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Students' Perceptions of AI-Powered Feedback in English Writing: Benefits and Challenges in Higher Education

Qianshan Chen[1,*]

[1]*School of Foreign Language Studies, Hangzhou Dianzi University, China*

Abstract: Collaboration between humans and artificial intelligence (AI) has the power to transform education, but research has yet to fully address how students engage cognitively with AI-powered feedback. Although studies suggest that AI can improve writing, few explore how students perceive and interact with AI tools. To fill this gap, the present study investigated Chinese university students' perceptions and experiences of using AI-powered English writing feedback tools: automated writing evaluation, generative AI, and corpora. Two hundred and ten student reflective journals were subjected to qualitative thematic analysis using NVivo software, along with analysis of classroom observations and students' writing. The students evaluated AI-powered feedback tools in three dimensions: content quality, delivery method, and overall effectiveness. They felt that these tools provided better grammar correction, instant feedback delivery, and an enhanced user experience, but challenges included vague explanations, limited emotional connection, and risks of overreliance. Based on these insights, this study introduces the Student-Teacher-AI Collaboration Model for feedback writing, which is designed to enhance collaboration between students, teachers, and AI in foreign language education. The findings have practical implications for the integration of AI tools into writing instruction and will inform policymaking in the rapidly evolving educational field.

Keywords: artificial intelligence, automated feedback, student perceptions

1. Introduction

English writing proficiency is the cornerstone of students' overall language competence, but it is often considered more difficult to master than other language skills. For example, studies show that Chinese students studying English as a foreign language (EFL) have limited writing skills [1, 2]. Solutions to this difficulty may lie in educational innovations brought about by the rapid development of technology. Artificial intelligence (AI) technologies, such as automated writing evaluation (AWE) systems, generative AI (GAI), and linguistic corpora, are particularly promising tools; they can provide immediate, personalized feedback that overcomes the limitations of traditional teacher-led approaches [3].

Despite their potential, however, integrating AI-powered feedback into writing instruction is challenging on several fronts (in this paper, "AI-powered feedback" refers to technology-driven responses that students receive through AWE, GAI, and corpora). Beyond general concerns about accuracy [4, 5], the following three crucial issues have emerged. (1) Systemic limitations, including algorithmic biases that may misinterpret the writing practices of non-native speakers, thereby disadvantaging EFL learners; and reliance on standardized algorithms that produce generic feedback, often ignoring individual stylistic or contextual needs [6–9]. (2) Pedagogical risks, as relying too heavily on AI can erode students' critical thinking and writing identity [10, 11], particularly when learners lack confidence in writing in English. (3) Ethical dilemmas, such as the growing complexity of detecting plagiarism with GAI; this raises concerns about academic integrity [12–15]. Compounding these challenges are unequal access to technology and students' varying levels of AI literacy, which may worsen educational disparities [7]. Another concern is the limited cultural adaptability of AI feedback, which often lacks depth, preventing it from fully accounting for cultural and educational nuances [8]. This issue is particularly pressing in the Chinese EFL context, where large classes and limited teacher availability make AI feedback an attractive option but also magnify its limitations, such as its lack of cultural sensitivity and inability to address higher-order writing skills.

Compared with the impact of AI on writing outcomes, the cognitive and affective dimensions of students' engagement with AI feedback are underexplored. A research gap is particularly evident regarding human–AI interactive negotiation competence (HAINC), which is defined as learners' ability to understand AI, set goals, give instructions, analyze feedback, and adjust strategies [16]. Developing students' HAINC is crucial to ensure that AI complements rather than supplants their cognition, enabling them to retain agency in the development of their writing. To fill this gap, the present study investigates how Chinese EFL students perceive, interpret, and engage with AI-powered feedback. Its aim is to understand how such feedback can be effectively integrated to improve writing proficiency and cultivate productive collaboration between humans and AI in second-language writing instruction.

***Corresponding author:** Qianshan Chen, School of Foreign Language Studies, Hangzhou Dianzi University, China. Email: qianshan@hdu.edu.cn

2. Literature Review

2.1. AI-powered feedback in English writing

Students who want to develop their writing skills need timely and effective feedback, as this can improve not only their written texts but also their understanding of writing practices and their engagement and autonomy in the writing process [4, 17–21]. Yet traditional teacher-led feedback practices are often subject to practical constraints such as high teacher–student ratios and limited resources [22–24]. Consequently, students may regard teacher feedback as either too general (due to time constraints) or too focused on class-wide instruction, making it ineffective in addressing individual writing goals [25, 26].

Integrating technological tools into English writing instruction may offer a way to address these limitations. The three major emerging tools for this purpose are AWE, GAI, and corpus tools. AWE systems provide real-time feedback, enabling an iterative revision process. GAI creates an interactive and immersive language learning environment through an AI-driven chatbot, which provides automated feedback. Corpus tools give students access to a huge range of authentic language resources, which can help them address weaknesses in their writing independently. These tools can motivate students to learn and enable them to dynamically adjust their learning strategies through instant feedback, thus developing their writing knowledge [4].

Feedback provided by AI can complement feedback provided by human teachers, making feedback more effective overall. The feedback given by AI-powered tools is timely and extensive; AI excels in providing highly accurate language-level corrections and positive reinforcement to motivate students [27]. On the negative side, however, AI feedback often lacks the nuance needed to address higher-order concerns such as content development and coherence, as AI is unable to deeply understand students' context, interpret complex emotions, or generate its own ideas [5, 28]. In contrast, human feedback offers personalized, metalinguistic guidance that can help students think critically and address higher-order concerns such as essay structure and content development [29, 30]. However, teachers' heavy workloads may lead them to offer only superficial or overly general comments; as a result, their feedback may fail to address students' specific needs [25, 26]. Combining the efficiency of AI in improving language accuracy with teachers' personalized support can allow each to complement the other. This approach can ease teacher workloads and support more equitable learning, particularly in under-resourced contexts [31]. Given the distinct strengths and limitations of feedback provided by AI and by teachers, understanding how students perceive AI feedback is essential to integrate it effectively with teacher guidance.

2.2. Students' perceptions of AI-powered feedback

Learners' perception of technological innovations is crucial for the effective integration of AI-powered feedback tools into education. For example, Davis [32] argues that user acceptance, which is influenced by perceived usefulness and ease of use, is crucial to technology adoption. Accordingly, it may be possible to determine how Chinese EFL students adopt AI feedback tools in English writing by examining their usage patterns and satisfaction. In line with this, Biggs's presage-process-product (3P) model [33] suggests that students' learning is influenced by their understanding of their context, their self-efficacy, and their responses to teaching strategies. In this light, the current study perceives students' self-efficacy as their belief in their writing ability and assesses the impact of AI tools in terms of their perceptions of benefits and integration challenges. Wen and Liang [16] further emphasize that the development of HAINC depends on "understanding AI," as this enables learners to tailor AI support to their needs by recognizing its affordances and limitations. Therefore, we must systematically examine learners' perspectives on and concerns about these emerging technologies to address the ethical and educational risks associated with AI tools, as well as to help realize their full potential.

2.2.1. Students' perceptions of AWE feedback

Learners hold various perceptions of AWE systems (e.g., iWrite, Pigai, Grammarly, Peerceptiv, Criterion, and My Access!). Powered by natural language processing, these tools can provide immediate and ongoing formative feedback [3, 23]. Students generally believe that these tools can improve their linguistic precision and help them learn autonomously [23, 34, 35]. Aside from efficiency, however, AWE feedback is often perceived as overly mechanical and generic, especially by advanced learners, who seek more sophisticated critiques of content and structure [4, 29, 36].

Although research on AWE systems is growing, studies to date focus on their scoring mechanisms and reliability rather than EFL learners' experiences and perceptions of AWE feedback. Filling this research gap may help to improve AWE systems to better meet learners' diverse needs and help them engage more deeply with the writing process.

2.2.2. Students' perceptions of GAI feedback

The text generation and editing capabilities of GAI systems (e.g., ChatGPT, Grok, DeepSeek, Wenxin Yiyan, and Doubao) are revolutionizing foreign language teaching. Through machine learning and natural language processing, traditional teacher–student interactions are being transformed into a teacher–student–machine triad [37].

Learners' perceptions of GAI-powered feedback reflect different experiences of using such tools. Students generally value the timely, targeted, actionable, and iterative feedback provided by GAI tools; this feedback can improve various aspects of writing, such as vocabulary, grammar, coherence, and organization [38, 39]. Furthermore, learners report that this feedback can improve their motivation, engagement, and confidence, especially when they face writing challenges [4, 11].

However, learners are also concerned about GAI's limitations. One issue is that the quality of GAI-generated feedback depends heavily on the specificity of user prompts: vague prompts often lead to imprecise responses [40]. Students also observe that GAI has a tendency to exhibit bias or make errors, making it less reliable in providing accurate feedback [41]. Second, students worry that overreliance on these tools may impede their development of critical thinking skills [11, 38]. Third, students question the authenticity of GAI-generated content, raising concerns about academic integrity [15, 42, 43]. To compound these issues, most studies on the use of GAI for writing focus on graduate students in academic English contexts [22, 44]. To date, the perceptions and experiences of undergraduate learners in nonacademic contexts have received insufficient attention.

2.2.3. Students' perceptions of corpus-driven feedback

Although research on students' perceptions of corpus-driven feedback is limited, students increasingly value corpora as a means of improving their writing through a learner-centered approach [45]. Corpora act as "textual mentors": they provide students with extensive language exposure and highlight vocabulary collocations and grammatical structures, as well as genre-specific stylistic conventions

[46]. Students feel that corpora can help them learn autonomously by tailoring feedback to their specific writing needs, and they believe that these tools excel in solving lexical problems relating to, for instance, collocations and word choice [47, 48].

However, the effective use of corpora is still challenging, due especially to a steep learning curve and accessibility barriers. First, extensive training is needed to master the complex interfaces of corpora, along with formulating effective queries and interpreting corpus data. These issues are particularly challenging for students who wish to address grammatical errors and integrate the results into their work [49–51]. Furthermore, user-friendly corpus tools and culturally responsive training (as some learners may be reluctant to engage with corpora due to cultural influences) are in short supply [52]. Although corpora have the potential to support students' writing, studies have not yet paid enough attention to students' perceptions and experiences of these tools outside academic writing contexts.

AWE, GAI, and corpus-driven feedback can each enhance students' writing in distinct ways, but they face common challenges. To make their use more effective, students' perspectives and experiences must be placed front and center. AWE systems target error correction but often lack the depth needed for advanced criticism, GAI relies on clear prompts for effective feedback, and corpora require extensive training for proficient use. Unsurprisingly, therefore, students struggle to apply these tools to complex writing tasks, whether by moving beyond AWE's formulaic feedback, interpreting GAI's suggestions, or incorporating corpus insights. As these tools rely heavily on user skill and available support, they have the potential to improve learner autonomy, but these characteristics also create limitations in terms of accessibility and efficiency.

Comparing AI-powered and human feedback reveals how they can jointly address student needs. Although students may appreciate AI's detailed and objective feedback, they prefer teachers' emotionally engaging and personalized feedback, especially in contexts where teacher authority is valued. It is thus important to devise a balanced approach to writing development in which AI provides support and teachers refine feedback [4].

Overall, research on learners' perceptions and experiences of AI-powered feedback reveals several key limitations. First, there is a lack of systematic investigations into learners' cognitive experiences, which limits understanding of what they actually need and expect [44, 53]. Second, the potential for deep human-machine collaboration to give learners greater agency in the revision process remains largely unexplored [54]. Third, little is known about how Chinese EFL learners understand and experience AI-powered feedback tools, creating a crucial gap in understanding the practical implementation and impact of these technologies in the EFL context [43, 55]. To address these gaps, this study examines the perceptions and experiences of Chinese EFL university students when using technologies for feedback, guided by the following research questions:

1) What AI-powered feedback tools do Chinese EFL university students use to write in English?
2) What benefits and challenges do students perceive when engaging with AI-powered feedback tools for English writing?
3) How should AI-powered feedback tools be integrated into writing instruction?

3. Research Methodology

3.1. Context and participants

This study involved students taking a compulsory English writing course for English majors at a key provincial university in eastern China. The aim of this course is to improve students' English writing proficiency, particularly their written expression and critical thinking. The participants were 210 first-year English majors, of whom 67 were male (32%) and 143 were female (68%).

3.2. Data collection

This study used a qualitative data collection approach. Reflective journals, classroom observations, and student texts were collected and analyzed to find out how Chinese EFL students perceived and experienced AI-powered feedback. Rooted in interpretivism, this qualitative approach prioritizes participants' personal perspectives and situated experiences [56], which was in line with the study's goal of better understanding students' cognitive processes and the contextual implementation of AI feedback in the Chinese EFL context.

Participation was voluntary and anonymous. After the participants had given their informed consent, the researcher explained the research purpose and ensured data confidentiality. All of the data, including reflective journals, screenshots, and texts, were anonymized with pseudonyms and used for research purposes only.

The author acted as a participant observer for two semesters (16 weeks each). The main areas of focus were the students' preferences for specific technological tools and how they used and interacted with these tools.

At the end of each semester, reflective journals were collected from all 210 students through an online learning platform. All of the participants had previously used technological tools to revise their writing. Reflective journals were selected to explore the students' perspectives on AI-powered feedback in diverse contexts over time, as they "offer the benefit of hindsight and reflection on writers' practices" and "provide valuable insights into social and psychological processes that might be difficult to collect in other ways" [57]. To mitigate self-reporting bias, whereby students might exaggerate positive perceptions or omit critical feedback due to the reflective nature of the process, a reflection prompt was used to encourage focused reflections on technology awareness, application contexts, perceived benefits, challenges encountered, and learning outcomes while allowing flexibility to address other issues related to AI feedback tools.

The study also collected the students' texts and screenshots of their interactions with technological tools during the writing process. These materials provided concrete evidence to analyze the students' tool use strategies and evaluate the impact of technological tools on their writing performance.

3.3. Data analysis

A qualitative thematic analysis was conducted [58] with the support of NVivo software. Chinese-language data were analyzed and then translated into English for reporting in this paper.

The analysis was divided into three stages to ensure a comprehensive review of the data collected. In the first level of coding, open coding, the author meticulously coded the data sentence by sentence, identifying notable or potentially significant segments relevant to the research objectives. At the second level of coding, axial coding, similar codes were grouped into broader preliminary categories; for example, first-level codes such as "grammar correction," "vocabulary differentiation," and "resource recommendation" were clustered under the category "content assistance." The third stage, selective coding, refined these categories into three overarching themes: "content quality," "delivery method," and "overall effectiveness." To enhance the reliability and validity of the findings,

data triangulation was applied [56], cross-checking insights from reflective journals, student texts, and classroom observations.

4. Findings and Discussion

4.1. Students' engagement with AI tools

The Chinese EFL students in this study showed a high level of familiarity with technological feedback tools. Based on their functional characteristics, these tools could be categorized into three types: AWE systems (e.g., Grammarly, Pigai, Instatext, DeepL Write), GAI tools (e.g., ChatGPT, Doubao), and corpus tools (e.g., SentenceStack, Linggle). Among these tools, Grammarly emerged as the most widely used by 52% of the participants, followed by Pigai at 22%. The popularity of these tools probably stems from their intuitive interfaces, accessibility, cost, and scope of feedback, which make them easy for students to use; as one student noted, they used "whichever is convenient."

Typically, the students used multiple tools within a single process of writing revision: a sophisticated and multi-layered approach to feedback use. One of their main strategies involved two steps: first, reviewing drafts with comments made by AWE or GAI tools for comprehensive feedback, and second, reviewing their writing using corpus tools or dictionaries to ensure that the initial feedback was accurate and contextually appropriate (see Table 1).

This cross-checking method reflects careful and critical engagement with tool-generated feedback. For instance, one student's reflective journal illustrates this deliberate strategy: "After checking my essay with Grammarly, I turned to SentenceStack, which was just as useful. When I looked up phrases or sentences, it gave me many excellent examples, showing me how to use them properly in my writing." Such comments show how the students strategically combined resources to refine their writing, which made the AI-powered feedback more reliable. In other words, they applied cognitive evaluation skills as part of a process of becoming "autonomous learners" [23, 59]. This strategic engagement also aligns with Biggs's 3P model, as the students' familiarity with AI tools enhanced their confidence as autonomous learners and facilitated their critical cross-checking of feedback. The students also demonstrated HAINC by using AI feedback to make their writing more precise and critically assessing the tools' outputs based on their stylistic and contextual goals.

4.2. Students' cognitive responses to AI-powered feedback

Based on the qualitative thematic analysis, the Chinese students involved in this study exhibited critical cognitive responses to AI-powered feedback. They consistently perceived these tools as assistive instruments and assessed their value in three dimensions: content quality, delivery method, and overall effectiveness (see Table 2).

According to this multidimensional evaluation, the students analyzed the AI tools carefully, gaining a nuanced understanding of the strengths and limitations of each tool in supporting their English writing.

4.2.1. Students' perceptions of AI-powered feedback on content quality

1) *Linguistic improvement: Grammar correction and refinement of expression*

Eighty-four percent of the participating students acknowledged the effectiveness of technological tools in improving their English writing by addressing common linguistic issues related to grammar, spelling, punctuation, redundancy, and Chinglish expressions. Their

Table 1
Classification and use of technological feedback tools in different revision stages

Feedback stage	Tool category	Examples
Initial feedback	AWE	Grammarly, Pigai, Instatext, DeepL Write, Haimingwei Editor
Initial feedback	GAI	ChatGPT, DeepWrite, Doubao
Secondary verification	Corpora	SentenceStack, Linggle

Table 2
Students' perceptions of AI-powered feedback

Dimension	Advantages	Limitations
Content quality	– Correction of spelling, grammar, and punctuation errors – Clarification of commonly confused words	– Unclear feedback explanations – Insufficient interactivity in feedback
Delivery method	– Instant feedback – Multilingual support – Cross-platform compatibility	– Minimal emotional engagement – Limited capacity for deep communication
Overall effectiveness	– Improved user experience through clear interfaces – Reduced challenges in personalized feedback	– Risk of dependency, limiting the development of creative writing – Existence of technical and financial barriers

reflective journals revealed that all of the participants had used these tools to tackle these language challenges. For example, one student noted, "Grammarly is very useful; it corrects my grammar mistakes, fixes spelling errors, and even removes redundant phrasing." Table 3 presents a student's acceptance and revision of their draft based on Grammarly's feedback, improving the readability and precision of the text.

Table 3
Student's acceptance of AI-powered feedback

Component	Content
Student draft	Juli had been trying many means to get close to Bryce, while Bryce tried his best to keep away from Juli.
Student revision	Juli had been trying many means to get close to Bryce, while Bryce tried his best to avoid Juli.
AI-powered feedback	Clarity. Change the wording. . . . his best to avoid Juli. Using a long phrase when a shorter one (or even a single word) will suffice can contribute to wordiness or vagueness. Though a sentence may be grammatically correct, writing more concisely is often a better choice. Consider your reader and context to make a determination. (Exact feedback from Grammarly)
Student reflection	When I used the wordy phrase "keep away from" instead of "avoid," Grammarly corrected it, explaining why "avoid" is clearer.

Table 3 shows the pre- and post-revision changes, which were consistent with the students' reported linguistic improvements. For example, one student felt that the tool worked well in interpreting linguistic and cultural nuances, saying: "The AI tool can distinguish whether the expression is Chinglish." Another student described a translation strategy as follows: "When drafting sentences, I often organize my thoughts in Chinese first and then translate them into English. Grammarly effectively refines my Chinglish by removing unnecessary colloquial elements. This is very helpful." Although debate is ongoing about the extent to which AI-powered feedback can improve language proficiency [23, 60], according to the participating students, these tools improve writing quality in terms of accuracy and appropriateness [3, 22].

However, the students were also unsure whether AI-powered feedback was sufficiently clear, accurate, and interactive. One student said: "The explanations for some corrections are unclear, and I still need my teacher's guidance to fully understand them." The students also felt that support for content-related cognitive processing was limited: "AI tools lack understanding of the writing context, so they cannot provide targeted advice on content." Feedback on stylistic flexibility was limited in a similar way, according to one student: "Grammarly occasionally lacks the flexibility to adapt to different writing styles." Based on these responses, it seems that AI-powered feedback tools struggle to offer tailored support beyond correcting surface-level errors [35].

The students also adopted a cautious and critical attitude toward the tools' linguistic improvements, demonstrating an awareness of their limitations. First, regarding feedback accuracy, the students often noted semantic misunderstandings, with one commenting: "Some over-corrections suggest that Pigai analyzes my essay paragraph by paragraph, failing to grasp my intended meaning holistically." Second, in terms of usage strategies, the students emphasized the need to critically engage with AI feedback. As one student explained: "Even with clear instructions, I cannot directly use the revised text without scrutiny. I must use the tool selectively as I cannot fully trust its suggestions." Another added: "We cannot blindly accept its recommendations. We need to review them ourselves because some corrections might change the intended meaning of our sentences." Table 4 illustrates a student's critical engagement with Pigai's feedback.

Table 4
Student's rejection of AI-powered feedback

Component	Content
Student draft	The book *Flipped*, written by Wendelin Van Draanen (from the United States), tells us the first love story between Juli and Bryce, aiming to explore the teenager's pure love and growth during adolescence.
Student revision	The book *Flipped*, written by Wendelin Van Draanen (from the United States), tells us the first love story between Juli and Bryce, aiming to explore the teenager's pure love and growth in the course of adolescence.
AI-powered feedback	[Preposition error] When "aim" is used as a verb to mean "targeting," it does not take a "to" phrase to indicate the object, but typically takes an "at" phrase. Suggested correction: change to "aim at." (Exact feedback from Pigai, translated from Chinese to English)
Student reflection	The phrase "aim to" functions as a verb phrase expressing purpose. Pigai interprets "aim" as "targeting," suggesting the preposition "at."

As shown in Table 4, Pigai flagged "aim to" as a potential preposition error, suggesting "aim at" instead. However, the student retained "aim to," which they considered more appropriate for expressing purpose. This exposed the tool's contextual limitations, in line with the finding of previous research that students often question the reliability of GAI feedback due to errors or biases [41]. It is vital to critically evaluate AI feedback to ensure that it fits the intended meaning and context. Such critical engagement reflects HAINC: students refine AI suggestions to match their intended meaning, which in turn improves their collaborative skills. Finally, the students regarded the AI tools as supplementary aids rather than primary solutions. They considered it important to maintain autonomy over and authorship of their work [3]. In the words of one student, "It's crucial to use your own judgment. Understanding grading criteria allows you to use tools like ChatGPT effectively, avoiding an unrecognizable revised essay." Although some researchers warn that overreliance on AI tools can handicap critical thinking [11], the Chinese students in this study exhibited critical thinking skills in their AI use: they actively evaluated AI feedback and incorporated it selectively into their writing process.

2) *Learning resource support: Supplementary materials and learning suggestions*

AI-powered feedback tools provide various types of support for students' writing development through a broad range of learning resources. First, AWE systems such as Pigai and Grammarly go beyond basic error correction; they provide detailed explanations and supplementary materials to help students understand how language is used. For instance, as one student noted, "Pigai is very intelligent. It reinforces my grammar knowledge by explaining commonly confused terms and suggesting expressions to expand my vocabulary." Research shows that combining correction with enrichment strengthens students' linguistic skills and makes them more confident in writing [4, 10]. Pigai specifically supports Chinese university students by providing materials they can use in national competitions and an extensive question bank. As one student commented, "Pigai's competition materials are highly relevant to our needs." Another highlighted the practical benefits of the question bank: "It is useful for translation practice and fosters a stronger sense of language." These features help to meet specific learning needs and identify areas for improvement, while also providing practical strategies that encourage independent learning [39, 61].

Second, tools with English-language interfaces, such as Grammarly, create immersive learning environments that support language acquisition. As one student explained, "At first, Grammarly's English interface was challenging, but it became intuitive after I adjusted, creating an immersive environment that enhanced my reading and writing fluency." Clearly, the authentic language contexts provided by such tools can help students improve both their writing and their reading skills.

4.2.2. Students' perceptions of the method of AI-powered feedback delivery

1) *Instant feedback: Improving efficiency and developing autonomous learning*

By providing instant feedback, AI tools can make students' writing more efficient and help them learn autonomously, because such feedback accelerates both revision and language learning, unlike traditional delayed feedback from teachers or peers. In the words of one student, "ChatGPT quickly polishes and rewrites my text, reducing the wait for teacher feedback." That is, by quickly identifying and correcting language errors, AI helps students resolve issues promptly.

Instant feedback can also lead to self-directed learning. "Online AI tools offer extensive support," said one student, "enabling me to manage revisions on my own." This autonomy is reinforced by the multi-platform accessibility of tools like Grammarly. A student observed, "Grammarly works not only on desktop but also on mobile. Once installed, it provides a keyboard that automatically corrects my English typos, making it very convenient." Such flexibility allows students to obtain feedback at any time and anywhere, which increases their control over their learning.

In short, AI-powered feedback can make learning more efficient by reducing delays and helping students learn independently. According to Wen and Liang, AI tools can act as "language exchange partners" that offer continuous, on-demand support for language development [16]. Their student-centered design also reduces the burden faced by teachers, whose workloads often make it difficult for them to provide timely and individualized feedback.

2) *Interaction limitations: Expectations of in-depth communication and teacher feedback*

Although the participating students appreciated the efficiency of AI-powered feedback, 89% felt that teacher feedback offers a unique depth and flexibility. They expected teachers' comments to focus on language, grammar, cohesion, organization, logic, topic focus, and cultural appropriateness. "Face-to-face discussions with my teacher provide tailored corrections and insights," said one student, "helping me pinpoint weaknesses in my English writing and plan for improvements." It is difficult for AI tools to replicate direct engagement of this kind, whose nuance and personalization help students tackle and overcome specific challenges. Their preference for teacher feedback is aligned with Chinese students' general view of teachers: in the Chinese context, teachers are regarded as authoritative knowledge providers who offer expert and reliable guidance [62]. Although the heavily exam-focused curricula and large classes that characterize the Chinese EFL context make AI an appealing approach to addressing linguistic errors, students in this context also rely on teacher feedback for nuanced guidance on cohesion, logic, and cultural appropriateness, reflecting cultural values surrounding authority.

The students also viewed writing as an emotional and communicative act, an area where AI tools fall short. As one student noted, "AI tools could not capture emotions or convey personalized expressions accurately." AI is unable to interpret subtle human feelings or intentions, which represents a glaring gap in its functionality. As Teng explains, AI thus lacks the nuanced skills of human writers [5], such as understanding complex emotions and generating original ideas—both of which are essential to high-quality writing. Ren et al. suggest that combining teacher guidance with AI technology can make feedback more comprehensive and precise [63], mitigating AI's shortcomings in emotionally resonant contexts demanding nuanced interpretation.

4.2.3. Students' perceptions of AI-powered feedback effects

1) *Positive effects: Increased writing confidence and efficiency*

AI-powered feedback makes students more confident in their writing and streamlines their learning through accessible and intuitive tools. Tools such as Grammarly are user-friendly, offering clear error annotation and an easy-to-use design. As one student commented, "Grammarly uses different colors to highlight various types of errors, making it easy to identify mistakes and improve." Another added, "The Grammarly website is straightforward and functional, with an English interface that poses minimal difficulty." These design features enable EFL students to easily access AI tools and integrate them seamlessly into their writing routines.

The functionality of AI tools is equally important, supporting writing development by detecting errors in real time and making constructive suggestions. Grammarly, for instance, corrects grammatical errors and recommends ways to build vocabulary and restructure sentences. One student said, "Grammarly's precise, rapid grammar checks and suggestions for vocabulary and structure enhance my daily writing, even though it occasionally misses stylistic nuances." Receiving immediate feedback improves students' technical accuracy and text management skills, as well as builds their confidence [17].

2) *Negative effects: Risk of dependency and limited creativity*

Although the benefits of AI-powered feedback are obvious, the students also recognized its limitations. For example, overreliance

on AI tools can prevent students from engaging in self-directed learning and critical thinking. As one student observed, "Grammarly's one-click corrections are convenient, but I often accept changes without understanding why." Similarly, by providing direct answers, tools such as ChatGPT discourage independent problem-solving. This can foster dependency and in turn weaken cognitive engagement [8, 10, 63]. Critical AI literacy skills must be developed to support autonomy [64].

AI is also limited in creativity, struggling to replicate human ingenuity and contextual nuances. This caused problems for the students. For example, they felt that AI tools lack the depth needed to inspire originality: "Creativity is inherently human. AI remixes ideas but cannot generate truly novel ones." Another described the tools as inflexible: "Grammarly sometimes flags correct choices as errors because it misses the context." A lack of emotional expression was another problem, with one student noting, "AI cannot convey emotions or personal expressions, lacking human nuances." This criticism demonstrates AI's limitations in supporting students' creative thinking, especially when writing requires nuance [65].

The problem of dependency is exacerbated by the limited feedback provided by AI, which often fails to support critical thinking. For example, the students observed that tools like Grammarly address basic grammar but provide only minimal explanations. "It doesn't explain why correction is needed when I'm confused," noted one student, "so I rely on teachers for clarity." For another, "a teacher's single sentence offers more insight than an AI-generated essay." These findings support earlier research suggesting that teachers are better at addressing higher-order skills such as argumentation and clarity. Although AI tools may complement teacher feedback, they cannot completely replace it [22, 59]. As Biggs's 3P model shows, the efficiency of AI depends on critical engagement, and HAINC is needed to avoid dependency and ensure autonomous learning.

Ethical and practical challenges arise alongside these limitations. Overreliance on AI-generated content can compromise academic integrity; as one student warned, "Content generating tools risk plagiarism by producing material that is too similar to online sources and will have a high plagiarism rate." The participating students showed ethical discernment in even-handedly balancing utility with integrity, echoing concerns raised by scholars about the ethics of using AI [42].

There are major technical and financial barriers to students' effective use of AI-powered feedback. According to one student, for example, Pigai has an "outdated interface and unclear features," while another found "Grammarly's all-English interface initially challenging." Technical barriers loom particularly large for corpus-driven feedback tools like SentenceStack and Linggle, which the students found "effective but difficult to navigate." As researchers point out, students need more intuitive corpus tools and guided practices to overcome these technical and interpretive challenges [48, 51]. With such support, students will be able to use corpora to improve their writing in an autonomous, data-driven manner.

Even more troublingly, paywalls limit access to advanced features. As one student explained: "Pigai limits the number of words per version unless you pay for a full submission." Another said, "Grammarly's free version handles the basics, but sentence suggestions often require a paid subscription." These financial barriers may worsen educational inequalities, as only students with sufficient financial resources can use the tools' premium features. These concerns echo broader issues of equitable access to GAI tools [7]. Tackling these challenges will require concerted efforts to ensure equitable access to AI tools and foster critical and creative thinking skills [66].

5. Conclusion

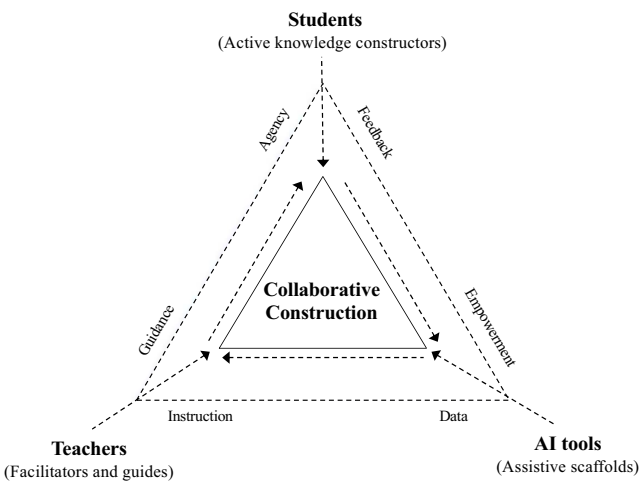
In the context of globalization and digitalization, this study investigates Chinese EFL students' perceptions and experiences of AI-generated feedback. The findings suggest that AI-powered feedback and teacher feedback interact in nuanced ways to support students' writing development. AI tools can enhance students' writing efficiency by providing real-time corrections and vocabulary enrichment, which encourages students to learn autonomously and with confidence. However, AI feedback struggles to handle higher-order skills such as content development, stylistic flexibility, emotional nuance, and creativity, as it often lacks clear explanations or contextual adaptability. Unlike AI, teacher feedback is emotionally engaged and therefore excels at providing personalized and in-depth guidance in areas such as cohesion, logic, cultural appropriateness, and critical thinking. Therefore, AI and teacher feedback can complement each other; indeed, students' overall writing development is likely to be best supported by a hybrid approach that combines AI's technical efficiency with teachers' nuanced guidance.

5.1. Implications of the study

Building on the insights gained from the university students, this study proposes the Student-Teacher-AI Collaboration Model (S-T-AI Model) for feedback writing. This framework offers a new way of thinking about the writing process, in which students take the lead, teachers facilitate their learning, and AI tools offer support. Together, they create a more dynamic and interactive system that integrates human insight with technological precision (see Figure 1).

The S-T-AI Model is designed to address the three main limitations of AI feedback identified in this study. In terms of content quality, AI tools can enhance linguistic accuracy but often fall short when students need higher-order skills. To tackle this problem, the Model assigns technical refinement tasks to these tools while leaving nuanced and contextual guidance to teachers. In terms of delivery method, AI's instant feedback may again enhance efficiency, but it cannot provide personalized interaction. Therefore, the Model pairs AI's quick feedback with the personal touch provided by teachers. In terms of overall effectiveness, while AI can build students' confidence, it may also make them dependent. To avoid this problem, the Model emphasizes training in AI literacy to encourage learners to think critically and learn autonomously.

Figure 1
The S-T-AI collaboration model



The Model enables students to actively construct knowledge by engaging critically with AI feedback. The results of this study reveal instances of overreliance on AI tools, which can limit their independent learning and critical thinking. In response, the Model integrates AI literacy training that equips students to evaluate the accuracy of AI feedback and compare it with their intended meaning. This training supports a shift from learners passively accepting AI input to using it as a collaborative tool and, ultimately, to taking the lead in managing how AI supports their learning [67]. This progression strengthens human–AI collaboration and cultivates skills that are essential for digital literacy and independent learning.

Teachers also take on broader roles that go beyond traditional instruction. They act as learning data analysts, using AI-generated data to keep track of students' writing development and learning trajectories, as well as their strengths and weaknesses. This allows them to tailor the right interventions for their students. They also serve as guides for higher-order thinking, encouraging students to critically assess problems with AI outputs, such as contextual errors and superficial emotions, to reinforce academic integrity and critical thinking skills [3, 40]. As a result, teachers can increase the benefits of AI while mitigating its shortcomings, creating a balanced learning environment.

AI tools serve as "assistive scaffolds" [3, 44, 68]. As intelligent feedback providers, they provide rapid, ongoing feedback that can help students improve their linguistic accuracy and develop their writing skills. As learning context constructors, these tools also enrich the learning environment by providing diverse and context-specific resources, stimulating learners' creativity despite being unable to generate original content.

The S-T-AI Model is designed to address both ethical and practical challenges to ensure that AI is used in a responsible way. The participating students were concerned about the risk of plagiarism in AI-generated content, which they felt could undermine originality and academic integrity. To address this concern, the Model combines AI literacy training, teacher-guided ethical discussions, and plagiarism detection tools. Together, these features enable students to use AI as support while still maintaining authorship of their work and upholding academic standards. However, putting the Model into practice may face challenges such as limited resources (e.g., access to premium AI tools) and the need to train teachers in integrating AI. Despite this, the S-T-AI Model creates synergy between students, teachers, and AI tools that can improve feedback writing in foreign language education.

5.2. Limitations and future research

Although it provides valuable insights, this study has certain limitations. First, it focused on English majors, leading to context-specific findings that may not fully apply to other student populations. Different groups may vary in their responses to AI tools based on their needs, preferences, and educational contexts. Second, because it used a cross-sectional design, the study could not track longitudinal changes in learners' perceptions, behaviors, or writing proficiency. This limited its insights into how the impact of AI tools and teacher feedback changes over time.

Future researchers should take steps to address these limitations and make the findings more generalizable and applicable. First, they could conduct longitudinal studies to explore how students' interactions with AI and teacher feedback impact their EFL writing performance over time. By integrating quantitative measures, such as analyzing error rates in student writing, they could generate numerical data on writing improvement to complement qualitative insights. Researchers could also triangulate data using methods such as interviews, writing performance assessments, or think-aloud protocols when using AI tools. This would help them capture real-time reactions and validate students' reflective accounts, thereby gaining richer and more reliable insights into students' cognitive and affective engagement with AI feedback. Second, researchers could gain a broader perspective by including a wider range of students from different institutions and with different educational and proficiency levels. Third, they could use the HAINC framework to better integrate AI tools with teacher guidance by creating design activities that engage students with AI feedback. They should also evaluate the effectiveness of the HAINC framework and the S-T-AI Model in different educational contexts. This would all provide a better understanding of how AI can improve writing instruction in the context of foreign language education.

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Conflicts of Interest

The author declares that she has no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Qianshan Chen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition.

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