Investigating the tripartite interaction among teachers, students, and generative AI in EFL education: A mixed-methods study

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ABSTRACT

This study explores the holistic integration of artificial intelligence (AI) in English as a Foreign Language (EFL) education, addressing significant gaps in empirical research on AI and EFL. Drawing on existing literature on the ecological views of AI in education, the study conceptualizes holistic integration as a balanced interaction among teachers, students, and AI technologies, enhancing rather than replacing traditional human interactions in pedagogy through mediating teacher-student interactions. The research utilized a mixed-method approach to investigate AI's impact on EFL students' proficiency and perceptions in teacher-led classrooms. 66 Participants from an eastern Chinese city were sampled and divided into an experimental group using AI tools and a control group following traditional education methods. Quantitative results from descriptive and inferential tests revealed that the students who learnt with AI-mediated teacher-student interactions achieved significantly better proficiency than those who did not. Moreover, qualitative findings highlighted that students believe in the effects of holistically integrating AI in EFL education for it (1) facilitated the collaboration among teachers, students and AI, (2) enhanced students' learning motivation, and (3) better fitted their learning preferences. The study concludes that the holistic approach of AI integration in EFL education can optimize EFL learning by leveraging AI's technological benefits and maintaining essential human interaction, indicating a collaborative, instead of a replacing, view of the AI-induced educational reformation. This research underscores the need for strategic AI integration that respects teachers' pedagogical roles, promotes student engagement and enhances students' learning experiences with cultural consideration.

1. Introduction

Integrating artificial intelligence (AI) into English as an foreign language (EFL) education is increasingly becoming a focal point in educational research and practice. With its abilities, such as natural language processing and deep learning, AI technologies are being leveraged to create more dynamic and interactive learning environments for EFL students. Technology perspective studies have highlighted AI's transformative potential in EFL education, emphasizing its advantages in personalizing learning experiences and satisfying individual learner needs (Fathi et al., 2024). From educational psychology perspective, studies have suggested that AI technologies contribute to EFL students' favoritism towards the English language (Chen, 2024), leading to better learning engagement and outcomes with the presence of AI technology (Guan et al., 2024; Huang et al., 2023).

The demonstrated benefits of AI in forming new learning dynamics and interactions suggest that adapting and integrating AI technologies into EFL education could significantly improve teaching practices. However, the adaptation of new technology into long-lasting systems is never easy. Past studies have discovered that educators have pessimistic views towards AI's presence in EFL education (Shen & Guo, 2024). On the one hand, they fear they lack the technological pedagogical knowledge to master AI's integration into EFL classrooms (Ong & Annamalai, 2024). On the other hand, educators are concerned that they might lose their jobs to AI (Hopcan et al., 2024). After all, information technologies such as social media and AI have been found to possess unique traits such as information exchange in virtual environments that improves learning performance, which can not be provided by traditional teacher-led classroom-based education (Hosen et al., 2021). To address these concerns, with discovered evidences from motivational

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and perceptional studies that suggesting the significance of human presence in computer-assisted language education (Rahimi et al., 2025), academia has begun to argue for a holistic integration of AI in education in which AI is seen as a partner of teachers and students in classrooms, rather than replacing human teachers, thus promoting human interactions in education. It is just as the studies of Koul and Nayar (2021) and Chan (2023) have suggested, AI in education is an ecology co-created by all involving stakeholders, in which AI technologies are utilized, integrated, and collaborated with humans for educational purposes. Thus, we contemplate the significance of a holistic integration for it could be of an ecological solution that actualizes collaboration between humans and technology as well as among human stakeholders.

However, there is a significant lack of empirical evidence to substantiate the holistic integration. In other words, little research has studied the effectiveness of AI-mediated teacher-student interaction from the holistic integration perspective nor students' firsthand cognitive acceptance of such integration. Such investigation is of significance. First, a significant number of the benefits of AI technology in EFL education were identified under out-of-class learning scenarios instead of the in-class educational contexts (Lin & Mubarok, 2021; Liu et al., 2024), which questions the benefits of in-class integration of AI technology. Although there have been some empirical studies addressing this research gap of in-class AI integration, the experimental designs were without the on-site presence of instructors (Hsiao & Chang, 2023; Wei, 2023), rendering the identified benefits of AI technologies to be subjective to students' autonomous learning behaviours, instead of the combination of teacher-led instructions and AI's pedagogical assistance.

Moreover, current studies identifying AI's benefits in EFL education have mainly been binary. Studies have testified whether or not AI technologies can improve students' English proficiency (Fathi et al., 2024), second language learning motivation (Wei, 2023), or the enjoyment of using the language (Zhang et al., 2024) without considering the impact of English teachers in these examinations. In practice, teachers' knowledge reservation, pedagogical style, and feedback behaviour all influence EFL students' performances and affections towards learning. Therefore, it is also essential to investigate the influence of teachers in AI-integrated EFL education from a holistic and ecological view.

Last but not least, to our best knowledge, there is little exploration into how teachers should practically work with AI to optimize students' EFL acquisition. Since AI is here to stay, an investigation into how the teacher-AI collaboration in EFL education should be carried out to optimize the benefits students get in EFL education, which yields practical significance.

To address the above-mentioned research gaps, we propose the following research questions:

(1) What are the effects of AI-mediated teacher-student interaction in improving EFL students' English proficiency?
(2) From student perspectives, what contributed to such effects?
(3) From student perspectives, what are teachers' roles in the holistic integration of AI in EFL education?

2. Literature review

2.1. Conceptualizing the holistic integration of AI in EFL education

The holistic integration of AI in education is still a novel terminology without unifying definitions among researchers. From the study of Koul and Nayar (2021), it is an ecological system responsible for the needs and demands of faculty, institute and policymakers for the AI-driven reform of classes. From the study of Chan (2023), holistic integration creates an AI-specific ecological system of education that balances the needs of all educational stakeholders with pedagogical, ethical, and operational considerations. More specifically, the ecological system is co-developed by teachers, management and IT staff to assist teachers and students in education, rather than replace the human interactions in

education (Chan, 2023). Therefore, based on these conceptualizations, we summarize that the holistic integration of AI in EFL education to be a balanced interaction among teachers, students and AI that does not replace but improves and transcends the traditional human-based teaching pedagogy to enhance students' learning experience that optimizes students' learning outcomes.

This conceptualization emphasizes the magnitude of both technology and human interaction. On the one hand, it recognizes the potential benefits and disadvantages of AI technology in education, particularly emphasizing on blended learning and personalized learning (Chen et al., 2020). These areas were highlighted due to their prominence in current educational research and their demonstrated potential to enhance teaching and learning outcomes (Chen et al., 2020). With AI's technological features, students can conveniently acquire detailed responses to a wide range of questions that may go beyond a teacher's knowledge reservation (Minn, 2022). Yet it may create reliance on AI tools for students' development of critical thinking skills (Suriano et al., 2025). With the emphasis on essential teacher-student interaction under the holistic integration approach, teachers could reduce the technological reliance and help students to obtain and well-rounded the answers they seek comprehensively, thus promoting learning engagement (Xia et al., 2022). On the other hand, by emphasizing the significance of human interaction, the holistic integration retains certain levels of teachers' control in education, allowing the teacher's managerial and instructional roles to optimize students' learning engagement and outcomes. To exemplify, studies have identified that these functions of teachers can help students to focus and engage in designated learning materials (Bennett et al., 2015) and students can be motivated in EFL education due to teachers' attention and teacher-aided development of self-confidence (Min & Chon, 2021).

This conceptualization also emphasizes the importance of teacher-AI collaboration. Through teacher-AI collaboration, teachers could relieve some of the existing heavy workload (Creagh et al., 2023) through AI's adequacy in providing instantaneous personalized feedback to student assignments and assessments (Maier & Klotz, 2022), as well as handling daily administrative tasks (Ghamrawi et al., 2024). More importantly, the teacher-AI collaboration could allow teachers and AI to devote their own strengths to student's EFL education. Under the holistic integration, knowledge-driven tasks in EFL education could be carried out by AI with teachers' support and supervision that optimizes student's use of AI technology for language learning purposes (Wang et al., 2023). Through the student-AI collaboration, students could obtain knowledge from various information sources (Lee & Song, 2024), get feedback and revision suggestions from AI's proof-reading (Fassbender, 2025), and receive personalized instructions for specific learning needs (Maier & Klotz, 2022), all of which benefits students' education.

Beyond the student-AI collaboration, the holistic integration of AI in education also emphasizes the mediating effect of AI technology in the interaction between students and teachers. Through student-AI collaboration, students could receive extensive amount of information immediately (Yuan & Liu, 2025), get personalized feedback for their specific learning needs (Maier & Klotz, 2022), and ease verbal and writing communications across different languages (Wang et al., 2024). Specifically in EFL classes, AI could help boost students' willingness to communicate, thus improving engagement in learning activities (Jeon, 2024). Nonetheless, what most studies of AI's integration in education have not considered is the mediating effects that AI could bring to teacher-student interaction because of these benefits. As suggested by many educational psychological theories (e.g., the Pygmalion effect, the self-determination theory), students showing improvement may receive more attention and support from their teachers, resulting in better expectations and encouragement from teachers to these students that further enhances their performances (Li & Rubie-Davies, 2017).

Therefore, based on the previous conceptualization, we endorse a holistic integration of AI in EFL education that focuses not only on the benefits of technology nor the human-computer interaction, but on the

mediating effects of AI in teacher-student interaction.

2.2. Teacher's presence in EFL education

According to Rodgers and Raider-Roth (2006), the above-mentioned benefits are actualized by the teacher's presence in EFL education. Coined as "a state of alert awareness, receptivity, and connectedness to the mental, emotional, and physical workings of both the individual and the group in the context of their learning environments, and the ability to respond with a considered and compassionate best next step" (Rodgers & Raider-Roth, 2006), teacher's presence in EFL education has been considered to be one of the most influential factors towards students' learning experience and learning outcomes (Lim & Richardson, 2021). Manifested through cognitive, social and teaching presence (Nami et al., 2018), teachers' presence develops a sense of community between teachers and students (Kurek & Müller-Hartmann, 2019), enhancing students' performance and engagement both in-class and out-of-class, on-line and off-line situations (Satar & Akcan, 2018).

Although equipped with large language model processing, these benefits may be difficult for AI to achieve alone. First, teachers can help students with understandings of subtle cues. A significant part of communications is not delivered through the language but through non-language cues, such as facial expressions and tones. Although some studies have designed specific codes to help intelligent systems to recognize these subtle cues, the results have been limited to the basic categories such as anger and happy with low recognition precision (Fernández et al., 2023), let alone being timely and emotionally responsive to students' learning needs and demands.

Second, teachers possess a holistic understanding of students' academic progress. Through actively engaging in students' EFL learning, EFL teachers could instantaneously tailor their instructions to students' specific learning needs (Boelens et al., 2018), instead of needing to inform the AI system beforehand. This active and holistic understanding of the academic progress not only ensures EFL students' learning engagement and learning outcomes (Boelens et al., 2018), but helps teachers get career development and promotions (Liu & Chang, 2024).

Third, teachers have the potential to form emotional connections. Through emotional connections, teachers can build strong, empathetic relationships with students, fostering a supportive learning environment and increasing the intensity of students' EFL practice in both formal and informal learning contexts (Zhang & Liu, 2024). Nevertheless, AI lacks the ability to form genuine emotional connections with students, which necessitates the teachers' presence in EFL education.

Last but not least, the need for human connections with significant others like teachers and peers maybe especially significant within exam-oriented cultures such as China, Singapore or South Korea. As students in these cultures facing intense academic pressures, many studies (e.g., Li et al., 2024; Zhang & Liu, 2025) have suggested their needs for emotional supports. Specific to EFL studies, Li et al. (2024) have found that, when students are placed in a little-supervised, and little-peer-supported learning environment, more pressure would be exerted. Conversely, when Chinese students perceive more teacher support, "they are more likely to dedicate more energy towards their education and be motivated to continue learning, leading to increased engagement" (Yan et al., 2024, p. 2).

Therefore, we argue for the significance of a holistic integration of AI in EFL education which focuses on not only the technological superiority of AI systems but the significance of teachers' presence and involvement in students' EFL learning, leading to the design of this empirical study.

2.3. The existentialism view of education

Although teachers' presence may have irreplaceable values for students in EFL education, the new materiality of AI's presence may inevitably redefine teachers' functions and roles (Meihami, 2023). According to studies (Ou et al., 2024; Yuan & Liu, 2025), students have grown accustomed to consult AI for knowledge and information, which bestows an identity of "my teacher" (Ou et al., 2024, p. 6) to AI technologies, challenging the traditional understanding of the teacher identity.

From the existentialism view within the theoretical underpinning of philosophy of education, teachers' functions are no longer to (at least not solely to) impart knowledge, but to provoke student's motivation and willingness to learn (Yang et al., 2025). By enhancing students' willingness to learn, educators can nurture students to be immersed in a more profound, more meaningful learning experience that fosters personal growth, lifelong learning and career readiness in the technologically immersive world (Ayanwale et al., 2022). Therefore, we argue that a holistic integration of AI in EFL education which addresses both technological and existential significance could greatly enrich the benefits for students in EFL education than any mechanical usage of AI for learning. After all, through a genuine collaboration between human educational stakeholders and AI technologies, it is possible to propel students' willingness to engage in learning and maximize their knowledge acquisition through both behavioural modifications and information comprehensiveness. Hence, we adopt the existentialism view of education as one of the analytical frameworks of this study.

3. Method

3.1. Sampling and participants

Ethical approval was obtained from the affiliation of the authors' university and the participants prior to participant recruitment. The recruitment process involved disseminating messages through personal connections with high school English teachers, collecting WeChat[1] contacts of prospective participants and signing the consent form. Initially, 73 individuals expressed interest in participation. Out of these, 66 participants signed the consent form and completed the study, resulting in a participation rate of approximately 90 %. Most participants (n = 63) were studying in the first or second year of high school with three being in the third year, and the average age of participants was 16.33.

The sample size of this study (66 participants) was determined to be sufficient to achieve the research objectives and provide meaningful insights into the research questions for several reasons. First, the participant pool was drawn from various high schools in China with a diverse range of admission grades in English. This diversity reflects different levels of pre-existing knowledge, minimizing the effect of pre-existing knowledge over experiment results, thus enhancing the external variability and generalizability of the findings (Meyer et al., 2019). Second, the sample size was, as suggested by Cohen (2016), adequate to achieving representativeness for a medium effect size of 0.5. Specifically, for the statistical analyses performed in this study (i.e., paired and independent sample t-tests), this sample size can provide an adequate statistical power of 0.80 at the significance level of 0.05 (Lakens, 2017), which aligns with established guidelines for sample size adequacy in language education research (Nicklin & Vitta, 2021).

The 66 participants were then randomly assigned to the experimental group (EG) and the control group (CG), with 33 in each group (16 males and 17 females in each). The officially released examination papers of the First Certificate in English (FCE) by the University of Cambridge were selected for pre-tests and post-tests, because of their high adaptability to students with different English proficiency levels (Cambridge University Press & Assessment) and because of their suitability to Chinese high-school EFL students (National Education Examinations Authority, 2018). The pre-test showed no significant disparity in English proficiency between EG and CG before the experiment. Table 1 shows the homogeneity of the two groups in English proficiency in each measurement.

Table 1

The pre-test results in each group and the *t*-test results.

	Experimental Group		Control Group		T-test		
	M	SD	M	SD	F	t	p
Reading	19.212	8.361	19.364	5.862	4.728	−0.086	0.932
Listening	10.606	4.623	11.121	2.945	5.205	−0.540	0.591
Writing	22.152	5.961	21.970	5.352	0.302	0.130	0.897
Speaking	22.546	8.537	22.424	5.368	8.786	0.069	0.945
Overall	74.515	21.384	71.121	20.789	0.824	0.654	0.516

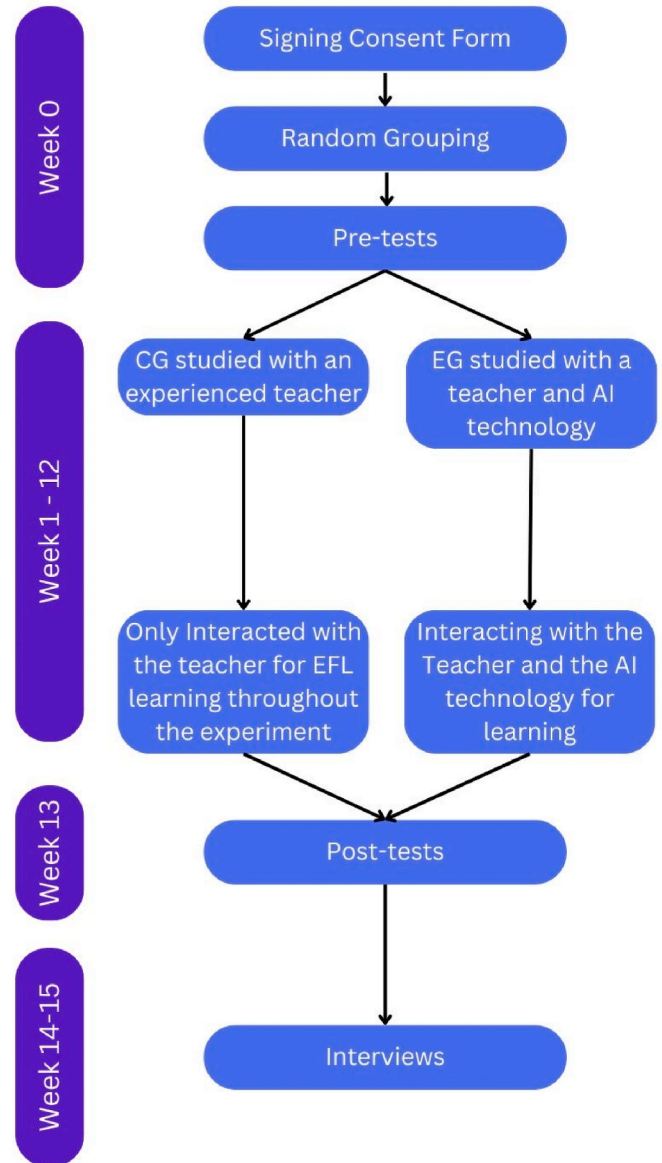### 3.2. The experimental design

To answer the effectiveness research question, an experiment was designed and carried out to collect quantitative data. Starting from week 1 and ending on week 12, the 66 participants went through a 12-week experiment, with an 8-h consecutive session each week taking place on the only day off they had in a week. In weeks 0 and 13, English proficiency tests based on Cambridge's official release of FCE examination papers and guidelines were administered to the participants. To ensure consistency in grading, the same AI technology, Iflytech[2] (讯飞星火), was used to grade the writing and speaking tests through textual and voice recognition functions with remarks to the FCE grading criteria. Moreover, in weeks 14 and 15, interviews were conducted to gather students' perceptions regarding the AI's assistance during the experiment. Fig. 1 illustrates the research procedure.

Participants were taught the same FCE textbooks in both groups by the same experienced teacher to eliminate threats to construct and internal validity. The CG participants learnt traditionally without the opportunity to use AI technology during the courses. However, the teacher encouraged the EG participants to use IflyTech to help them gather information, suggest ideas, learn grammar and vocabulary, structure sentences, and proofread writings in classes for almost every task. When using IflyTech in such tasks, students were free to opt verbal or textual modality for inputs and outputs. And most students chose the textual modality for written tasks and audio modality for speaking tasks for convenience. In this way, their English-medium interactions with the teacher (in both written and oral) were prepared by AI's large language processing ability so that their meanings were clearly conveyed.

For CG students, although they might also have autonomously used AI technology after classes, due to the 6 a.m. to 9 p.m. daily school routine of these students and the banning of digital devices on school premises (The General Office of the Ministry of TheGeneral Office of the Ministry of Education, 2021), those in the CG had minimal opportunity to engage in AI-assisted learning, thus eliminating the bias of uncontrollable usage of AI technologies in test results. Furthermore, to ensure that every student in the EG has the experience of using AI for English learning, students were asked to reflect on their learning experience with AI technology for some of the learning tasks and submit AI usage proofs to the teacher, containing the assignments and how AI has helped students for the assignment. Fig. 2 demonstrates one submission of AI usage proof.

3.3. The individual interviews

To address the perceptional research questions regarding AI's contribution and AI's integration into EFL education, interviews followed the post-tests to collect qualitative data for student perceptions and experiences, due to the interview's suitability in exploring human cognition in nuanced contexts (Miller et al., 2014). The interviews are for knowing students' perceptions and experiences of AI used during the experiment, so only the EG group was invited to participate. Among the 33 EG participants, 13 volunteered, with 8 males and 5 females and an average age of 16.76. The interviews lasted for about 45 min each, and the protocol questions are listed in Appendix. For easy comparisons between the qualitative and quantitative data, the coding for

Fig. 1. The experimental procedure.

interviewees consisted of their participation coding in the experiment, which may appear non-sequential. To maximize responses, the interviews were conducted in the interviewees' first language and then later translated into English. Table 2 indicates the demographic information and coding of the interviewees. The interviews were conducted in Chinese, recorded, transcribed and translated into English by Author-1 and the accuracy of transcriptions was checked by the other authors before analysis.
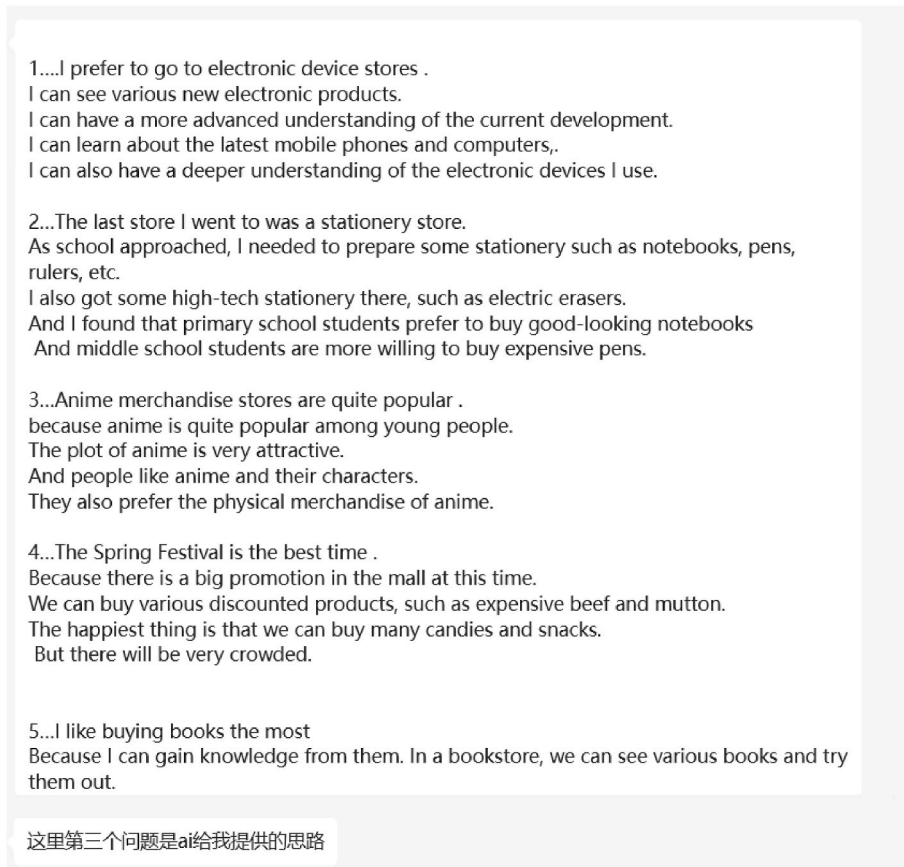
1....I prefer to go to electronic device stores .
I can see various new electronic products.
I can have a more advanced understanding of the current development.
I can learn about the latest mobile phones and computers,.
I can also have a deeper understanding of the electronic devices I use.

2...The last store I went to was a stationery store.
As school approached, I needed to prepare some stationery such as notebooks, pens, rulers, etc.
I also got some high-tech stationery there, such as electric erasers.
And I found that primary school students prefer to buy good-looking notebooks
And middle school students are more willing to buy expensive pens.

3...Anime merchandise stores are quite popular .
because anime is quite popular among young people.
The plot of anime is very attractive.
And people like anime and their characters.
They also prefer the physical merchandise of anime.

4...The Spring Festival is the best time .
Because there is a big promotion in the mall at this time.
We can buy various discounted products, such as expensive beef and mutton.
The happiest thing is that we can buy many candies and snacks.
But there will be very crowded.

5...I like buying books the most
Because I can gain knowledge from them. In a bookstore, we can see various books and try them out.

这里第三个问题是ai给我提供的思路

Fig. 2. An example of AI usage proof from students (Translation: AI provided ideas for me for the third question).

Table 2
The coding and demographics of interviewees.

Interviewee Codes	Gender	Age	Year of High School
E1	M	17	2nd
E2	F	17	2nd
E8	M	15	1st
E9	M	18	3rd
E10	M	17	2nd
E11	F	16	2nd
E12	F	17	2nd
E14	M	17	2nd
E15	F	16	1st
E19	M	17	2nd
E20	M	17	2nd
E23	F	17	2nd
E24	M	17	2nd

3.4. Data analysis

The quantitative data was analyzed with SPSS 28 using the pre-and post-test results, by calculating descriptive (e.g., means, standard deviations) and inferential statistics (e.g., t-tests) to examine differences in reading, listening, writing, speaking, and overall English proficiency between the experimental and control groups. Because the test results from validated examinations were interval data that follows a normal distribution and because study aimed to detect mean differences between and within groups (Plonsky & Oswald, 2014), paired sample t-tests and independent sample t-tests were deemed appropriate for quantitative analysis.

The qualitative data (e.g., interview transcripts) were coded with NVivo 12 to identify reoccurring patterns for thematic analysis, during which the five-step thematic analysis procedure established by Braun and Clarke (2006) guided this qualitative analysis, following data familiarization, manual coding, thematic identification, theme reviews, and theme naming, in this precise sequence to guarantee the coherence, consistency, and presentation of the identified themes (Nowell et al., 2017).

4. Findings

4.1. The quantitative findings

4.1.1. Both groups demonstrated significant improvements in English proficiency

The data from the pre-test to the post-test within the group comparison indicated significant improvements in students' English proficiency tests, regardless of AI usage. Tables 3 and 4 indicate the *M, SD* and paired-sample *t*-test results for within group comparisons. AI technology helped EG students in all modalities of outputs such as real-time conversations to gather information (listening and speaking practices) and academic proofreading (reading and writing practices), which CG students who learnt in the traditional way were exposed with no such opportunities. The effect size and statistical power suggest that, over the 12 weeks of learning FCE, both AI-integrated and traditional methods can very significantly boost students' FCE test scores.

4.1.2. The experimental group demonstrated significantly better improvements than the control group

Using between group comparisons, it was identified that participants in the EG demonstrated more improvements in English proficiency than those of CG. According to Table 5, the *M, SD*, and individual sample *t*-test results support that EG statistically outperformed CG in reading, writing and overall proficiency with various effective sizes and

Table 3
The within-group comparison for EG's test results.

	Pre-test		Post-test		T-test			
	M	SD	M	SD	t	p	Cohen's d	Statistical Power
Reading	19.212	8.321	32.333	10.086	−10.910	0.000	6.909	1.000
Listening	10.606	4.623	13.424	5.339	−4.342	0.000	3.729	1.000
Writing	22.152	5.961	28.515	5.072	−8.906	0.000	4.105	1.000
Speaking	22.546	8.537	27.182	10.206	−7.815	0.000	3.408	1.000
Overall	71.516	24.384	101.455	23.888	−17.267	0.000	8.962	1.000

Table 4
The within-group comparison for CG's test results.

	Pre-test		Post-test		T-test			
	M	SD	M	SD	t	p	Cohen's d	Statistical Power
Reading	19.364	5.862	23.273	6.970	−6.764	0.000	3.320	1.000
Listening	11.121	2.945	13.061	3.112	−4.598	0.000	2.423	1.000
Writing	21.970	5.352	24.985	5.476	−5.384	0.000	3.217	1.000
Speaking	22.424	5.368	26.030	6.008	−6.432	0.000	3.220	1.000
Overall	71.121	20.788	89.712	14.668	−8.271	0.000	12.912	1.000

Table 5
The between-group comparison for post-test results.

	EG		CG		T-test				
	M	SD	M	SD	F	t	p	Cohen's d	Statistical Power
Reading	32.333	10.086	23.273	6.970	5.582	4.245	0.000	1.045	1.000
Listening	13.424	5.339	13.061	3.112	5.107	0.338	0.736	0.083	0.102
Writing	28.515	5.072	24.985	5.476	0.014	2.717	0.008	0.669	1.000
Speaking	27.182	10.206	26.030	6.008	10.775	0.559	0.579	0.138	0.200
Overall	101.455	23.888	89.712	14.668	4.863	2.406	0.019	0.592	1.000

statistical powers, suggesting that the holistic integration can significantly better improve reading and writing results with medium to strong effect sizes that leading to significant overall English grade improvements.

4.2. The qualitative findings

4.2.1. The holistic integration of AI in EFL education contributes to their proficiency improvements

First, the qualitative data shows that interview participants held positive views towards the holistically integrating AI to teach and learn English. Specifically, participants found the student-AI collaboration to be convenient (13/13), enjoyable (12/13), and novel (13/13). For examples:

E1: Sometimes I have trouble saying what I want to say to answer questions in English. And I can use GAI to help me translate it. I just need to read them out loud, which is very convenient for me.

E9: I find using GAI tools for class activities enjoyable. For example, when the teacher was looking up popular tourist destinations in Denmark for a speaking task, AI provided textual descriptions and but pictures to illustrate these destinations, vividly presenting the information.

E12: It is pretty novel to use AI tools in English classes. Normally we are not allowed to bring digital devices to school premises. So this exposure to AI is very new to me. I mean I did use some AI tools, such as Duolingo, before. But I didn't know that AI can help us search for information so quickly or provide feedback to our writing assignments so academically. A teacher only has so much free time to help us, and normally a teacher could not provide writing feedback with such intensity. But by [teachers] assigning this job to AI, I realized that AI can do a good job [sounding surprised]!

When asked what benefits these positive views of holistic AI integration can bring to their EFL learning, participants mentioned that they feel they are better engaged in English learning activities (13/13). For instances:

E1: Normally, when I don't know how to express myself in English, I'd be quiet and be a little afraid that the teacher may call upon me. But with AI's help, I felt less nervous to prepare an answer to the teacher's questions.

E8: I think even if the novelty has gone after being allowed to use AI in classes, I'd still be more engaged in English learning because the experience could bring me closer to English.

E23: I'd feel less nervous when doing my English homework. I may not enjoy it, but I certainly would be less willing to do it without AI, because I know I can receive better grades in my homework with the help of AI.

E23 provides an exemplary answer to the mediating effect of AI in teacher-student interaction. E23 is not a student talented in the English language. She often receives sup-optimal grades from tests and homework, which has resulted in certain levels of amotivation to learn the English language. Contrary to her negative experience and amotivation, during the experiment, although lasting for 8 h a session, she persisted on engaging in almost every task because the teacher was kind to her for her improvements in English. The same was identified in the responses of other participants (13/13). For examples:

E10: Because the teacher would praise us when we did some challenging tasks right, I felt AI usage to be a pleasure.

E15: AI can give us rewrite suggestions before we hand in the assignments. So I've grown accustomed using AI for feedback before turning in my writing. In this way, the teacher would give me better grades, to which I find satisfactory.

4.2.2. Students believe that AI partially contributes to their learning

Subsequently, the interviewees were asked about the contribution of AI technology to their grade improvements. All of them (13/13) suggested a 20 to 30 percentage of grade improvements being subjective to the holistic integration of AI. For examples:

E11: I think AI may helped about 30 percent of it. Using AI for proof-reading at least helped me to learn new vocabulary. I'd write them down on my notebook and recite them later. I think that is why I felt easier when reading the passages in the post-test.

E12: [AI helped] not so much, about 10 percent or so. FCE is easy for me, so for most of the tasks, I do not have to use AI for linguistics. So I just used it to help me create ideas to write or talk about. But because AI would provide extensive text, it helped me in my reading. … Oh, I want to add that AI also helped me to rewrite in academic ways, so so that I can mimic the structure and phrasing of the rewrite. So, maybe 20 to 25 percent of my grade improvement was contributed by AI.

E24: About 30 percent. Although AI can help us develop writing and speaking scripts better than just by ourselves, I sometimes find the extensive amount of texts difficult to read. … But teachers could give us better feedback when we use AI to help with communication, so they developed my confidence in using English for communication, which benefited my speaking.

Based on the previous responses, it is identifiable that participants not only benefit from the student-AI collaboration in learning and task completion, but also from the teacher's encouragement through feedback or grades in enhancing their willingness to learn. Therefore, the mediating effect of AI between teacher-student interaction positively influences students' will to learn, making the holistic integration of AI in EFL education significant.

4.2.3. Students prefer teachers' presence in their EFL education

Although students identified AI technology as useful in improving proficiency through both student-AI collaboration and the mediating effect between teacher-student interaction, most interviewees (12/13) still preferred learning from teachers, instead of AI technologies. For instances:

E2: I still want to learn from teachers. Teachers know better about what students need to learn and help us gain better marks.

E19: Teachers would be better. Without telling the AI, it doesn't know what you want. But your teachers can know that because they understand your progress in English learning and can give suitable answers according to the demands of different contexts, which is more convenient for students.

E24: Teachers, definitely, because AI couldn't chew the knowledge up and feed it to you. It provides too much knowledge, more than what you need for exams.

Even the only interviewee who chose AI over teachers to learn suggested the significance of teachers' presence as well.

E8: I think it would be more fun to learn English from AI so that I could improve my willingness to learn. Also, there is a sense of novelty that makes me want to learn English autonomously. But sometimes I may lack the awareness to actively and autonomously begin my learning. And I think teachers should nurture this awareness.

4.2.4. Students believe that teachers have centering roles in the holistic integration of AI in EFL education

At the end of the interviews, interview participants were invited to identify teachers' significance in the holistic integration of AI in EFL education. All interviewees (13/13) suggested that teachers should assume the centering role in the holistic integration. Specifically, they believed that teachers should: (1) develop students' willingness to learn (13/13), (2) be more proactive in the student-AI collaboration (11/13), and (3) only use AI when they couldn't do as well as AI in education (12/13). For examples:

E2: I think that teachers should help students to want to learn English.

E19: Us students have much pressure in doing well at exams. We know the pressure is important. But we desperately need to rest. Therefore, without teachers' encouragement, I don't think I'll study this hard.

E20: AI indeed has many benefits for our English learning. But it is easy for students to be reliant with the technology. So I think teachers should supervise and regulate our AI usage.

E24: We are not allowed to bring smartphones to school, so I think maybe teachers can bring AI to the class so that we can use it when needed.

E14: I think, now, teachers can do a better job in teaching English than AI. But AI does have its strengths. So I think teachers should judge the teaching between themselves and AI, and only use AI when AI can do better.

E24: Teachers should not use AI to teach, I think. Like I said, AI could not chew the knowledge up before feeding it to you. As high school students, we do not have time to learn the knowledge we do not need in exams. So unless the teacher has no time to address our learning needs, they should teach English themselves instead of using AI.

These interviewees' suggestions reflect a heavy influence of the exam-oriented school culture in AI's holistic integration into EFL education. Combined with the state policy of banning digital devices on school premises (The General Office of the Ministry of TheGeneral Office of the Ministry of Education, 2021), students are likely to depend more on teachers than on AI technologies for language acquisition. This unique cultural context is further discussed in the discussion section.

5. Discussion

5.1. Theoretical and practical discussions

The findings of this study suggest that EFL students who studied in the holistic AI-integration group (the EG group) gained better English proficiency in the post-tests compared to those studied in the AI-free group (the CG group), and students attribute about 20–30 percent of their grade improvements to the appearance of AI. Specifically, they argue that AI can help ease the difficulty of task completion, provide additional learning opportunities, and encourage better teacher evaluations. More importantly, the data suggests that these benefits are obtained through not only the technological capabilities of AI, such as detailed feedback and rewrite, but the emotional values that AI helps students to develop, such as the language confidence and elicitation of positive teacher-student interactions.

Moreover, these results bring empirical evidence and a scholarly understanding of the significance of a holistic integration of AI in EFL education. First, these findings, similar to those in the past literature, recognize the benefits of student-AI collaboration in (1) helping students with corrective feedback and rewrites to mimic (Maier & Klotz, 2022), (2) fostering positive perceptions of learning and using language (Wei, 2023; Zhang et al., 2024), both of which ultimately lead to improvements in language proficiency (Fathi et al., 2024). Second, the findings also recognize the benefits of student-AI collaboration in obtaining more detailed feedback for learning purposes (Maier & Klotz, 2022). More importantly, the findings reflect the significance of AI's positive mediating effect in teacher-student interaction that not only fosters healthy relationships but encourages active learning engagements in student

learning behaviours. It is just as how educational psychologists have suggested that "much of the human behaviour is not intrinsically motivated" (Ryan, 1995, p. 405) and that extrinsic motivation such as teacher's appraisal and encouragement "build initial interest and accomplished performance until natural consequences take over" (Cameron & Pierce, 2002, p. 61). Therefore, not only are the collaboration opportunities among teachers, students and AI important, but the study also suggests for the utilization of AI's mediating effects in teacher-student interaction, necessitating the need for a holistic integration, instead of a mechanic one.

Furthermore, this study suggests that the holistic integration of AI in EFL education not only demands the presences and support of teachers, but provides opportunities for teachers to give more support. From the students' perspective, the ones in this study have collaborated with AI to (1) enhance the quality of their assignments, (2) structure responses to communicate with the teachers, and (3) obtain additional learning opportunities, all of which lead to positive appraisals from their teachers. From the teachers' perspective, they can collaborate with AI to reduce the time needed for administrative tasks (Ghamraw et al., 2024), thus saving time to focus on supporting students' learning. Furthermore, considering the emphasis on AI's mediating role in teacher-student interactions, students' usage of AI technology to enhance the quality of their work, although it maybe deemed unethical by some, creates a phenomenon of "fake it until you make it" (Nielsen, 2015, p. 265) that may help students to self-develop steady aspiration in their academic journey, which propels deeper student engagement in active EFL learning (Bessadok, 2022).

5.2. Policy and cultural discussions

In addition to such benefits of facilitating teacher-student, teacher-AI and student-AI interaction, this study reveals that the holistic integration of AI in EFL education also brings about cultural considerations, which can be manifested as the importance of teacher presence. Different from studies in Europe which discover that students prefer to acquire knowledge from AI technologies (Ou et al., 2024), student participants in this study have claimed that they prefer to learn from human teachers, although they find AI useful for their EFL learning. Compared to that in European schools, the Chinese school culture is heavily examination-oriented, meaning students' active engagement in education may originate from their willingness of getting good grades from assessments and examinations. Studies (Li et al., 2024) have also demonstrated that teacher support develops students' anticipation of such good grades, leading to active learning engagements that ultimately lead to improvements in grades, indicating the significance of teachers' presence in fostering EFL learning motivation among Chinese students. Specific to AI's integration in EFL education within the Chinese school culture, studies have also identified the importance of teachers' emotional support in the intensity of students' English learning with AI technology (Chiu et al., 2023), which corresponds with the findings of this study. Thus, it is suggested that when adopting the holistic integration of AI in EFL education, differences in school cultures must be considered to determine the intensity of AI and teachers' participation to maximize student engagements in EFL learning. For other exam-oriented cultures such as South Korea and Singapore, teachers presences and AI to be integrated for mediating human-human interactions may be the next pragmatic step.

6. Conclusion and suggestions for further research

In summary, this empirical study examines AI's contribution to Chinese EFL students' English proficiency improvements with a 12-week experiment and sequential interviews under the holistic integration of AI in EFL education. Within the underpinnings of the holistic integration of AI in EFL education and teachers' presence, we discover that students' English proficiency can be significantly better improved with the holistic

integration, in which the student-AI collaboration, the teacher-AI collaboration, and the mediating effects of AI in teacher-student interaction all contribute to the improvements. These findings highlight (1) the significance of the holistic integration of AI in EFL education, (2) the need for cultural consideration in conducting the holistic integration, and (3) how the teachers' support can benefit and be benefited by the holistic integration, suggesting a few practical considerations for the holistic integration of AI in EFL education.

However, this study is not without limitations. One of these is the textual-based modality of AI collaboration. The quantitative data suggests significantly better proficiency test results for the EG in the reading and writing tests, instead of the listening and speaking tests, compared with the CG. This may be a result of the modality of AI used in classes. Exemplified by the included E11, E12, E15 and E24 transcripts, their student-AI collaboration has mostly benefited their reading and writing, because the modality of AI's generative content was mostly textual. This happened because students were studying in a compact room and the reading out loud would disturb others so that the teacher suggested using the textual modality. Therefore, we would like to encourage future studies to adopt more modalities of AI outputs to study for the effects on listening and speaking proficiency, when the authenticity permits.

Future studies are encouraged to further address the research question of how AI should be holistically integrated in EFL education by examining both teachers' and students' perceived affordances and constraints of specific AI tools in EFL education. Further studies are welcomed especially to conduct theoretical and practical investigations of the holistic integration into different sociocultural contexts of EFL education and to study the more specific niches.

Last but not least, the relatively small sample size in this study may limit the generalizability of the findings to broader populations. Although the diverse backgrounds of participants, drawn from various high schools with different admission grades, mitigate this limitation to some extent by providing a heterogeneous sample for external validity, future research with larger and more representative samples is encouraged to further validate and extend these findings.

CRediT authorship contribution statement

Lihang Guan: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **John Chi-Kin Lee:** Writing – review & editing. **Yue Zhang:** Writing – review & editing, Writing – original draft, Supervision. **Mingyue Michelle Gu:** Supervision.

Notes

1. WeChat or Weixin (Chinese: 微信; pinyin: Wēixìn; 'micro-message') is a Chinese instant messaging, social media, and mobile payment app developed by Tencent. First released in 2011, it became the world's largest standalone mobile app in 2018 with over 1 billion monthly active users.
2. iFlytek (Chinese: 科大讯飞; pinyin: Kēdà Xùnfēi), styled as iFLYTEK, is a partially state-owned Chinese information technology company. It creates voice and textual recognition software and voice-based internet/mobile products covering education, communication, music, intelligent toys industries. (Wikipedia)

Statements on open data and ethics

The study was approved by an ethical committee with ID: 2023-2024-0283. Informed consent was obtained from all participants, and their privacy rights were strictly observed. The data can be obtained by sending request e-mails to the first or corresponding author.

Declaration of competing interest

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.caeai.2025.100384.

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