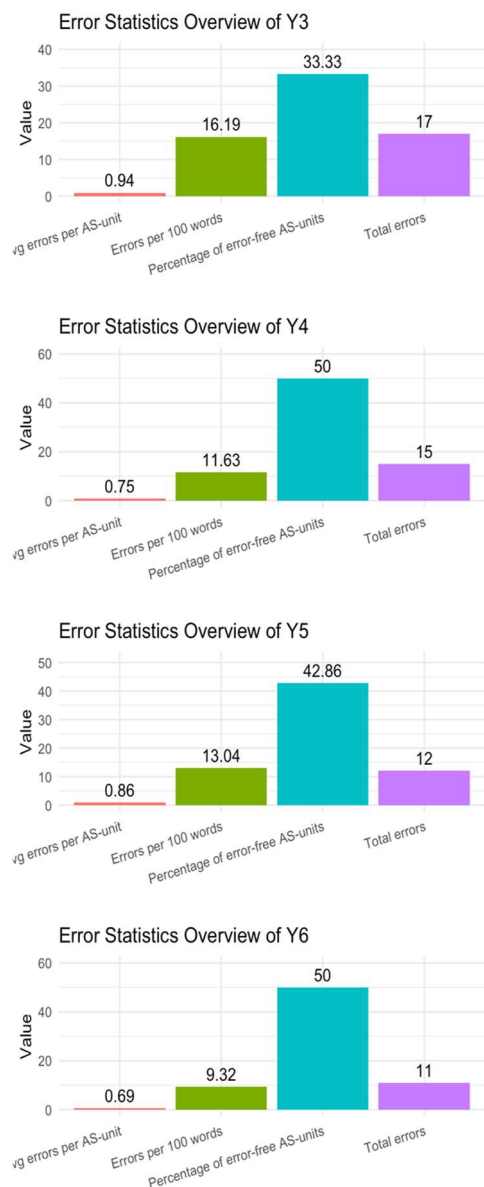


Fig. 1. Error statistics overview of student Y.

b) Complexity

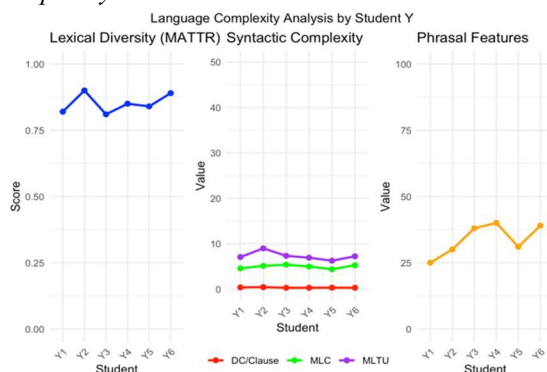


Fig. 2. Language complexity analysis of student Y.

According to Fig. 2 above, five variables were employed in this study to measure the “complexity” dimension of writing performance. MATTR was used to assess lexical complexity, while DC/Cause, MLC, and MLTU were applied to measure syntactic complexity at the sentence level. Finally, the number of noun phrases was taken as an indicator of informational density in a text.

From the perspective of MATTR, in all student’s writing tasks, the values of the second composition assisted by DeepSeek tended to be higher. According to the formula of MATTR, this indicated an increase in lexical types, which in turn suggested that lexical diversity had been enhanced. As for syntactic complexity, several results were predicted from the figure: first, there were no significant changes in DC/C for six compositions; second, for Writing 1 and 3, the MLC and MLTU values increased a bit from traditional writing compared to the AI-aided versions (e.g., Y1 vs. Y2 and Y5 vs. Y6). Concerning the number of noun phrases, the yellow curves showed a general increase from Y1 to Y4, but the number had dropped a lot in the fifth composition. This could suggest that the impact of DeepSeek support on informational density may differ across different task conditions.

2) Qualitative results

From Interview Question One and the participant’s reply, the reason why she has low motivation for English writing (before attending this study) is that she only wrote for extrinsic reasons (i.e., Student Y only wrote when it was an exam or homework). Question Two examined the possible positive reasons behind using AI-assisted writing for the first time. For instance, Student Y learned new sentence patterns from DeepSeek, which may be the reason why her language complexity increased in Y2. Questions Four and Five examined the change in students’ motivational levels by considering whether their motivation shifted from extrinsic influences to intrinsic motivation. For example, after using DeepSeek, Student Y demonstrated greater confidence and enjoyment in writing activities. This could be the underlying factor that explains why Student Y increased both writing accuracy and complexity. The interview data revealed that the participant perceived DeepSeek as a facilitator of writing motivation and expressed her willingness to continue using it in future writing tasks. Nevertheless, she also voiced concerns that reliance on AI might reduce her thinking, suggesting a nuanced perception of the benefits and potential drawbacks of AI-assisted writing.

IV. CONCLUSION

Building upon Vygotsky’s social constructivist framework and ZPD theory, the primary aim of this study was to explore the impact of an AI-assisted language learning approach on the writing skills and writing motivation of Chinese EFL high school learners. The quantitative data consisted of 6 writing samples of one participant collected longitudinally over three months. These samples were on complexity and accuracy to measure evolution in writing proficiency. To measure motivation, the participant was asked to retrospectively think about her writing experience. The qualitative data were gathered through a semi-structured interview, measuring AI-assisted learning on her writing skills and motivation, and a comparison to a traditional writing method.

Regarding RQ1, the quantitative results indicate that, compared to conventional self-directed writing, DeepSeek-assisted writing enhanced students’ performance in accuracy and complexity. Across six samples, all tasks showed that DeepSeek-assisted versions reduced errors per AS-unit and

per 100 words while increasing the percentage of error-free AS-units, with Student Y demonstrating consistent improvements across all three tasks. The TAASSC results suggested that DeepSeek assistance generally promoted greater lexical diversity and, in some cases, modest gains in syntactic complexity, particularly in MLC and MLTU. Noun phrase use trended upward in earlier tasks but declined sharply in the fifth composition, indicating that AI support's effect on informational density may vary by task conditions. Overall, AI involvement can enhance certain aspects of writing complexity, though its influence is not uniform across all dimensions or tasks. In addressing RQ2, based on Student Y's response, her overall attitude toward using DeepSeek was positive. If she were to encounter a similar writing task in the future, she stated that she would choose to use DeepSeek to assist her.

However, several limitations should be acknowledged. First, as a single case study, the findings regarding the participant's attitudes toward DeepSeek may not generalize to the broader population of Chinese EFL high school learners. The restricted sample also provides insufficient evidence for claims about improved writing proficiency and motivation at the group level. Second, given the intraindividual variation design, the results capture the participant's signature dynamics rather than group-level patterns. Third, the three-month intervention period may have been too brief to fully reveal the potential benefits of AI-assisted instruction. Future intra-individual variation studies involving larger, gender-balanced samples and longer observation periods (e.g., six months to two 10 years) are therefore recommended, as they would enable meaningful comparisons between group averages and individual trajectories and shed light on the long-term effects of AI-assisted language learning.

APPENDIX A: TASK LIST

Task One

Suppose you plan to study in the UK and need to rent accommodation there. Please write an English email to the British landlord Mr. Smith to inquire about renting a property. Requirements: You hope to rent a single room with basic furnishings, and the property should have a shared kitchen and a communal living room. The email should include a brief self-introduction, a description of your rental needs, and a polite inquiry about the response time. Pay attention to the formal email format and the appropriateness of English expressions.

Task Two

You are a university student planning to study in the UK. Write an email to a potential flatmate, Lucy, who has posted an advertisement for sharing an apartment. Introduce yourself, mention your study plans, and explain your living habits (e.g., clean, quiet). Ask about the rent, the apartment's facilities (including if it has a washing machine and Wi-Fi), and if there are any house rules. Also, express your interest in meeting Lucy and seeing the apartment.

Task Three:

You're an international student preparing to study in Canada. After seeing a flat-share advertisement posted by a local student named Alex, write an email to express your interest.

Requirements:

1. Introduce yourself (Name, school/program)
2. Describe living habits (e.g., environmentally conscious, regular schedule)
3. Request key information:
 - Rental cost inclusions
 - Common area usage rules
 - Neighborhood safety
4. Express viewing interest

APPENDIX B: INTERVIEW

Student Y

"How would you describe your motivation level in English writing tasks before using DeepSeek? What factors influenced this?"

(1) I only write English when there is an exam or homework.

I am not very proficient in long and difficult English sentences and interrogative sentences, and I am not familiar with the use of words. I don't like to write essays at ordinary times, and my writing level is poor.

"What was your first impression when using DeepSeek for writing? Did it immediately affect your willingness to engage with the task?"

(2) DeepSeek provides many English translations of the same sentence. From them, I can learn or consolidate new sentence patterns or help me understand the subject better, so that I can deal with it more experienced next time.

"Comparing traditional and AI-assisted writing, which approach makes you feel more motivated to write? Can you describe the key differences?"

(3) One point is that DeepSeek helps me learn different English sentence patterns, and better apply the learned words to memorize some sentence patterns, which makes writing more confident and improves my writing motivation.

"Has using DeepSeek changed your confidence in English writing? If so, how does this affect your motivation?"

(4) improves my confidence in English writing and reduces the worry about some sentence errors.

"Do you find the writing process more enjoyable with AI assistance? Why or why not?"

(5) I prefer to use DeepSeek. It is more convenient to look up some English words or phrases. The sentence types are more diverse, and you can choose to write what you are good at and learn some sentences.

"After this experience, would you prefer to use DeepSeek for future writing tasks? What drives this preference?"

(6) You may rely on DeepSeek's function of translating the whole sentence, but DeepSeek will provide different types of sentences for reference. Broaden the types of sentences we write. It may improve my writing confidence, but DeepSeek sometimes reduces my thinking when writing.

"Did any aspects of AI-assisted writing reduce your motivation? (e.g., over-reliance, creativity suppression)"

"Do you believe using DeepSeek helps improve your independent writing skills? How does this belief influence your motivation?"

I think that using DeepSeek will improve my writing ability. Apply the sentences provided by DeepSeek to the next writing and strengthen the accumulation of writing. I will be more confident in the next writing and shorten the

time of the same type of writing.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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