Advancing Educational Equality: Using AI Technology in K-12 English Language Education in Rural China

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Abstract
The development of artificial intelligence (AI) technologies provides the opportunity for students from disadvantaged areas to have equal access to educational resources. This paper applies the theory of educational equality to examine AI technology as an alternative to the current ICT practices for the improvement of English language education in rural China. A systematic review was conducted to analyze the research on AI in English language education published between 2017 and 2022. The overall findings show that the use of AI technology can effectively promote English proficiency. Lastly, the paper also establishes pedagogical implications and suggestions for future study.

Keywords: Artificial Intelligence (AI), Educational Equality, English Education, K-12 Education, Rural Chin

Introduction

The advent of digital technologies such as Artificial Intelligence (AI) and Information and Communication Technology (ICT) has provided the opportunity for students in disadvantaged areas to receive equal education (Vincent-Lancrin & van der Vlies, 2020). ICT, known for its far-reaching possibilities, has been widely adopted to promote equality in English language education throughout many countries over the past three decades. Although ICT integrates several types of technology and media to facilitate language teaching and learning, the primary applications of ICT in rural English education are DVDs and recorded videos (McQuaide, 2009; Zhao & Jiang, 2019). These do in fact promote educational equality to some extent but also sacrifice the most valuable aspect of language education – the teacher-student interaction (Li et al., 2018).

K-12 English language education in rural China likewise faces similar dilemmas. English is taught as a foreign language (EFL) and it plays an important role in the Chinese education system (McKay, 2002). However, the quality of English instruction and acquisition is relatively low in rural Chinese schools. After visiting 18 primary schools in rural western China, Su (2010) revealed that inadequate equipment for teaching English and insufficient qualified English teachers were the main reasons for poor English proficiency among rural students. Two years later, the Chinese government established policies to increase investment in educational technology to promote educational equality, with special attention given to the west and central regions (Bai et al, 2016). Benefiting from the 10-Year Development Plan of Educational Informatization (MOE, China 2012), and the 13th Five-Year Plan of Educational Informatization in China (MOE, China 2016), 99.7% of rural schools are now connected to the Internet, and 95.7% of primary and secondary schools have built multimedia classrooms (MOE, China 2020). However, despite this technological support, Li (2019) claimed that rural students' English proficiency, especially speaking, had not been greatly improved due to the lack of interaction in the recorded lessons. The studies by Su (2010) and Li (2019) indicated that although ICT does compensate somewhat for the low quality of K-12 English education in the less prosperous regions, it has not provided very much benefit to rural students. For instance, Fan and Cheng (2015) revealed that even the outstanding rural students still performed below the urban average in the college entrance examination (as cited in Guo et al., 2018).

Although existing studies have shown that ICT has improved the quality of English education in rural areas in China (Li et al., 2018) and narrowed the gap between urban and rural K-12 education to a certain degree (Zhao & Jiang, 2019), the lack of interactivity of ICT is not conducive to the improvement of rural students' English proficiency in the long term (Liu, et al., 2019). When looking to the future, it seems that AI, as a more advanced form of technology (Holmes et al., 2019), therefore offers an alternative solution to ICT.

Artificial intelligence (AI) is the product of the big data era. Although it is a new technology, research investigating the effectiveness of using AI technology in language education has been conducted in many countries. For example, Sternberg et al. (2017) acknowledge the high value of using AI tools in English education. Researchers from developed countries such as Denmark and the United Kingdom have also demonstrated the effectiveness of AI applications in language learning (Hibert, 2019; Simonsen, 2021). Moreover, UNESCO called for the use of AI to ensure equitable access to quality education (2019), and more countries overall have begun using AI technology to promote sustainable development in education. One leading example is China. In 2017, the Chinese government issued the Next

Generation Artificial Intelligence Development Plan to prompt the development of AI-assisted technology in education (MOE, 2018). As a result of the new AI policy and the rapid development of 5G technology, Chinese AI educational companies, together with schools in developed regions, have used AI technology to improve the quality of English education.

Previous research has focused on applying AI technology in schools in developed regions (Wu, et al., 2021). It appears that research examining AI practices has been conducted elsewhere, but not rural China. Therefore, it is important to examine how existing AI technology can inform practice in K-12 English education in rural China. As such, this paper aims to explore the possibilities for using AI technology as an alternative to ICT for English language instruction in rural regions of China by answering the following research questions:

1. What AI technology is being used in English language education?
2. How effective is the use of AI technology in English language education?
3. How can AI technology be used to advance educational equality in K-12 English language education in rural China?

To address these questions, a systematic literature review was conducted to synthesize the latest studies of AI in English language education in non-English speaking countries. The conclusion based on the analysis highlights implications for AI practices in rural K-12 English language education and sheds light on ways to advance educational equality in rural China.

Literature Review

This section is organized as indicated in Figure 1 to situate AI in the broader context and the premises associated with the perspective of educational equality.

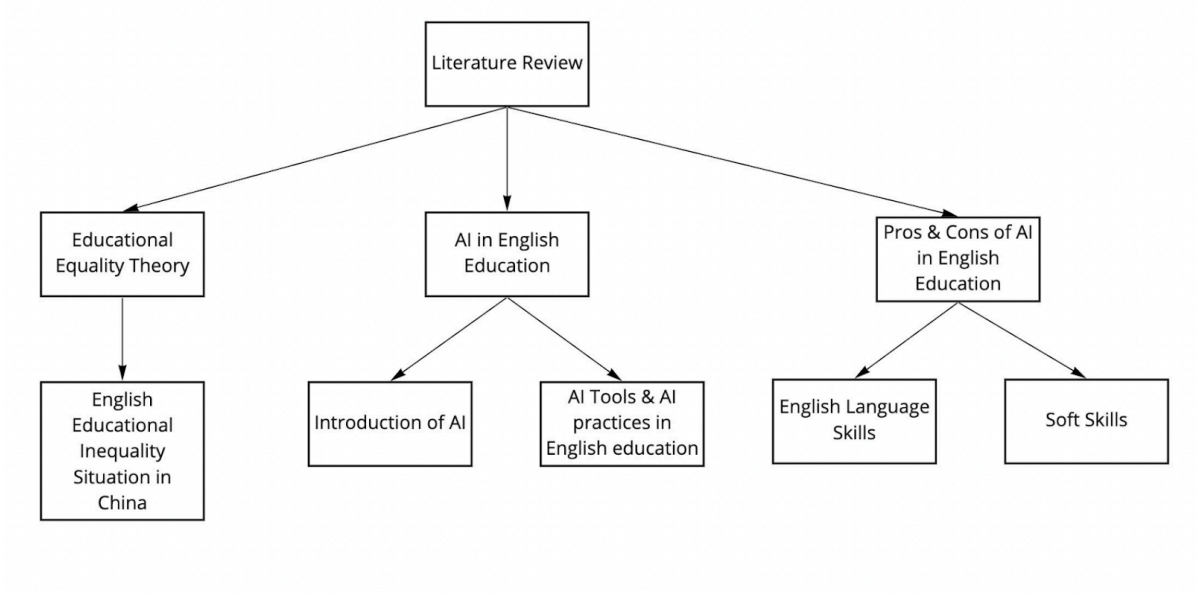

Figure 1: The Mind Map of Literature Review

Educational Equality Theory

Farrel (1999, as cited in Espinoza, 2007) summarized four aspects of educational equality: (a) equality of access; (b) equality of survival; (c) equality of output; (d) equality of outcome.

According to Espinoza (2007), the equality of access to education could be defined as access to equal educational opportunity, which aims to achieve equal education results with the premise of equal resource allocation.

English Educational Equality Context in China

The past two decades have witnessed great efforts being made by the Chinese government to promote educational equality. Prior to 2007, the Chinese government established educational equity as a national strategy, with special attention given to the development of rural education (MOE, 2007). To further promote educational equality and narrow the gap between urban and rural education, the Chinese government introduced the "Internet + Education" policy in 2020 (NDRC, 2020). With the support of these policies, there has been some gradual reduction in the urban-rural educational disparity. Although equality in rural education has improved with the help of Internet technologies, there is still a significant gap between rural and urban education in modern subjects such as English (McQuaide, 2009). The reason for this imbalance is not only because of the lack of qualified English teachers in rural schools (Bao, 2006), but also because the current ICT technology cannot provide rural students with high-quality English education due to technical limitations, with the result being that rural students' English linguistic competence is far inferior to that of urban students (Li et al., 2018).

Introduction of AI

In 1956, John McCarthy introduced the concept of artificial intelligence (AI). Since then, machine-assisted learning has gained in popularity among scholars, educational practitioners, and members of the public involved in different areas of activity. Now AI has penetrated almost every aspect of existence and AI technology applications have become an important part of our daily lives (Nayak & Dutta, 2017). Natural language processing, facial recognition, and autocorrect are a few examples of applications of artificial intelligence. In addition, researchers and educational practitioners are applying AI technology to improve the education process. This AI-assisted educational practice is referred to as artificial intelligence in education.

AI Tools and Practices in English Education

Language education benefits from AI developments in many ways. Pokrivcakova (2019) summarized seven types of AI technology in foreign language education: (a) the customization of learning materials; (b) machine translation; (c) AI writing assistants; (d) conversational chatbots; (e) AI-powered language learning software; (f) intelligent tutoring systems (ITS); and (g) virtual reality (VR). Different AI technologies are applied to suit the needs of the learners based on the four different skills (listening, speaking, reading, writing) in learning English.

AI in English Listening

In terms of listening skills, the most used AI tools are chatbots and AI-powered language learning platforms. For instance, Zhou (2020) designed an AI-based self-learning platform for EFL college students to improve their listening proficiency. In the study made by Hu and Hu (2020), an AI robot called King of Listening Study was applied to promote Chinese EFL learners' listening skills. The AI robot contained several functions, such as providing

intelligent guidance, designing learning paths, detecting weaknesses, and controlling learning progress. Jeon (2022) also created an AI chatbot for enhancing Korean students' English listening abilities.

AI in English Speaking

Regarding speaking skills, AI technologies such as conversational chatbots, AI-powered language learning applications, intelligent tutoring systems, and virtual reality are frequently used. Many studies have examined AI chatbots in English language classrooms (Han, 2020; Kim et al., 2019; Lin & Mubarok, 2021; Tu, 2020; Yang et al., 2022). Equipped with automatic speech recognition technology (ASR), voice-based chatbots can not only correct students' pronunciation automatically but also provide personalized answers in response to students' messages (Kim et al., 2019; Pokrivcakova, 2019). In contrast to the conversational chatbots, virtual reality has been viewed as a more advanced AI technology that can create an immersive language environment for learners. For example, Guo et al. (2017) developed an English learning system by using virtual reality technology to provide more language exposure for students to improve oral English proficiency. Wang and Shi (2021) also combined virtual reality technology to build an AI virtual English oral pronunciation accuracy correction model for detecting EFL learners' pronunciation. In speaking, an intelligent tutoring system (ITS) functions as a virtual speaking partner and Lyra Virtual Assistance was one of the AI applications to combine the ITS technology used to enhance students' English speaking performance (Junaidi, 2020).

AI in English Reading

For reading, the most used technologies are AI-powered language learning software and customization. To support young English language learners' reading, researchers from Canada designed AI-aided tangible reading software called PhonoBlocks for Chinese EFL learners (Fan et al., 2018). In terms of customizing English reading materials, the Indian government implemented the RightToRead program in 2013 to improve English literacy among Indian students (Srinivasan & Murthy, 2021).

AI in English Writing

Regarding writing, the most used technologies are machine translation and AI writing assistants. Automatic translation tools such as Google Translate and Bing are gaining popularity among foreign language learners for their high-quality translation (Pokrivcakova, 2019). In addition to using translation machines to complete writing tasks, English learners also use AI writing assistants to assist them in their writing. AI writing assistants employ adaptive learning technology, which can provide automated writing evaluations (AWE) and correct grammatical errors during the writing process (Pokrivcakova, 2019). This AI-based writing tool has been used in different English writing classrooms. For example, Cotos (2011) adopted the AWE in an English academic writing program while Stevenson and Phakiti (2019) used it for the purposes of business writing in English.

AI in the Promotion of English Language Skills

A large and growing body of literature has investigated the effectiveness of using AI in English language education. While most studies indicate that using AI in English classrooms

has a positive impact on learners' English language skills, some studies also reported negative findings.

AI in the Promotion of English Listening Skills

Listening is regarded as an input skill in linguistic competence that requires greater exposure from the outside world (Nomass, 2013). Therefore, AI chatbots and language learning platforms equipped with multiple listening resources are useful in promoting learners' English listening proficiency. For instance, Mohammed Mahmoud Ghoneim and Elsayed Abdelsalam Elghotmy (2021) reported that there was noted improvement in English listening performance for the group of students using the AI-based learning platforms, which generated authentic listening materials and interactive activities for EFL pupils. Fryer and Carpenter (2006) examined the effectiveness of several listening chatbots such as ALICE bots and Jabberwacky, stating that AI chatbots could create a fun learning experience for English beginners with interesting listening materials. Moreover, they also pointed out that the current chatbots would benefit from further design improvement to cater to the needs of advanced English learners (Fryer & Carpenter, 2006).

AI in the Promotion of English Speaking Skills

Lee and Hwang (2022) conducted a meta-analysis on the effects of using AI chatbots in Korean EFL education, showing that both text-based and voice-based chatbots could contribute to the improvement of EFL learners' speaking performance. Similar findings were also reported in the research of Ruan et al. (2021), who demonstrated that students' vocabulary acquisition and communication fluency were slightly improved after using the AI-powered EnglishBot. However, studies also revealed the technological limitations of AI chatbots. For instance, Fryer and Carpenter (2006) claimed that chatbots were not effective for English beginners since most chatbots only identify simple keywords regardless of grammatical errors. Virtual reality (VR) is another sophisticated AI technology applied in spoken English education. Bendeck et al. (2020) stated the advantages of integrating VR in English classrooms, indicating that students' communication skills were significantly improved in the VR-created immersive language context.

AI in the Promotion of English Reading Skills

Regarding reading skills, previous studies have focused on investigating the utilization of AI chatbots and language learning platforms. Bailey et al. (2021) examined students' reading comprehension performance as well as reading attitudes on using the AI storybots, revealing that the latter not only enhanced L2 learners' English reading proficiency but also served to motivate them to read further. Srinivasan and Murthy (2021) acknowledged the effectiveness of AI-powered language learning platforms, demonstrating that significant improvements were observed in Indian students' English reading comprehension after participating in the AI-aided RightToRead program.

AI in the Promotion of English Writing Skills

Regarding writing skills, prior studies have explored the effectiveness of AI-powered machine translation and AI writing assistants in English language education. Lee (2019) examined the effects of using machine translation tools in EFL writing classrooms. The study showed that the use of machine translation software positively improved students' writing

quality but over-reliance on machine translation tools could lead to negative results such as mistranslation and dependence on first language writing style (Lee, 2019). With a similar point of view, Lee (2021) affirmed the usefulness of machine translation tools in foreign language learning, claiming that translation tools can effectively reduce lexical and grammatical errors in second language writing. However, Lee (2019) also expressed concerns about English teachers' negative attitude towards students' frequent use of machine translation in language learning. To address the problem, Steding (2009) called for actions to prevent academic dishonesty regarding English writing. Another tool frequently used in the EFL classroom is an AI writing assistant, or automated writing evaluation. Numerous studies have reported positive effects from using automated writing evaluation in English writing such as improved accuracy in writing (Liao, 2016; Parra & Calero, 2019; Wang et al., 2013). However, not everyone has expressed a positive opinion of automated writing evaluation systems. Liu and Kunnan (2016) claimed that some automated writing evaluation systems like WriteToLearn were not advanced enough to provide personalized feedback to EFL learners. Similarly, Parra and Calero (2019) also reported insufficient interaction between automated writing evaluation tools and English learners.

AI in the Promotion of Soft Skills

In addition to increased English proficiency, the development of soft skills was also observed as a result of using AI technologies. UNESCO (2019) highlighted four main advantages of AI technology in education, with one of them being advancements in collaborative learning abilities. Numerous studies have shown that using AI in English classrooms can effectively alleviate learners' speaking anxiety, since students feel more comfortable when communicating with an AI robot than a human speaker (Åhs et al., 2020; Bashori et al., 2020; Han, 2020; Zheng et al., 2021). Studies have also shown that AI technologies can increase students' motivation and engagement in language learning. For example, Mohammed Mahmoud Ghoneim and Elsayed Abdelsalam Elghotmy (2021) found that listening lessons were more memorable as the AI-based listening program motivated and engaged students. Parra and Calero (2019) also highlighted findings of increased motivation when automated writing evaluation tools were used by EFL learners. Other studies found social implications for integrating AI in English education. Bailey et al. (2021) demonstrated that students could incorporate language learning in real-life contexts by interacting with the storybots. Furthermore, leaners have been observed to develop autonomy and self-regulation from AI language learning practices. The outcome was rather significant for the use of automated writing evaluation systems since EFL learners could review their writings without help from writing teachers (Pokrivcakova, 2019; Wang et al., 2013).

Methodology

This systematic review aims to examine AI-assisted English learning tools and practices. The review was based on a meta-analysis (PRISMA) process (Selçuk, 2019) and there were multiple rounds of selection to ensure the quality and relevance of the articles.

The relevant papers were manually selected from the Web of Science and Scopus databases, which are known for featuring high-quality, reputable social science publication (Mongeon & Paul-Hus, 2015). Due to the rapid advances in AI technology, only articles published between 2017 and 2022 were used for analysis.

In the initial round of screening, the keywords AI, artificial intelligence, ESL, EFL and their random combinations were entered into the Web of Science and Scopus databases, which yielded 123 and 372 articles, respectively.

The second round of selection focused on screening the abstract, introduction, and conclusion. To screen suitable articles from the research pool, the following criteria were applied in the second round of screening:

(a) studies conducted in non-English speaking countries or areas;
(b) ESL or EFL learners;
(c) topics related to AI-assisted English learning technology;
(d) conclusions related to the impact of AI technology on English language learning;
(e) studies that involved any of the English listening, speaking, reading, and writing skills.

Following the above five criteria, literature review articles concerning only micro English language skills such as vocabulary, pronunciation, grammar, and translation were excluded for further analysis. After the second round of selection, 56 articles were selected for the next screening process.

In the third round of selection, articles were reviewed. The criteria applied in the second round were used again in the final selection. After careful screening, a total of 26 papers were selected for final analysis as illustrated in Figure 2. The data was presented in table format, as exemplified by Figure 3, by speaking, writing, listening and speaking, and reading, indicating the types of the studies and the findings in Appendix A to F.

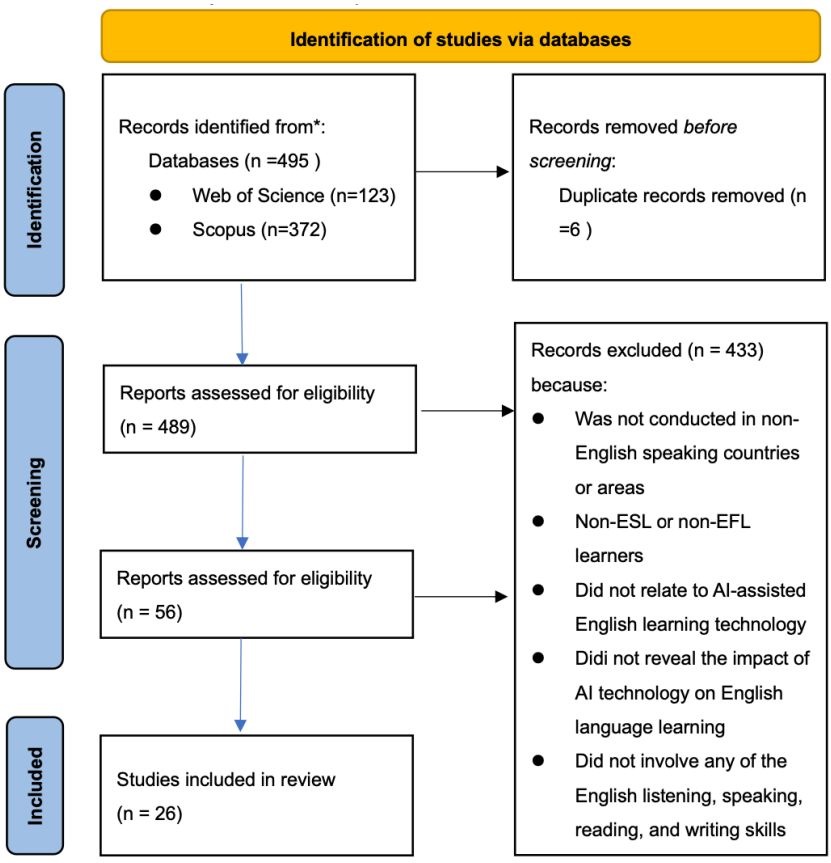

Figure 2: The PRISMA Process for Meta-Analysis Review

Appendix B

A summary of using AI technology for English listening and speaking skills

ID	Authors/Year	Place of studies	Research Question	Participants	Educational Level	Macro-skills	AI Type	Findings
1	Jeon (2022)	South Korea	To investigate how chatbots affect ESL students' motivation to learn a language.	36 Korean EFL learners	K-12	Listening & Speaking	Chatbots	Using the chatbot in EFL classrooms can promote students' listening and speaking skills and reduce their speaking anxiety.
2	Chen et al. (2018)	Taiwan	To introduce a novel methodology for adopting an AI robot in the drama-based digital learning theatre to help ESL students learn English.	ESL students from a junior high school in China	K-12	Listening & Speaking	AI robot	Data under collection.
3	Latypova et al. (2018)	Russia	To investigate the potential use of using the interactive mobile application ELEVATE to improve ESL learners' English performance without teacher's help.	27 first-year Russian undergraduates at the C1 level in English	Higher Education	Listening & Speaking & Reading	AI-powered language learning app	ESL students' English learning performance and critical thinking ability were considerably enhanced by using the MALL-based language learning technology.
4	Mageira et al. (2022)	Greece	To examine the efficacy of using AI chatbot technology to enhance EFL students' foreign languages and cultural content learning.	28 Greek EFL high school students	K-12	Listening & Speaking & Reading	Chatbots	The use of AI chatbot technology can efficiently support the learning of foreign languages and cultural content at the same time.

Figure 3: An Example of Summary for the Use of AI Technology by English Skills

Discussion of Findings

In this section, the findings are discussed in response to the overarching research question "*How can AI technology be used to advance educational equality in K-12 English education in rural China?*" by answering the following two operational questions:

1. What AI technology is being used in English education?
2. How effective is AI technology in English education?

AI Technology in English Education

Within the results obtained from the systematic review, it was possible to conclude that there were four types of AI technologies that have been commonly used in the English education in recent years: (a) conversational chatbots; (b) AI-powered language learning software; (c) automated writing evaluation (or AI writing assistants); and (d) machine translation. These are in keeping with Pokrivcakova's (2019) categorization of AI technology in language education. According to the data analysis, chatbots and AI-powered language learning software were frequently used in teaching English listening, speaking, and reading skills, while automated writing evaluation and machine translation were mostly applied in English writing, the results of which are likewise in accordance with the previous literature. However, AI technologies such as virtual reality (VR) and intelligent tutoring systems (ITS), which were considered as effective tools in improving spoken English, were not found in the results (Guo et al., 2017; Junaidi, 2020; Wang & Shi, 2021). This is probably because the AI technology required to build VR and ITS is too complex, and the investment is relatively high compared to other AI-aided tools. Therefore, since most of the non-English speaking countries are in economically underdeveloped areas such as Asia, Africa, and South America (in this study, primarily Asian countries were represented), it is difficult to build complex systems at this initial stage of integrating AI technologies in English education due to the lack of technology and funding.

The Effectiveness of AI Utilization in English Education

According to the research results, the overall findings showed that using AI in English education has a positive impact on improving students' language competency and their development of soft skills. For instance, studies on the use of AI chatbots and AI-powered language learning platforms in teaching spoken English match previous studies, which showed that AI-based conversational agents promote students' English speaking performance (Lee & Hwang, 2022; Ruan et al., 2021). Although most of the articles reviewed in this research are in accordance with previous several investigations that indicate that using AI chatbots can decrease students' speaking anxiety, one study challenged such results (Åhs et al., 2020; Bashori et al., 2020; Han, 2020; Zheng et al., 2021). This outcome may be explained by students' unfamiliarity with the AI tools or the poor design of the AI chatting systems. Another negative impact that demonstrated the ineffectiveness of using AI chatbots for advanced learning was also consistent with the ideas advanced by Fryer and Carpenter (2006).

Findings regarding the utilization of AI in English writing were mostly positive. One unanticipated result was that using the automatic feedback system would disrupt students' thinking process during the writing process, which was contrary to most of the previous findings determining that the use of automated writing evaluation was effective in promoting students' English writing skills (Cotos, 2011; Pokrivcakova, 2019; Stevenson & Phakiti, 2019). Regarding the AI translation tools, Pokrivcakova (2019) showed that AI-based translation tools can facilitate students' production of high-quality writing. Despite acknowledging the effectiveness of machine translation tools, this study also revealed that the mistranslations produced by translation tools would be detrimental to students' English writing, which was consistent with the study by Lee (2019). Nevertheless, no findings in this study reported any academic dishonesty or plagiarism behavior caused by the translation machine (Lee, 2021; Steding, 2009).

What was surprising was that only a few studies investigated the use of AI in English listening and reading. One possible explanation for this might be that because ESL and EFL learners perform less satisfactorily in English speaking and writing in comparison with listening and reading, greater emphasis was placed on improving their speaking and writing competency. Although less attention was paid to designing AI-aided listening and reading tools, the study also found that students' listening and reading comprehension was significantly improved through the use of AI-powered language learning application, which agreed with previous studies (Bailey et al., 2021; Srinivasan & Murthy, 2021).

What was curious about this finding was that the development of soft skills was also observed in the study. It can be seen from the analysis that the soft skills were unexpected outcomes benefiting from the use of AI tools. For instance, the most prominent soft skills fostered by AI were the increase of learning motivation and the development of learning autonomy, affirming the previous findings that AI technology is beneficial to personal development (Mohammed Mahmoud Ghoneim & Elsayed Abdelsalam Elghotmy, 2021; Parra G. et al., 2019; Pokrivcakova, 2019; Wang et al., 2013). Several factors could explain this observation. Firstly, the AI tools were initially designed to replace part of the work of the language teachers. In this case, students could learn English through AI without the help of teachers, thus fostering their independent learning abilities. Secondly, the AI tools presented interesting content such as colorful pictures and captivating videos that could actively engage students in the process of learning English. One unexpected finding was the development of

critical thinking abilities, which did not feature in the literature review conducted for this study. A possible explanation for this finding may be that the existing studies focused more on investigating the relationship between the use of AI and students' linguistics competence and psychological development rather than using AI to cultivate a specific soft skill.

Using AI to Advance Educational Equality in K-12 English in Rural China

The results from this systematic review indicated that AI technology is effective in promoting English language learning. Compared to the traditional ICT technology, AI is an advanced alternative that can effectively improve the quality of rural English education, thus advancing educational equality in rural China. Therefore, the lessons learned from this study can inform policy and further research to improve AI practices in rural China. In terms of policy, it is necessary to promote rural education in ways that provide adequate financial support to rural schools to facilitate the implementation of AI technologies. In terms of practice, it is necessary to strengthen rural teachers' and students' information literacy to ensure the effective practice of AI technology. In addition, promoting school-enterprise cooperation is imperative to enable the sustainable development of informatization (Knox, 2020).

Limitations

Despite the positive outcomes of the studies mentioned in the systematic review conducted in this study, a note of caution is necessary regarding K-12 English education in the context of rural China. Since some of the AI practices were implemented in higher education and different culturally specific contexts, educational practitioners need to further consider ways to transfer AI practices that have been successful in higher education to K-12 education in rural China. Moreover, the combinations of the keywords in the database search phase might also affect the number of yielded articles.

Conclusions

Achieving educational equality has always been a goal for the Chinese government (MOE, 2007). Overall, students from rural China have fair opportunities to receive education; however, the problem of high-quality educational opportunities lacking in the less developed regions remains (Bao, 2006). In the past three decades, ICT technology has allowed students from rural China to have fair educational opportunities for education. Regarding its influence on English language instruction in particular, previous studies have shown that ICT has effectively compensated for the disadvantages of English language education in rural areas. However, due to the limitations of ICT technology, such as a lack of interactivity and an inability to personalize learning, it is not sufficient to solely rely on ICT technology in the long term to improve the quality of rural English language education. Therefore, more advanced technology is needed to compensate for the limitations of ICT to support the development of equality with high-quality English language education in rural China. Advances in AI technology have demonstrably made it possible to enhance the quality of English education. Many countries have conducted studies investigating the effectiveness of using AI technology to promote education, with China being at the forefront of such measures. Since the implementation of the "AI + education" national policy in 2017 and the rapid development of 5G technology, AI-based educational technology has been applied in schools in developed regions of China. However, no studies have yet explored the possibility of applying AI technologies to K-12 English language education to enhance educational equality in rural China. Therefore, drawing on the theory of educational equality, the present

study serves to showcase the possibility of using AI technology to advance equality in K-12 English education in rural China.

This systematic review examined 26 articles published between 2017 and 2022 that studied the AI-supported applications in English education in non-English speaking countries. According to the analysis, most studies proved that AI technology could effectively facilitate the learning of English. In terms of speaking skills, AI-powered human-computer interaction technology allowed students to talk with chatbots, effectively allowing them to avoid "dumb English." Regarding writing skills, AI-assisted automatic feedback systems effectively improved English learners' writing skills. Moreover, machine translation also made it possible to narrow the gap between skilled and less skilled English writers, thus building up students' learning confidence. In terms of listening and reading skills, AI-based applications such as chatbots and robots proved to improve English learners' listening and reading comprehension skills. Some studies also indicated that the use of AI technology, in addition to enhancing English skills, can help students develop soft skills such as improving critical thinking abilities, increasing learning motivation, and developing independent learning behavior. In summary, compared to traditional ICT technology, AI-based applications encourage students to engage in English learning actively. By using AI technology, students have the opportunity to learn English in an authentic language environment, thus improving their English skills in a comprehensive way. Therefore, using AI technology has the potential benefit of enhancing the quality of English education in rural China, thereby upholding rural students' rights to receive a high-quality education. Lastly, this article provides new perspectives for policymakers and educational practitioners in terms of applying AI in English language education in rural China. Future research could include empirical studies to investigate the effectiveness of using AI in rural English language education in China.

Appendices

Appendix A: A summary of using AI technology for English speaking skills

ID	Authors/Year	Place of studies	Research Question	Participants	Educational Level	Macro-skills	AI Type	Findings
1	Yang et al. (2022)	South Korea	To examine the appropriateness of using AI chatbot to encourage EFL learners to engage in conversation.	314 Korean EFL learners	K-12	Speaking	Chatbots	The chatbot highly encouraged students to engage in conversation.
2	Chen (2022)	Non-English-speaking countries (not specified)	To investigate the effects of using instructional feedback to decrease ESL learners' public speaking anxiety.	33 university EFL students	Higher Education	Speaking	Automatic feedback system	The instructional feedback generated by AI decreased the participants' public speaking anxiety.
3	Chen et al. (2022)	Taiwan	How speech recognition and corrective feedback technology improved ESL students' English speaking skills and reduced learning anxiety.	56 fifth-grade Chinese EFL students	K-12	Speaking	Automatic speech recognition technique; Corrective feedback	The automatic speech recognition and corrective feedback technologies can effectively improve the students' English-speaking skills and decrease their English speaking anxiety.
4	Lin et al. (2021)	Taiwan	Compare the effectiveness of using the mind map-guided AI chatbot and conventional AI chatbot to promote EFL learners' English speaking performance.	50 EFL students	Higher Education	Speaking	Chatbots	The mind map-guided AI chatbot approach (MM-AI) promoted the students' English speaking performance.
5	Kim et al. (2021)	South Korea	Analyze the effectiveness of using three different types of interactions (two AI chatbots) to improve English speaking performance.	A total of 110 university students (38 face-to-face; 35 text-chatting AI; 37 voice AI)	Higher Education	Speaking	Chatbots	Using AI text-chatting and AI voice-chatting technologies improved students' speaking performance after the experiment.
6	El Shazly (2021)	Egypt	Investigate the effects of using AI chatbots to improve EFL learners' linguistic output gains.	48 undergraduate Egyptian students	Higher Education	Speaking	Chatbots	AI chatbots are promising for significantly improving linguistic output gains and are beneficial in advancing FL learning with significant potential in EFL contexts, facilitating interaction and oral communication. However, AI did not reduce speech anxiety.
7	Tai & Chen (2020)	Taiwan	Investigate the impact of intelligent personal assistants on EFL learners' willingness to communicate.	112 eighth grade EFL learners	K-12	Speaking	Automatic speech recognition technology	Using intelligent personal assistants can create a less threatening EFL learning environment and increase students' engagement, motivation, and confidence.
8	Hsu (2020)	Taiwan	Investigate the learners' levels of attention, meditation, and brainwaves while interacting in three different chatting contexts (face-to-face; virtual; AI chatbot).	30 Chinese non-English-major sophomores	Higher Education	Speaking	Chatbots & AI-powered language learning platforms	An AI chatbot may be of great assistance to EFL learning. However, in the long term, they may not be sufficient to enable EFL learners to comprehend advanced or complex sentences.
			Investigate the effectiveness of using a 3D holographic learning support system (virtual personalized instructor) to reduce adult EFL learners'	12 Chinese EFL	Higher		3D Interactive learning	The proposed 3D holographic platform did create the environment and provide opportunities for EFL learners to apply their target language and reduced their foreign language

9	Chen (2018)	Taiwan	English speaking anxiety.	sophomores	Education	Speaking	support system	speaking anxiety.
10	Jeon (2022)	South Korea	To investigate the outcomes of using a self-directed interactive app in promoting students' English speaking skills and language learning motivation.	179 EFL primary school learners	K-12	Speaking	Interactive agent	The use of a conversational agent effectively enhanced students' speaking skills and motivated them to speak English confidently.

Appendix B: A summary of using AI technology for English listening and reading skills

ID	Authors/Year	Place of studies	Research Question	Participants	Educational Level	Macro-skills	AI Type	Findings
1	Jeon (2022)	South Korea	To investigate how chatbots affect ESL students' motivation to learn a language.	36 Korean EFL learners	K-12	Listening & Speaking	Chatbots	Using the chatbot in EFL classrooms can promote students' listening and speaking skills and reduce their speaking anxiety.
2	Chen et al. (2018)	Taiwan	To introduce a novel methodology for adopting an AI robot in the drama-based digital learning theatre to help ESL students learn English.	ESL students from a junior high school in China	K-12	Listening & Speaking	AI robot	Data under collection.
3	Latypova et al. (2018)	Russia	To investigate the potential use of using the interactive mobile application ELEVATE to improve ESL learners' English performance without teacher's help.	27 first-year Russian undergraduates at the C1 level in English	Higher Education	Listening & Speaking & Reading	AI-powered language learning app	ESL students' English learning performance and critical thinking ability were considerably enhanced by using the MALL-based language learning technology.
4	Mageira et al. (2022)	Greece	To examine the efficacy of using AI chatbot technology to enhance EFL students' foreign languages and cultural content learning.	28 Greek EFL high school students	K-12	Listening & Speaking & Reading	Chatbots	The use of AI chatbot technology can efficiently support the learning of foreign languages and cultural content at the same time.

Appendix C: A summary of using AI technology for English writing skills

ID	Authors/Year	Place of studies	Research Question	Participants	Educational Level	Macro-skills	AI Type	Findings
1	Liu et al. (2021)	China (Mainland)	To investigate the effectiveness of using AI-supported English writing approach in EFL writing.	103 EFL university students	Higher education	Writing	Automated writing evaluation	The AI-supported English writing approach not only significantly improved the students' English writing performance, but also improved their self-efficacy and self-regulated learning, and significantly reduced their cognitive load.
2	Morch et al. (2017)	Norway	Compare the effectiveness of using two different feedback conditions to improve EFL students' English writing grades.	173 Norwegian secondary students	K-12	Writing	Automated writing evaluation	The students using the EssayCritic technology included more ideas (content) in their essays.
3	Nazari et al. (2021)	Iran	To examine the efficacy of using an AI-powered writing tool for non-English speaking students' English academic writing.	120 26- to 39-year-old Iranian postgraduate students	Higher education	Writing	Automated writing evaluation	AI-powered writing tools could be an efficient tool for promoting learning behavior and attitudinal technology acceptance through formative feedback and assessment for non-native postgraduate students in English-language academic writing.
4	Johnson et al. (2021)	Germany	Using an AI-supported chatbot to appraise the influence of group learning and gamification on enhancing motivation and engagement in remote learning scenarios.	12 EFL secondary school students	K-12	Writing	AI-assisted adaptive learning	The study suggests that Escapeling has potential as a collaborative language learning environment.
5	Wang (2020)	China (Mainland)	To investigate the effectiveness of using the online automated essay evaluation system to enhance students' English writing ability.	188 Chinese EFL undergraduate from China Agricultural University	Higher education	Writing	automated essay evaluation (AEE) system	The students' independent learning abilities and English writing abilities were significantly improved at the end of the program.
6	Chew et al. (2019)	Malaysia	To investigate the efficacy of the Summary Writing-Pal (SW-PAL) to improve the students' English summary writing.	53 Malaysian computer science major undergraduate students	Higher education	Writing	Automated writing evaluation	Students using SW-PAL made significantly better improvements in English summary writing.
7	Conijn et al. (2019)	Belgium	To investigate how an automated writing evaluation tool's different feedback timing conditions influence students' writing revision process.	60 Belgian ESL undergraduate students	Higher education	Writing	Automated writing evaluation	Negative: Feedback during the full writing process did not result in higher satisfaction, but was considered significantly more disruptive compared to feedback during the revision stage only.
8	Chon et al. (2021)	South Korea	To examine the role of machine translation (MT) in L2 writing.	66 Korean EFL undergraduate students	Higher education	Writing	Machine translation	Machine translation narrowed the difference in writing ability between the skilled and less skilled learners, facilitated learner use of lower frequency words, and produced syntactically more complex sentences. Negative: MT-translated compositions contained more mistranslations and a greater number of poor word choices.

9	Gayed et al. (2022)	Japan	To evaluate the potential impact of AI KAKU on EFL student writing.	10 Japanese EFL adult students who attend a language school	Adult education	Writing	Web application; Automated Writing Evaluation (AWE) technologies	The participants writing under the condition of AI KAKU were able to produce sentences with greater "sentence fluency".
10	Sun & Fan (2022)	China (Mainland)	To examine the effects of using an automated writing evaluation system on business English writing.	73 Chinese EFL undergraduate students	Higher education	Writing	Automated writing evaluation	Using an AWE-aided assessment approach produced long-term improvement in language accuracy and organization.
11	Cheng (2017)	Hong Kong	To investigate the impact of online automated feedback (OAF) on the quality of EFL students' reflective journals.	138 Chinese EFL undergraduate students	Higher education	Writing	Online automated feedback (OAF)	Online automated feedback (OAF) has a positive impact on facilitating EFL students' reflective journal writing and can foster students' learning autonomy.

Appendix D: A summary of using AI technology for English reading skills

ID	Authors/Year	Place of studies	Research Question	Participants	Educational Level	Macro-skills	AI Type	Findings
1	Mageira et al. (2022)	Greece	To examine the efficacy of using AI chatbot technology to enhance EFL students' foreign languages and cultural content learning.	28 Greek EFL high school students	K-12	Reading & Listening & Speaking	chatbot; conversational AI	The use of AI chatbot technology can efficiently support the learning of foreign languages and cultural content at the same time.
2	Liu et al. (2022)	Taiwan	To explore the AI-based chatbot's role of the interaction in students' engagement and interest in English reading.	68 fifth-grade elementary school Chinese EFL students, aged 11 to 12	K-12	Reading	chatbot	The chatbot was helpful for creating positive interaction experiences and for maintaining students' English reading interest and facilitate reading comprehension.
3	Latypova et al. (2018)	Russia	To investigate the potential use of employing the interactive mobile application ELEVATE to improve ESL learners' English performance without teachers' help.	27 first-year Russian undergraduates at the C1 level in English	Higher Education	Reading & Listening & Speaking	AI-powered language learning app	ESL students' English learning performance and critical thinking ability were considerably enhanced by using the MALL-based language learning technology.

Appendix E: A summary of other outcomes (soft skills) from using AI technology

English skills	Purposes	Other outcomes (soft skills)	Example sources
Speaking & Listening & Reading	To improve ESL learners' English performance	ESL students' critical thinking abilities were considerably enhanced	Latypova et al. (2018)
Speaking	To promote students' English speaking skills	The use of a conversational agent effectively motivated students to speak English	Jeon (2022)
Writing	To support students' English writing	The AI-supported English writing approach improved students' self-efficacy and self-regulated learning, and significantly reduced their cognitive load	Liu et al. (2021)
Writing	To enhance students' English academic writing ability	AI-powered writing tools can be an efficient tool for promoting learning behavior	Nazari et al. (2021)
Writing	To enhance students' English writing ability	The students' independent learning abilities were significantly improved	Wang (2020)
Writing	To improve EFL students' English reflective journal writing	Online automated feedback (OAF) can foster students' learning autonomy	Cheng (2017)

Appendix F: A summary of negative effects by using AI technology

English skills	Purposes	Negative effects	Example sources
Speaking	Investigate the effects of using AI chatbots to improve EFL learners' linguistic output gains	AI did not reduce speech anxiety	El Shazly (2021)
Speaking	Investigate the learners' levels of attention, meditation, and brainwaves while interacting with an AI chatbot	AI chatbot may not be sufficient to enable EFL learners to comprehend advanced or complex sentences in the long term	Hsu (2020)
Writing	To examine the role of machine translation (MT) in L2 writing	MT-translated compositions contained more mistranslations and a greater number of poor word choices	Chon et al. (2021)
Writing	To investigate how an automated writing evaluation tool's different feedback timing conditions influence students' writing revision process	Feedback during the full writing process did not result in higher satisfaction, but was considered significantly more disruptive compared to feedback during the revision stage only	Conijn et al. (2019)

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