International Journal of Artificial Intelligence in Education
https://doi.org/10.1007/s40593-025-00470-0

ARTICLE

Transforming EFL Teaching with AI: A Systematic Review of Empirical Studies

Arnab Kundu[1] · **Tripti Bej**[1]

Accepted: 23 March 2025

Abstract

This systematic review explores the integration and impact of Artificial Intelligence in English as a Foreign Language teaching in schools, evaluating the effectiveness, challenges, and pedagogical implications of AI-driven tools. After screening 189 studies from seven databases, 22 relevant empirical studies focusing on experiential learning outcomes with AI use were selected, following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The findings highlight AI's transformative impact on school-based EFL education, offering tailored, interactive experiences. Students using AI tools showed significant improvements in reading, writing, listening, speaking, vocabulary, and overall language comprehension compared to traditional methods. Improvements in language proficiency align with all three domains of Bloom's Taxonomy. Tools like Natural Language Processing and Intelligent Tutoring Systems enhance instruction but struggle with language nuances and cultural contexts. Challenges like the digital divide, literacy gaps, teacher readiness and role confusion, cognitive load, and context-specific adaptation persist. Addressing these requires robust infrastructure, teacher training, and institutional support. The review offers valuable insights for teachers, policymakers, and researchers dedicated to advancing school-based EFL education with innovative AI solutions.

Keywords AI in Education · EFL · Language Teaching · School Education · PRISMA

✉ Arnab Kundu
arnab.kundu@ierp.org.in; arnabkundu5@gmail.com

Tripti Bej
tripti.bej@ierp.org.in

[1] Institute for Educational Research and Policy, Bankura, India

Published online: 07 April 2025

Introduction

The integration of Artificial Intelligence (AI) in education has evolved rapidly, offering transformative changes across various dimensions of teaching and learning (Li & Chan, 2024). In the context of English as a Foreign Language (EFL) teaching, AI technologies are becoming increasingly pivotal, particularly in enhancing instructional strategies, personalizing learning experiences, and supporting the development of linguistic competencies among students (Chiu, 2023; Wang & Xue, 2024). As schools worldwide adopt AI-based tools, there is a growing interest in understanding how these technologies are reshaping the EFL learning environment, making language acquisition more interactive, engaging, and effective.

The field of EFL education has historically faced contextual challenges related to learner engagement, personalized learning, and the provision of timely feedback (Rao, 2019). Traditional teaching methods often fall short in addressing the diverse needs of EFL learners, particularly in large classrooms where individual attention is limited (Kundu & Bej, 2024a). The emergence of AI presents an unprecedented opportunity to bridge these gaps, as it can offer adaptive learning, Intelligent Tutoring Systems (ITS), and real-time feedback, which are crucial for language development (Al-Ansi et al., 2023; Li & Chan, 2024). AI technologies such as Natural Language Processing (NLP), machine learning, and intelligent agents are now being leveraged to facilitate language instruction by providing instant corrective feedback, personalized vocabulary exercises, and enhanced speaking practice through interactive bots (Chen & Zhao, 2024). As a result, AI has the potential to revolutionize EFL teaching, enabling teachers to deliver more tailored and efficient pedagogical interventions (Wang & Wang, 2024).

Despite the optimistic outlook, the incorporation of AI in school-based EFL teaching remains in its infancy, especially in developing countries like India (Ghamrawi et al. 2024; Tai, 2022; Kundu & Betal, 2022). While there are notable instances of successful AI applications in higher education and private language learning platforms, its systematic use in school settings is less established (Kohn & Hoffstaedter, 2017). The unique challenges faced by school teachers, including limited technological infrastructure, lack of training, mother tongue domination, and varying levels of student digital literacy, may hinder the effective implementation of AI in EFL classrooms (Richards & Rodgers, 2014; Su et al., 2023). Thus, a comprehensive examination of existing empirical studies is necessary to evaluate the actual impact of AI on EFL teaching practices in school contexts and to understand the barriers and facilitators in this integration process.

This study bridges the knowledge gap by systematically reviewing empirical studies on AI in school-based EFL teaching. By synthesizing evidence, it highlights how AI is reshaping EFL education across primary, middle, and secondary levels, offering valuable insights into its impact. The findings will contribute to the existing knowledge base by identifying effective AI tools and strategies, evaluating their specific impacts on EFL learning outcomes, and exploring the practical challenges faced by users in implementing these technologies (Neumann et al., 2023). Moreover, this study will provide recommendations for educators, policymakers,

and technology developers on how to leverage AI effectively to enhance EFL teaching practices, thereby supporting the broader goal of improving language education quality in schools (Hsu et al., 2023). The main research questions that this review aims to answer are as follows:

1. What types of AI technologies and tools are being used in EFL teaching?
2. What specific aspects of EFL learning (e.g., vocabulary, grammar, speaking, listening, reading, writing) are being targeted by AI applications?
3. What are the pedagogical approaches associated with AI-enabled EFL teaching?
4. How does AI impact students'EFL proficiency and achievement?
5. What are the integration challenges perceived by the teachers and students?

Literature Review

The incorporation of AI into EFL teaching has garnered increasing attention in recent years, as AI-driven tools have demonstrated potential to enhance student engagement, provide personalized learning experiences, and offer real-time feedback (Kundu & Bej, 2024b; Wei, 2023; Baskara & Mukarto, 2023). The current literature highlights several key areas where AI can significantly contribute to EFL instruction, including NLP-based applications for language assessment, ITS, and adaptive learning platforms (Al-Ansi et al., 2023).

One of the most prominent AI applications in EFL education is the use of NLP technologies for automated feedback and language practice (Kurni et al. 2023). Tools like automated essay scoring systems and speech recognition software have shown promise in improving learners'writing and speaking skills by providing instant, detailed feedback (Chen & Zhao, 2024). These AI tools not only reduce the burden on teachers but also allow for more frequent and individualized feedback, which is crucial for language acquisition (Zhang & Zou, 2020).

ITS represent another significant AI innovation in EFL teaching. ITS are designed to mimic one-on-one human tutoring by adapting instruction based on the learner's progress and performance (Su et al., 2023; Wei, 2023). Studies indicate that ITS can effectively support vocabulary acquisition, grammar practice, and reading comprehension by providing targeted exercises and hints, thereby catering to individual learning needs (Baskara & Mukarto, 2023). Additionally, the use of AI-powered chatbots and virtual assistants has been explored to enhance students' conversational skills, offering them a safe, non-judgmental environment to practice speaking (Li & Chan, 2024).

The impact of AI on EFL teaching practices is multifaceted, with research suggesting improvements in learner engagement, motivation, and overall language proficiency (Sun et al. 2021). AI tools can facilitate differentiated instruction by adapting content and exercises to suit diverse learner profiles, addressing the challenges posed by heterogeneous classrooms (Alahi et al. 2023).

The effectiveness of AI in EFL education hinges on teacher readiness, access to technology, school culture, and alignment with pedagogical goals, encompassing

three key dimensions: attitude, skill, and device (Chen & Zhao, 2024; Kundu et al. 2020). Despite the potential benefits, several challenges remain. Teachers often express concerns about the reliability of AI-generated feedback, the risk of over-reliance on technology, and the lack of adequate training and resources for effective implementation (Kundu & Bej, 2024b; Divekar et al., 2022). Furthermore, there is limited empirical evidence on the long-term effects of AI on student learning outcomes, particularly at the primary and secondary school levels, highlighting the need for more rigorous and context-specific studies (Chiu, 2023; Woo et al. 2023).

Research Gap

While there is substantial literature on the general application of AI in education, few studies focus specifically on its use in school-based EFL contexts (Zhang & Huang, 2024). Much of the existing research emphasizes higher education or private language learning settings, where learners often have better access to attitude, technology, and higher digital literacy (Chen & Zhao, 2024). Additionally, the majority of studies tend to highlight the potential benefits of AI without thoroughly addressing the practical challenges, pedagogical implications, and the role of teachers in facilitating AI integration (Han, 2020). This gap underscores the need for a comprehensive review of empirical studies that investigate the specific applications, outcomes, and barriers of AI use in school-based EFL teaching environments.

Conceptual Framework

A conceptual framework is essential for a systematic and theoretically grounded review of empirical literature (Maxwell, 2013). The conceptual framework for the study (Fig. 1) is designed to illustrate the key elements, interactions, and outcomes involved in the integration of AI technologies in school-based EFL teaching. The framework is structured to capture the complex relationship between AI

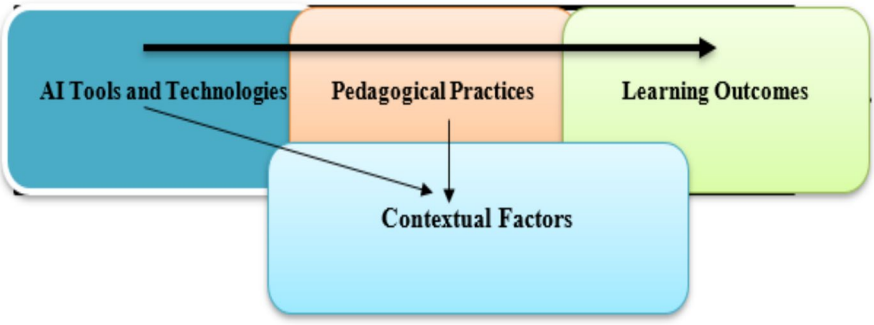

Fig. 1 Conceptual framework (Source: Authors)

tools, pedagogical practices, and student learning outcomes, while also accounting for contextual factors influencing the adoption and effectiveness of AI in EFL education.

The diagram above illustrates the interplay between four main components:

1. **AI Tools and Technologies:** According to Yongjun et al. (2021), AI technology serves as the basis for intelligent systems, whereas AI tools are useful programs created to address EFL teaching issues. This component represents the various AI applications used in EFL teaching, including:
    - NLP: Used for language assessment, automated feedback, and speech recognition
    - ITS: Personalized instruction based on student performance.
    - Adaptive Learning Platforms: Tools that customize content and exercises based on individual learning needs.
    - Conversational Agents/Chatbots: Virtual assistants that help students practice conversational skills in a non-judgmental setting.
2. **Pedagogical Practices:** This element focuses on the changes in teaching strategies driven by the integration of AI. Key aspects include:
    - Personalized Learning: Tailored activities and feedback for individual students.
    - Data-Driven Instruction: Leveraging AI analytics to inform teaching decisions.
    - Enhanced Feedback Mechanisms: Providing immediate, targeted feedback to improve student learning outcomes.
    - Collaborative Learning Opportunities: Utilizing AI tools to facilitate peer interactions and discussions.
3. **Learning Outcomes**

    The impact of AI integration on EFL students'learning outcomes is a central focus. Key outcomes include:
    - Improved Language Proficiency: Enhanced reading, writing, listening, and speaking skills.
    - Increased Engagement and Motivation: Higher levels of student participation and interest in learning.
    - Autonomy in Learning: Development of self-directed learning skills through personalized and adaptive learning experiences.
4. **Contextual Factors**

    This component includes the various external factors influencing the effectiveness of AI in EFL education:
    - Technological Infrastructure: Availability of necessary hardware, software, and internet access.
    - Teacher Readiness and Training: Teachers' familiarity with AI tools and their ability to integrate them into the curriculum.

- Student Digital Literacy: Students' ability to effectively use AI-enhanced tools for learning.
- School Policy and Support: Institutional support, policies, and investment in AI technologies for education.

Arrows indicate the relationships between components, showing how AI tools shape pedagogical practices, which in turn affect learning outcomes, while contextual factors influence the integration process. This framework provides a structured approach to understanding the complex dynamics of AI use in school-based EFL teaching.

Method

In this study, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework was employed to ensure a rigorous and transparent approach to synthesizing empirical studies on AI in EFL teaching. The PRISMA method is widely recognized for its ability to enhance the clarity, replicability, and methodological rigor of systematic reviews (Page et al., 2021).

PRISMA was chosen for its structured approach to identifying, selecting, and appraising literature, aligning with the study's goal of comprehensively analyzing AI's role in EFL education. By adhering to PRISMA guidelines, this research systematically evaluates evidence to reveal trends, challenges, and the impacts of AI integration in school-based EFL education.

PRISMA's high transparency ensures an accessible, reproducible review process, enhancing rigor and credibility (Moher et al., 2009). Its flexibility supports both qualitative and quantitative studies, making it ideal for exploring AI's pedagogical impact in EFL education. This systematic approach grounds findings in evidence, contributing meaningfully to the field.

According to the"Frascati Manual 2015"(OECD, 2015), the study is also categorized as"applied research"since it makes use of pre-existing implications while attempting to provide novel ideas or approaches to deal with the highlighted problem.

A literature search was conducted using Scopus, Google Scholar, PsycInfo, PubMed, Web of Science, Science Direct, and ERIC databases to identify articles on AI in educational contexts. We employed Boolean operations "AND" and "OR" to comprehensively search for relevant studies. The Boolean "AND" ensured the inclusion of research focusing on both AI and EFL teaching, ensuring that studies discuss the direct application of AI within this educational context. Conversely, the Boolean "OR" broadened the search to include literature that discusses either AI in education broadly or EFL teaching methodologies, allowing for the identification of studies that might offer indirect insights or related methodologies. This approach facilitates a robust collection of diverse sources, providing a nuanced understanding of how AI tools are being utilized to enhance EFL instruction, the challenges encountered, and the outcomes observed in various educational settings.

The comprehensive search on the use of AI in school-based EFL teaching resulted in the identification of 216 articles. These articles were systematically analyzed using the Rayyan web-based system (https://www.rayyan.ai/), a free web and mobile application tool known for its high usability in the efficient screening and organization of research literature using a process of semi-automation (Ouzzani et al., 2016). The use of *Rayyan* facilitated the categorization of studies based on relevance, themes, and methodological quality. This process enabled a streamlined and thorough examination of the literature, providing insights into the current state of AI applications in school-based EFL teaching, identifying prevalent trends, methodologies, and gaps in the research. The analysis highlighted key findings and offered a foundation for future studies to build upon, contributing to the advancement of AI-driven pedagogical strategies in EFL teaching. Duplicates were removed, and 109 unique articles were identified. The selected articles were then filtered to remove articles that met exclusion criteria presented in Table 1.

The selected articles were initially analyzed by examining their abstracts, with a focus on identifying their objectives and activities related to good pedagogical practices. Articles that primarily constituted literature reviews or systematic reviews, or those that primarily defined or analyzed the importance of developing good practices, were excluded.

Each article was thoroughly reviewed in three aspects. The first aspect involved the analysis of informative data, such as the author's name or names and the respective year of publication. The second aspect focused on identifying the instances of good pedagogical practices within the articles, including descriptions of the activities undertaken. The third aspect involved evaluating how the good pedagogical practice was presented or visualized. These three selected aspects were identified and documented in a table for better comprehension. The authors analyzed the activities described in each research article and synthesized each finding through interpretation.

The search was conducted between 1 st January 2020 and 30 st March 2024, comprising 22 studies. Older studies might not account for recent developments, shifts in educational policies, or changes in student needs and behaviors. Current research reflects the most recent empirical evidence, providing a robust basis for drawing accurate conclusions and making informed recommendations (Hooda et al., 2022). This approach is critical as well for influencing policy changes and encouraging the adoption of innovative AI technologies in EFL teaching (Luckin et al., 2016).

The authors carried out a rigorous selection procedure, concentrating on papers that were most relevant to the study, taking into account each article's abstract and conclusion. A graphical depiction of the preselection process was produced in the form of the PRISMA diagram, as seen in Fig. 2 (Page et al., 2021).

Findings

This section presents results in two subsections: a descriptive analysis of evaluated studies, and addressing research issues and findings.

Table 1 Inclusion and exclusion criteria for article selection

Criterion	Inclusion	Exclusion
Article Topic	Incorporate AI into EFL teaching learning in school contexts	Do not incorporate AI into other school contexts
Article Type	Empirical Studies	Editorials, Reviews, Commentaries, Conference abstracts, and Opinion papers
Article Publication	Published	Unpublished or pre-printed or under-review
Article Availability	Available online as full text	Not available online
Article Language	English	Non-English
Population	K- 12 settings or within the age range of K- 12 schools	Higher and adult education are excluded
Measure	Studies related to AI-enabled EFL pedagogy in school that discuss learning tools, pedagogical strategies, learning outcomes, and assessment methods	The focus is not related to AI in school-based EFL learning context

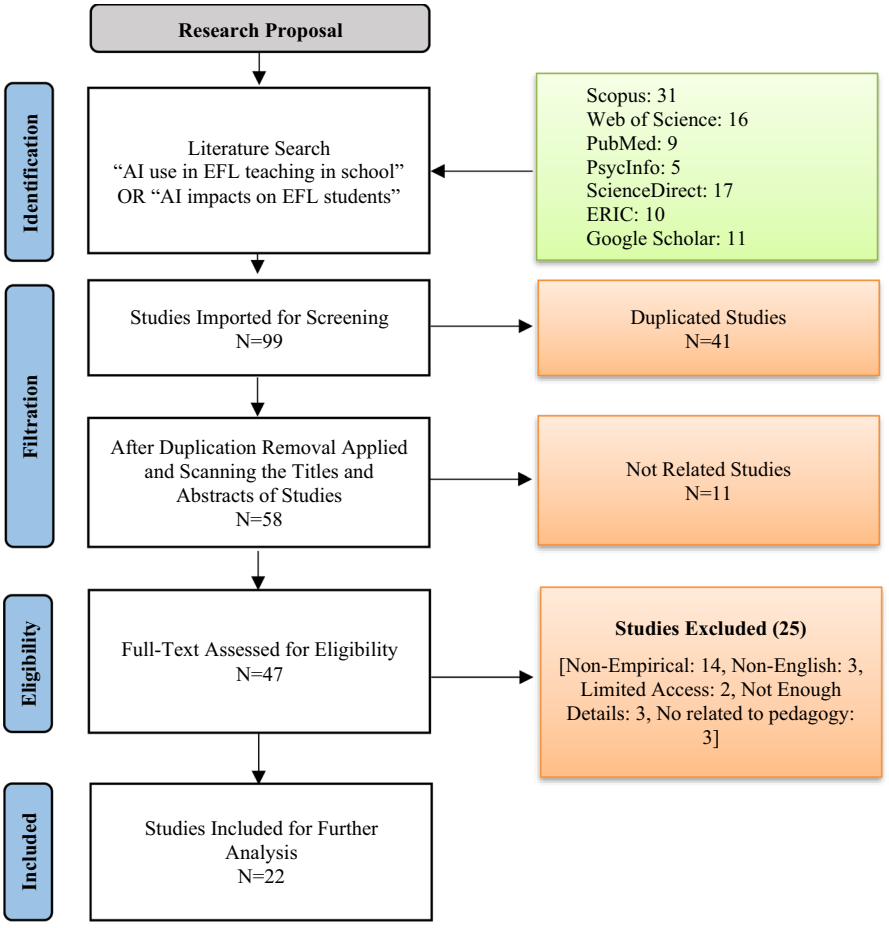

Fig. 2 The flowchart for study selection process (Source: Authors)

Part 1: Descriptive analysis

The analysis of evaluated studies considers factors like educational attainment, nation distribution, research methodology, sample knowledge, primary goals, and key conclusions.

A) **The number of reviewed studies and publication years**

The total number of the reviewed studies was 22 (9 from primary school level, 7 from Middle school level, and 6 from secondary school level) which shows all school levels are included under the investigation irrespective of grades. All studies were empirical studies and published in different journals focusing on AI-enabled EFL teaching–learning in school. The studies are reported serially as

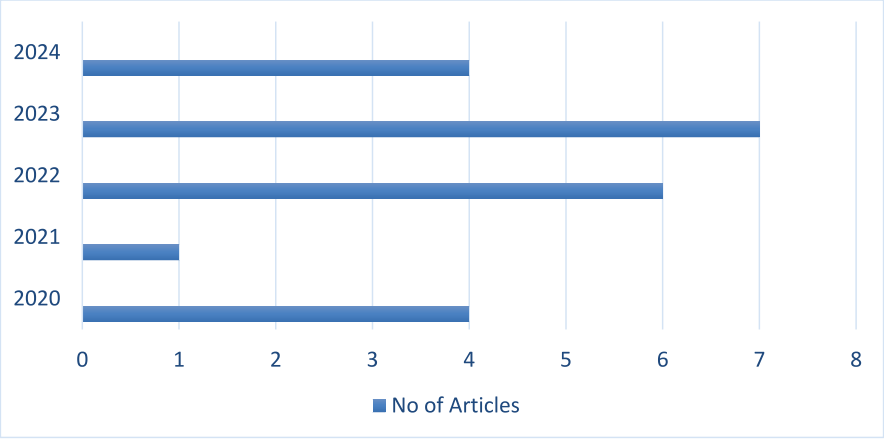

Fig. 3 Year-wise distribution of the selected articles

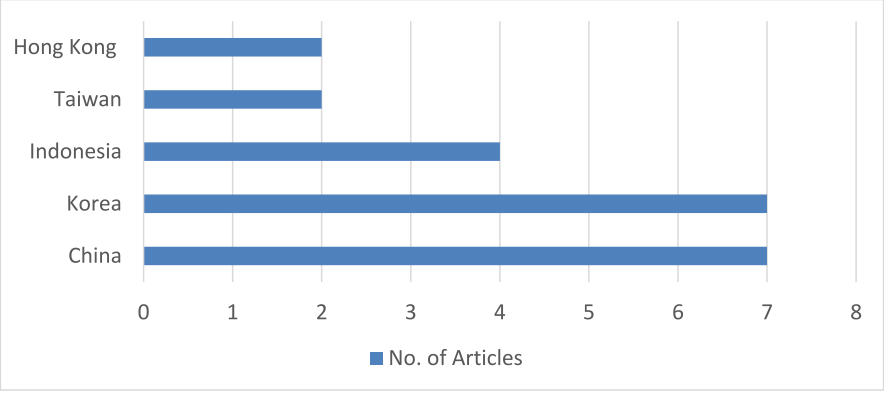

Fig. 4 Country-wise distribution of the selected articles

per their publication year (Fig. 3) which shows that the number of studies is on an increasing trend indicating the growing interest of the research field.

B) **Country distribution**

The evaluated studies are from six different countries, but the data they contain are focused on Southeast Asia rather than the entire globe. China (7), Korea (7), Indonesia (4), Taiwan (2), and Hong Kong (2) are the nations (Fig. 4). This geographical concentration supports the observation of Kirkpatrick and Sussex (2012) that the region's historical, economic, and educational dynamics have contributed to a strong emphasis on English language acquisition.

C) **Research methodology approaches and source(s) of data**

Majority of studies (9) adopted mixed-method research method followed by quantitative (8) and qualitative (5). Beyond this basic data-based divisions, the highest number of studies (10) adopted quasi-experimental method followed by survey (8) and case study (4) (Fig. 5).

The studies exhibit several methodological strengths and limitations. Among the strengths is the use of advanced data analytics and machine learning techniques to personalize and enhance learning experiences. Studies often employ robust experimental designs, including randomized controlled trials, which provide strong evidence of AI's effectiveness in improving language skills. Additionally, the integration of qualitative methods, such as interviews and observations, enriches the understanding of AI's impact on student engagement and motivation.

However, limitations persist. Many studies face issues of small sample sizes and limited generalizability due to specific contextual factors. There is often a reliance on short-term assessments, which may not capture the long-term effects of AI interventions. Ethical concerns, including data privacy and consent, are sometimes inadequately addressed. Furthermore, the rapid pace of technological advancement can render some findings quickly outdated. Addressing these limitations in future research will enhance the validity and applicability of findings in the field of AI-enabled EFL education in schools.

Part 2: Main Findings Of The Reviewed Studies

After the selection of articles, an in-depth analysis was conducted following the proposed theoretical framework developed in Fig. 1 and the details are presented in Tables 2 and 3.

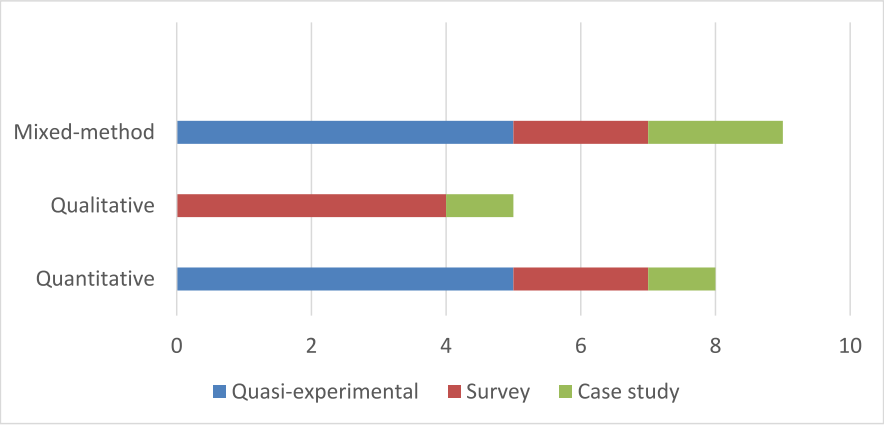

Fig. 5 Method-wise distribution of the selected articles

Table 2 Key elements, interactions, and outcomes involved in the integration of AI in school-based EFL teaching

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/ constraints)
1	Han (2020)	*Echodot* (voice-based AI chatbots)	Personalized learning with minimal teacher interference	Speaking	*Opportunities*: Voice-based AI chatbots enhanced speaking competence among students, increasing motivation and interest in EFL while reducing anxiety *Constraints*: Not mentioned
2	Tai et al. (2020)	*Mondly VR*	Task-Based Language Teaching	Vocabulary learning and retention	*Opportunities*: VR-mediated vocabulary learning was found to be motivating, interacting, and engaging *Constraints*: Lacking interactivity and easy distraction
3	Tai and Chen (2020)	Google Assistant	Personalized learning with less teachers' intervention	Speaking and Communication	*Opportunities*: Google Assistant's interactive games and chatbots increased students'engagement, motivation, and confidence in EFL. It fostered meaningful and less threatening communication *Constraints*: Needs material and cultural readiness
4	Junaidi et al. (2020)	*Lyra* Virtual Assistant (LVA)	Competency-Based Learning	Speaking along with four components- pronunciation, grammar, vocabulary, and fluency	*Opportunities*: LVA has found an effective AI app for EFL students to improve their speaking skills *Constraints*: Not mentioned

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
5	Tlili et al. (2021)	*Jungle Animals Game*	Gamification	Vocabulary	*Opportunities*: The smart game with LA significantly improved motivation and performance in learning English vocabulary *Constraints*: Needs institutional support
6	Hadi and Junor (2022)	Google Assistant	Personalized learning	Speaking	*Opportunities*: Google Assistant significantly enhances EFL students'communicative confidence, willingness to communicate, and speaking anxiety by assisting them in practicing fluent and accurate English language skills in various situations *Constraints*: Needs teacher readiness
7	Lin et al. (2022)	Educational robot and an IoT-Based 3D book	Gamification	Vocabulary	*Opportunities*: The AI intervention, utilizing a robot and 3D book, significantly enhanced children's vocabulary learning by providing elicitation cues for effective oral practice *Constraints*: Instructional designers should consider learners'multimodal learning styles when designing multimodal cues to ensure positive affective behaviours in language learning

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
8	Tai and Chen (2022)	Google Assistant via Google Nest Hub and Google Nest Min (Intelligent Personal Assistant (IPA)	Inquiry-Based Learning	Listening	*Opportunities*: Google Assistant, particularly via Google Nest Hub, enhanced participants'listening comprehension by providing authenticity, flexibility, and enjoyment in EFL listening *Constraints*: Not mentioned
9	Jeon (2022)	*Google Dialogflow* (AI chatbots)	Task-Based Language Teaching	Speaking proficiency	*Opportunities*: The chatbots facilitated the students' motivation to utilize the chatbots, which led to active engagement in speaking English *Constraints*: The individual experiences anxiety about misrecognition and may repeat a conversation from the beginning when unrecognized input is present
10	Lee and Jeon (2022)	Voice-controlled conversational agents (VCAs)	Competency-Based Learning	Speaking	*Opportunities*: VCAs have shown significant potential (in generating anthropomorphism in them) as interactive language partners in EFL contexts, contributing to social learning alongside cognitive and affective aspects *Constraints*: Digital divide and digital literacy among teachers and students

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/ constraints)
11	Agustini (2023)	ChatGPT	Collaborative Learning	English Language Acquisition	*Opportunities*: ChatGPT integration in language learning programs fosters vocabulary, writing and speaking skills, motivation, and autonomy *Constraints:* Needs teacher training
12	Jeon (2023)	*Google Dialogflow*	Interactive and personalized learning	Vocabulary learning	*Opportunities:* Chatbot-Assisted Dynamic Assessment (CA-DA) enhances students'vocabulary acquisition and provides diagnostic information about individual learners for better vocabulary learning *Constraints*: Not mentioned
13	Jeon and Lee (2023)	ChatGPT (a generative AI chatbot powered by a large language model)	Collaborative Learning	Learning depends on Teacher-AI collaboration	*Opportunities*: Four ChatGPT roles were identified, focusing on the interlocutor, content provider, teaching assistant, and evaluator, promoting quality pedagogical decisions, student involvement, and raising AI ethical awareness *Constraints*: Teachers need pedagogical expertise in using AI tools

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
14	Lee et al., (2023a, 2023b)	AI-based content generator-based activity	Competency-Based Learning	Reading	*Opportunities*: Enhanced EFL students' enjoyment and interest in reading English books *Constraints*: Lack of digital infrastructure
15	Utami et al. (2023)	AI-based software for writing version 3.0	Project-Based Learning	Academic writing	*Opportunities*: AI-based learning tools aid students in academic research planning and drafting, offering flexibility and accessibility *Constraints*: The report recommends optimizing AI-based learning tools by adding features for editing Indonesian text, and enhancing AI literacy to effectively utilize existing features

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
16	Lee et al., (2023a, 2023b)	AI web-based English learning support system (based on the LGC framework)	LGC-based blended learning, through which learners become the creators of their learning contexts and construct knowledge autonomously by interacting with or creating resources	Overall English language learning experience	*Opportunities*: AI-applied learning assistance systems enable learners to create their own learning contexts, fostering autonomous learning experiences without specific instructors, curriculum, or location, thereby enhancing education *Constraints*: The AI learning support system alone cannot fully address LGC (Learner-Generated Context)-based learning, requiring understanding of social conditions, technical improvements, educational environment, and human assistants
17	An et al. (2023)	No specification	AI enabled pedagogy	EFL Teaching	*Opportunities*: EFL teachers'perceptions, knowledge, and behavioral intention matters in the integration of AI in pedagogy *Constraints*: Effort Expectancy (EE), Facilitating Conditions (FC), AI technological pedagogical knowledge (AI-TPK), had indirect effects on behavioral intention

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
18	Woo et al. (2024a)	AI-NLG (AI-writing tools)	Project-Based Learning	Writing	*Opportunities*: AI-NLG tools helped EFL students with writing challenges, but not all students benefit. Competent writers can use AI-generated text for high-quality compositions. AI-word usage varies based on a student's writing ability, and high usage does not guarantee high performance *Constraints*: Differentiated pedagogical strategies are proposed for EFL students to effectively utilize AI-writing tools
19	Woo et al. (2024b)	ChatGPT	Collaborative Learning	Writing (with prompt)	*Opportunities*: ChatGPT effectively engages EFL students in writing classes, and students' motivation scores slightly increased in AI classes *Constraints*: Students experienced high cognitive load during prompt engineering, suggesting educators should use an iterative design process for effective use of ChatGPT in EFL writing

Table 2 (continued)

No	Study	AI Tools and Technologies	Pedagogical Practices	Learning Outcomes	Contextual Factors (opportunities/constraints)
20	Zhang and Huang (2024)	Chatbot (LLMs)	Project-Based Learning	Vocabulary	*Opportunities*: AI chatbots using LLMs enhance EFL vocabulary acquisition, long-term retention, and incidental learning, promoting strategic teaching methods and effective language learning aids *Constraints*: Digital divide
21	Yang and Zhao (2024)	AI-mediated instruction on students' emotions	Blended learning	Overall, language learning experience	*Opportunities*: EFL learners experienced a wide spectrum of positive and negative emotions considering AI-based EFL education largely due to their novelty to both teachers and learners *Constraints*: Limited familiarity and literacy in AI among EFL students
22	Yang et al. (2024)	AI technology (integration into English-speaking teaching)	Blended learning	Overall, language learning experience	*Opportunities*: A professional development program helped teachers overcome challenges in integrating AI-based EFL teaching, increasing their self-efficacy and facilitating a transition from traditional practices *Constraints*: Teachers need experiences in transitioning from traditional to AI-based instructional practices

Table 3 Categorization of tools based on their functionalities

No	AI Technology	AI Tools (Studies)
1	Natural Language Processing	• Google Assistant (Hadi & Junor, 2022; Tai & Chen, 2020) • AI-NLG (Woo et al. 2024a • EchoDot (Han, 2020) • Voice-controlled conversational agents (Lee & Jeon, 2022) • AI-based content generator-based activity (Lee et al., 2023a, 2023b) • AI-based software for writing version 3.0 (Utami et al., 2023) • Mondly VR (Tai et al., 2020) • AI web-based English learning support system (based on the LGC framework) (Lee et al., 2023a, 2023b)
2	ITS (Chatbots and Virtual Tutors)	• Lyra Virtual Assistant (Junaidi et al., 2020) • Google Dialogflow (Jeon, 2022, 2023) • ChatGPT (Agustini, 2023; Jeon & Lee, 2023)
3	Gamification	• Jungle Animals Game (Tlili et al., 2021) • Educational robot and an IoT-Based 3D book (Lin et al., 2022)
4	Adaptive learning platforms	• AI-mediated instruction on students' emotions (Yang & Zhao, 2024)
5	Speech and Pronunciation Tools	• Chatbot (LLMs) (Zhang & Huang, 2024)
6	Content creation and management tools	• AI web-based English learning support system (based on the LGC framework) (Lee et al., 2023a, 2023b)
7	AI-powered assessment tools	• AI-NLG (AI-writing tools) (Woo et al. 2024a)
8	Virtual Reality (VR) and Augmented Reality (AR)	• Lyra Virtual Assistant (LVA) (Qiao & Zhao 2023)

Discussion

Types of AI Technologies and Tools are Being Used in EFL Teaching

The analysis finds that in EFL teaching, a variety of AI technologies and tools are being utilized to enhance the learning outcomes. Table 3 displays the tools'classifications according to their features and language learning components.

NLP appears as a popular and efficient AI technology in school-based EFL education, providing tailored, interactive experiences for students. It aids in precise grammar correction, real-time pronunciation feedback, and personalized vocabulary building, enhancing writing, speaking, listening, and reading skills (Hadi & Junor, 2022; Tai & Chen, 2020; Tai et al., 2020). NLP enables the development of intelligent chatbots and virtual tutors that can engage students in meaningful conversations as well, enhancing their fluency and comprehension (Lee & Jeon, 2022). Overall, the integration of NLP into EFL teaching not only aids in addressing individual learning needs but also fosters a more engaging and efficient language learning environment for the school students.

Additionally, chatbots and virtual tutors, part of ITS technology, offer continuous support and adaptability to individual learning paces (Jeon, 2022, 2023). Gamification excels in sustaining student interest and participation. Adaptive learning platforms provide personalized learning experiences, dynamically adjusting to individual student needs and learning paces (Yang & Zhao, 2024).

Speech and pronunciation tools like Chatbots offer immediate feedback on verbal skills, crucial for developing accurate pronunciation and fluency. Content creation and management tools streamline the design, distribution, and organization of educational materials, enhancing instructional efficiency (Lee et al., 2023a, 2023b). AI-powered assessment tools deliver real-time, objective evaluations of student performance, facilitating targeted interventions. VR and AR create immersive and interactive learning environments, making language acquisition more engaging and contextually relevant (Junaidi et al., 2020).

A holistic approach, leveraging the strengths of each technology, emerges as the most effective strategy for optimizing EFL education in schools.

Specific Aspects of EFL Learning Being Targeted by AI Applications

AI applications in EFL learning targeted several specific aspects to enhance language acquisition. These include vocabulary development through personalized flashcards and spaced repetition algorithms, and grammar improvement via real-time error correction and feedback (Jeon, 2023; Lin et al., 2022; Tai et al., 2020; Tlili et al., 2021; Zhang & Huang, 2024). Speaking skills are honed using speech recognition technology that provides pronunciation and fluency feedback, while listening abilities are enhanced through interactive listening exercises with instant comprehension checks (Hadi & Junor, 2022; Han, 2020; Jeon, 2022; Junaidi et al., 2020; Lee & Jeon, 2022; Tai & Chen, 2020). Reading comprehension is supported

by AI-driven tools that offer text analysis and contextual understanding aids (Lee et al., 2023a, 2023b; Lee et al., 2023a, 2023b). Writing skills are developed through automated essay scoring and detailed feedback on structure, coherence, and style (Utami et al., 2023; Woo et al. 2024a; Woo et al. 2024b).

Collectively, these AI applications provide comprehensive, targeted support across all 'core areas' (reading, writing, speaking, listening) of EFL education.

We investigated the impact of AI-enabled EFL teaching on school students'cognitive, affective, and behavioral learning outcomes (Table 4) through the lens of Bloom's Taxonomy (Anderson & Krathwohl, 2001) to provide a structured framework for analyzing the multifaceted effects of AI in education. Bloom's

Table 4 Analyzing AI-enabled EFL learning outcomes following Bloom's Taxonomy

Domain	Learning outcomes following the Bloom's Taxonomy
Cognitive	1. *Remembering*: AI use spaced repetition algorithms and personalized flashcard systems to help students remember vocabulary and grammar rules (Utami et al., 2023) 2. *Understanding*: AI-powered tools provide interactive reading and listening exercises that adapt to the learner's level, offering explanations and translations as needed (Hadi & Junor, 2022; Tai & Chen, 2020) 3. *Applying*: AI-enabled platforms offered simulations and real-life scenarios where learners use language skills, such as role-playing games or conversation practice with chatbots (Lin et al., 2022; Tlili et al., 2021) 4. *Analyzing*: AI analyzed students' language patterns and errors, providing detailed feedback, and encouraging learners to identify and correct their mistakes (Agustini, 2023) 5. *Evaluating*: AI facilitated peer review and self-assessment activities, using NLP to provide feedback on writing and speaking exercises (Tai et al., 2020) 6. *Creating*: AI tools supported creative tasks such as writing essays or stories by providing suggestions, grammar checks, and even collaborative writing environments (Lee et al., 2023a, 2023b)
Affective	1. *Receiving*: AI helped gauge students' initial interest and engagement through interactive and engaging content, personalized learning paths, and gamification (Woo et al., 2024b) 2. *Responding*: AI encouraged active participation by providing instant feedback, encouraging responses, and rewarding effort and progress (Zhang & Huang, 2024) 3. *Valuing*: AI tracked student preferences and tailor content to match their interests, helping them to see the value in their learning (Woo et al. 2024a) 4. *Organizing*: AI helped students set and organize learning goals, track their progress, and suggest next steps based on their performance and interests (Lee et al., 2023a, 2023b) 5. *Characterizing*: AI supported the development of language learning habits and attitudes by providing consistent and ongoing opportunities for practice and reflection (Yang & Zhao, 2024)
Behavioral	1. *Imitation*: AI tools provided models for students to imitate, such as pronunciation guides using speech recognition technology (Woo et al., 2024a) 2. *Manipulation*: AI offered interactive writing exercises, such as drag-and-drop activities for sentence construction and word order (Woo et al. 2024b) 3. *Precision*: AI helped students refine their skills through detailed feedback on pronunciation and writing, highlighting specific areas for improvement (Utami et al., 2023) 4. *Articulation*: AI supported advanced learners in combining language skills fluidly, such as through AI-driven conversational agents that simulate real-life interactions (Jeon, 2022, 2023; Junaidi et al., 2020) 5. *Naturalization*: AI facilitated the automatic use of language skills in varied contexts, helping learners to become more fluent and natural in their language use (Yang & Zhao, 2024)

Taxonomy allows for a comprehensive evaluation of how AI tools influence various levels of student learning, from knowledge acquisition (cognitive) to emotional engagement (affective) and student behavior (behavioral). This approach helps to deepen our understanding of AI's transformative potential in enhancing language learning across different domains.

Table 4 shows that the integration of AI-enabled technologies in school-based EFL teaching has the potential to revolutionize traditional pedagogy by addressing all domains of Bloom's Taxonomy: cognitive, affective, and psychomotor. AI technologies such as NLP, adaptive learning platforms, and virtual tutors enhance cognitive skills by providing personalized feedback and tailored learning experiences, promoting higher-order thinking skills (HOTs) like analysis, evaluation, and creation, having referenced in Luckin (2016).

Emotional engagement and motivation, key aspects of the affective domain, are bolstered through gamification and interactive AI tools that make learning more engaging and enjoyable. AI technologies such as gamified learning platforms, adaptive learning systems, and virtual tutors provide personalized and engaging experiences that foster positive emotional connections to language learning. These tools can adapt to individual student interests and preferences, making learning more enjoyable and reducing anxiety, the findings support the propositions in Holmes et al., (2019) and Wei (2023).

Additionally, speech recognition and pronunciation tools improve psychomotor skills by offering real-time feedback on speaking and listening practices, supporting the previous claims in Su et al. (2023), Divekar et al. (2022), Xu et al. (2022), and Hsu et al. (2023). This holistic approach not only improves language proficiency but also fosters critical thinking, creativity, and emotional intelligence.

Leveraging AI can shift EFL education from rote learning to a dynamic, student-centered approach, fostering critical thinking and real-world communication skills. This is especially relevant in South Asia, where education in countries like India and China has often been criticized for emphasizing memorization over application and analysis (Kundu & Betal, 2022; Crehan, 2016; Divekar et al., 2022).

AI technologies like virtual tutors and chatbots offer personalized feedback, boost motivation, reduce anxiety, and track student progress. By fostering consistent engagement and self-regulation, AI supports a shift from teacher-centred to learner-driven approaches, aligning with global education reforms.

Pedagogical Approaches Evolved During AI-enabled EFL Teaching

Key pedagogical approaches that evolved include personalized learning, blended learning, gamification, project-based learning, collaborative learning, inquiry-based learning, competency-based learning, and task-based language teaching (Table 5). These approaches enhance students' engagement, personalization, and effectiveness by leveraging AI's capabilities to create more dynamic, responsive, and impactful learning experiences.

In personalized learning, AI tailors instruction to individual student needs, and adaptive learning, which adjusts content difficulty based on student performance

Table 5 Pedagogical approaches were used in the reviewed studies

No	Pedagogic approach	Nuanced practices
1	Personalized Learning	• Adaptive learning platforms (Han, 2020) • Personalized feedback and recommendations (Tai et al., 2020) • Learning analytics to monitor progress and adjust instruction (Tai & Chen, 2020)
2	Blended Learning	• Learning Management Systems (LMS) (Lee et al., 2023a, 2023b) • AI-driven content recommendations and personalized study plans (Yang et al., 2024) • Online discussion forums and virtual collaboration tools (Yang & Zhao, 2024)
3	Gamification	• Gamified language learning apps like *Jungle Animals Game* (Tlili et al., 2021) • Adaptive difficulty levels based on learner performance (Lin et al., 2022) • Real-time feedback and progress tracking (Tlili et al., 2021)
4	Project-Based Learning	• AI-driven research assistants and data analysis tools (Utami et al., 2023) • Collaborative platforms for project management (Woo et al., 2024a) • AI-based feedback on project drafts and presentations (Zhang & Huang, 2024)
5	Collaborative Learning	• AI-powered chatbots and virtual assistants for group work (Agustini, 2023) • Collaborative platforms like Google Workspace or Microsoft Teams (Jeon & Lee, 2023) • AI analysis of group interactions to improve collaboration (Woo al., 2024b)
6	Inquiry-Based Learning	• AI-generated suggestions and feedback on inquiry projects (Tai & Chen, 2022)
7	Competency-Based Learning	• Adaptive assessments and quizzes (Junaidi et al., 2020) • Personalized learning pathways (Lee & Jeon, 2022) • Real-time tracking of competency development (Lee et al., 2023a, 2023b)
8	Task-Based Language Teaching	• AI-driven role-playing and simulation environments (Tai et al., 2020) • VR and AR tools for immersive experiences (Jeon, 2022)

(Tai et al., 2020). AI tools integrate online and traditional learning methods, offering supplementary exercises, tracking progress, and adjusting content delivery based on student performance for a seamless transition (Yang et al., 2024). AI allows for the creation of interactive educational games that adjust difficulty based on student performance, motivating them through rewards and progress tracking (Lin et al., 2022; Tlili et al., 2021). AI tools aid in project-based learning by facilitating research, collaboration, and management, providing resources, suggesting ideas, and offering feedback to ensure students meet learning objectives (Woo et al., 2024b).

AI improves collaborative learning by grouping students based on skills and learning styles, enhancing real-time communication, resource sharing, and problem-solving efficiency in group work (Jeon & Lee, 2023). AI systems aid inquiry-based learning by providing immediate access to vast information, guiding students through research, suggesting relevant questions, and connecting concepts (Tai & Chen, 2022). AI platforms facilitate competency-based learning, tracking student progress, providing real-time assessments (Junaidi et al., 2020), and facilitating task-based language teaching through interactive tasks, ensuring immediate feedback and context-specific practice (Jeon, 2022).

Personalized learning experiences, adaptive platforms, and ITS have all been made possible by AI technology, which has had a substantial impact on school-based EFL education. These findings have also been confirmed by earlier research by Su et al. (2023), Xu et al. (2022), and Divekar et al. (2022), although most of these studies proposed in higher education context.

NLP enhances interactive practice, while AI-driven analytics provide insights for data-informed teaching strategies. Virtual learning environments foster collaborative learning, shifting from traditional teacher-cantered methods. Here, teachers' performance expectancy, social influence, and AI language technological knowledge significantly predict his behavioural intention to use AI, while effort expectancy, facilitating conditions, and AI-TPK indirectly affect it (An et al., 2023).

These innovations have the potential to shift from traditional teacher-centred methods to more student-centred, adaptive, and engaging pedagogical approaches in EFL education.

AI Impacts on Students'Language Proficiency and Achievement

Students using AI-driven tools in EFL learning showed notable improvements in vocabulary acquisition, grammar accuracy, speaking fluency, and overall language comprehension compared to traditional learning methods. We have categorized these linguistic effects into a few categories along with the nuanced effects presented in Table 6.

Table 6 shows the integration of AI in EFL teaching has markedly enhanced school students'language proficiency and overall achievement. AI technologies facilitate improved personalization and adaptation, enabling tailored instruction that aligns with individual learning needs and paces, thereby fostering better engagement and motivation (Han, 2020; Tai et al., 2020). Enhanced engagement and motivation stem from AI-driven interactive and gamified learning experiences, making

Table 6 Impacts of AI-enabled EFL learning on school students

No	Type of impact	Nuanced impacts
1	Improved personalization and adaptation	• Targeted practice: Learners receive exercises that address their specific weaknesses (Han, 2020) • Adaptive feedback: Real-time, personalized feedback helps learners correct mistakes and improve faster (Tai et al., 2020)
2	Enhanced engagement and motivation	• Increased time on task: Gamified elements like points, badges, and leaderboards encourage continuous practice (Tlili et al., 2021) • Engaging content: Interactive and varied content keeps learners interested and reduces the likelihood of boredom (Jeon & Lee, 2023; Zhang & Huang, 2024)
3	Improved language skills (pronunciation, grammar, vocabulary, fluency)	• Accurate pronunciation: Immediate feedback helps learners correct pronunciation errors (Lee & Jeon, 2022) • Fluency development: Regular practice with AI tools improves speaking fluency (Jeon, 2022) • Writing improvement: Continuous feedback helps learners improve their writing skills over time (Utami et al., 2023; Woo et al. 2024b) • Error reduction: AI tools highlight and correct grammatical and syntactical errors (Woo et al. 2024a) • Reading improvement: (Lee et al., 2023a, 2023b) • Listening improvement: (Tai & Chen, 2022)
4	Increased access to learning resources	• Flexibility: Learners can study at their own pace and on their own schedule (Woo et al. 2024b; Utami et al., 2023) • Resource variety: Access to diverse materials caters to different learning styles and preferences (Lee et al., 2023a, 2023b)
5	Better assessment and feedback	• Continuous monitoring: AI systems can constantly assess learners'performance and provide instant feedback (Jeon, 2022) • Actionable insights: Detailed analytics help learners understand their strengths and weaknesses (Hadi & Junor, 2022; Junaidi et al., 2020)
6	Support for autonomous learning	• Self-paced learning: Learners can progress at their own speed (Tai & Chen, 2020) • Resource availability: AI offers a wealth of learning materials and tools for self-study (Lin et al., 2022)
7	Enhanced collaborative learning	• Interactive learning: Collaborative tools enable peer-to-peer interaction and learning (Agustini, 2023) • Diverse perspectives: Learners can collaborate with peers from different backgrounds, enhancing their cultural understanding and language use (Jeon & Lee, 2023)

Table 6 (continued)

No	Type of impact	Nuanced impacts
8	Real-world language use	• Practical application: Learners practice the language in contexts that mimic real-life situations (Lee et al., 2023a, 2023b) • Confidence building: Simulated interactions help build learners'confidence in using the language (Woo et al. 2024b)
9	Reduced negative impacts	• Reduced anxiety (Hadi & Junor, 2022; Han, 2020) • Facilitates pedagogic transformation (Yang et al., 2024)

language acquisition more enjoyable and effective (Jeon & Lee, 2023; Zhang & Huang, 2024).

AI tools significantly improve language skills by providing precise feedback on pronunciation, grammar, vocabulary, and fluency, helping students achieve higher proficiency levels (Hadi & Junor, 2022; Junaidi et al., 2020). The increased access to diverse learning resources, including virtual tutors and extensive digital libraries, ensures that students can learn anytime and anywhere, broadening their educational opportunities (Lee et al., 2023a, 2023b). AI's capabilities in providing better assessment and feedback allow for real-time, detailed insights into student progress, enabling targeted interventions and continuous improvement (Jeon, 2022).

Support for autonomous learning is strengthened through AI applications that promote self-paced study, empowering students to take charge of their education (Lin et al., 2022). Furthermore, AI enhances collaborative learning by facilitating communication and resource sharing among peers, fostering a cooperative learning environment (Agustini, 2023; Jeon & Lee, 2023).

Real-world language use is encouraged through AI simulations and contextual learning activities, preparing students for the practical application of their skills (Lee et al., 2023a, 2023b). This is particularly vital for non-English contexts like India and China thus overcoming geographical and socio-economic barriers to authentic language use (Warschauer, 2013).

Finally, AI reduces negative impacts, such as learning anxiety and frustration (Hadi & Junor, 2022; Han, 2020), by offering supportive, adaptive, and non-judgmental learning environments (Yang et al., 2024). These advancements collectively contribute to significant improvements in students'language proficiency and academic achievement.

Contextual Factors and Implementation Challenges

Contextual factors play a critical role in the successful adoption and implementation of AI in school-based EFL teaching, as highlighted by this systematic review. It highlights several significant challenges in the transition from traditional to AI-based instructional practices in EFL education. The digital divide in schools as pointed out in several studies (Lee & Jeon, 2022; Lee et al., 2023a, 2023b; Tai & Chen, 2020; Zhang & Huang, 2024), hinders the implementation of AI-enhanced learning tools, exacerbating existing educational inequalities. Teachers require experiential learning opportunities to effectively shift from conventional methods to those incorporating AI, as emphasized by Jeon and Lee (2023). They must be aware of their new roles (Yang et al., 2024). Additionally, there is a prevalent issue of limited familiarity and literacy in AI among EFL students, as noted by Yang and Zhao (2024).

Moreover, teacher readiness and institutional support are identified as another key determinant of effective AI integration in schools. Many teachers express concerns about their lack of expertise in using AI tools and the limited professional development opportunities provided by schools (Hadi & Junor, 2022; Tai & Chen, 2020). Institutional policies and support structures, including investment in digital

infrastructure and training programs, are crucial for overcoming these barriers and fostering a culture of innovation in EFL teaching (Tlili et al., 2021).

The research also identifies that students experience a high cognitive load during prompt engineering, suggesting a need for teachers to adopt an iterative design process for the effective use of tools like ChatGPT in EFL writing, as discussed by Woo et al. (2024b). Lee et al., (2023a, 2023b) emphasized the need for tailored pedagogical strategies to meet diverse learning needs, highlighting the importance of social contexts, technological advancements, educational settings, and the role of human support.

Moreover, instructional tools need be adapted to local needs and contexts, as emphasized by Utami et al. (2023). Individual experiences of anxiety in using these new tools are also a concern, as highlighted by Jeon (2022). Instructional designers need to consider learners'multimodal learning styles to design effective multimodal cues (Lin et al., 2022) and teachers' perceptions, knowledge, and behavioral intention (An et al., 2023) that foster positive affective behaviours in language learning.

Finally, the review notes the challenges of lacking interactivity (Jeon & Lee, 2023), ethical considerations like student privacy (Lee et al., 2023a, 2023b) and the potential for easy distraction (Tai et al., 2020) associated with the AI-based instructional tools.

These challenges underscore the necessity for a comprehensive approach that includes experiential learning for teachers, iterative design processes, context-specific tool adaptation, anxiety mitigation, and consideration of multimodal learning styles to effectively integrate AI into EFL education.

Implications for Practice, Policies, and Research

The review highlights the potential of AI in improving EFL learning outcomes, emphasizing the need for effective professional development programs to equip teachers with the necessary skills and confidence to effectively integrate AI tools into their teaching practices.

Policymakers must invest in infrastructure, promote digital literacy, and ensure equitable access to AI technologies in educational institutions. Collaboration among stakeholders is crucial to maximize AI's potential in EFL education, while addressing challenges.

Future research should explore AI's role in adaptive learning, student engagement, ethical concerns, teacher training, data privacy, and bridging the digital divide. Key areas include AI's long-term effects on language learning, its influence on teaching roles and pedagogies, impacts on younger learners, and varying outcomes across proficiency levels.

Limitations

A limitation of this systematic review is the relatively small number of studies included, with only 22 empirical studies examined. This limits the breadth of the findings and may affect their generalizability. Additionally, the focus of

the reviewed studies is heavily concentrated on Southeast Asian contexts, which may not fully represent the diversity of language learning environments in other regions. Cultural and contextual factors in these regions, such as educational practices and access to technology, could influence the applicability of the findings to other parts of the world. Further research in different geographic and cultural contexts would help strengthen the generalizability of the results.

Conclusion

In conclusion, this systematic review highlights the transformative role of AI in enhancing school-based EFL teaching. AI-driven tools personalize learning, improve language proficiency, and expand access to innovative resources like adaptive platforms, virtual reality, and interactive apps, enriching the EFL experience for school students. AI's transformative impact on language learning spans all three domains of Bloom's Taxonomy. The review highlights the need for ongoing teacher training to adapt strategies, interpret AI data, new roles, and address ethical issues like data privacy and bias. Overall, the study underscores the need for strategic implementation, continuous research, and ethical considerations in harnessing AI's potential to transform EFL pedagogy. By embracing AI-enabled teaching approaches, schools can create more adaptive, engaging, and effective learning environments that prepare students for success in a technologically advanced world.

Acknowledgements We would like to express our sincere gratitude to the Institute for Educational Research and Policy, and its dedicated school research team members for their invaluable support in our study. Their collaboration and insights have significantly contributed to the success of this research.

Author Contribution The first author led the research, designing, conducting methods, analyzing, developing a framework, and writing the manuscript, with the second author contributing to planning, results discussion, and manuscript proofreading.

Funding This research was funded by the *Institute for Educational Research and Policy, Bankura, India* under the grant vide letter no. 10/2023, dated 15 th October 2023.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Ethics Approval There were no human subjects involved in this secondary literature survey research. Nevertheless, the Ethics Review Board of *Institute for Educational Research and Policy* supervised ethical issues.

Conflict of Interests The authors declare that no potential conflicts of interest exist in the writing and publication of this article.

References

Agustini, N. P. O. (2023). Examining the Role of ChatGPT as a Learning tool in Promoting Students' English Language Learning Autonomy relevant to Kurikulum Merdeka Belajar. *Edukasia: Jurnal Pendidikan Dan Pembelajaran, 4*(2), 921–934. https://doi.org/10.62775/edukasia.v4i2.373.

Alahi, M. E. E., Sukkuea, A., Tina, F. W., Nag, A., Kurdthongmee, W., Suwannarat, K., & Mukhopadhyay, S. C. (2023). Integration of IoT-Enabled Technologies and Artificial Intelligence (AI) for Smart City Scenario: Recent Advancements and Future Trends. *Sensors, 23*, 5206. https://doi.org/10.3390/s23115206

Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Social Sciences & Humanities Open, 8*(1), 100532. https://doi.org/10.1016/j.ssaho.2023.100532

An, X., Chai, C., Li, Y., et al. (2023). Modeling English teachers' behavioral intention to use artificial intelligence in middle schools. *Education and Information Technologies, 28*, 5187–5208. https://doi.org/10.1007/s10639-022-11286-z

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Longman.

Baskara, F. R., & Mukarto, F. X. (2023). Exploring the implications of Chat GPT for language learning in higher education. *Indonesian Journal of English Language Teaching and Applied Linguistics, 7*, 343–358. https://eric.ed.gov/?id=EJ1391490.

Chen, Y., & Zhao, H. (2024). The Role of AI in Primary and Secondary EFL Education: A Systematic Review. *Educational AI Research Journal, 9*(3), 201–218.

Chiu, T. K. F. (2023). The impact of Generative AI (GenAI) on practices, policies and research direction in education: a case of ChatGPT and Midjourney. *Interactive Learning Environments*, 1–17. https://doi.org/10.1080/10494820.2023.2253861

Crehan, L. (2016). *Cleverlands: The secrets behind the success of the world's education superpowers*. HarperCollins.

Divekar, R. R., Drozdal, J., Chabot, S., Zhou, Y., Su, H., Chen, Y., et al. (2022). Foreign language acquisition via artificial intelligence and extended reality: Design and evaluation. *Computer Assisted Language Learning, 35*, 2332–2360. https://doi.org/10.1080/09588221.2021.1879162

Ghamrawi, N., Shal, T., & Ghamrawi, N. A. (2024). Exploring the impact of AI on teacher leadership: Regressing or expanding? *Education and Information Technologies, 29*, 8415–8433. https://doi.org/10.1007/s10639-023-12174-w

Hadi, M. S., & Junor, R. S. (2022). Speaking to devices: Can we use Google assistant to Foster Students' speaking skills? *Journal of Languages and Language Teaching, 10*(4), 570–578. https://doi.org/10.33394/jollt.v10i4.5808

Han, D. E. (2020). The Effects of Voice-based AI Chatbots on Korean EFL Middle School Students' Speaking Competence and Affective Domains. *Asia-pacific Journal of Convergent Research Interchange, 6*(7), 71–80. https://doi.org/10.47116/apjcri.2020.07.07

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Center for Curriculum Redesign.

Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial Intelligence for Assessment and Feedback to Enhance Student Success in Higher Education. *Mathematical Problems in Engineering, 1*, 1–19. https://doi.org/10.1155/2022/5215722

Hsu, T. C., Chang, C., & Jen, T. H. (2023). Artificial intelligence image recognition using self-regulation learning strategies: effects on vocabulary acquisition, learning anxiety, and learning behaviours of English language learners. *Interactive Learning Environments 1*–19. https://doi.org/10.1080/10494820.2023.2165508

Jeon, J. (2022). Exploring AI chatbot affordances in the EFL classroom: Young learners' experiences and perspectives. *Computer Assisted Language Learning, 37*(1–2), 1–26. https://doi.org/10.1080/09588221.2021.2021241

Jeon, J. (2023). Chatbot-assisted dynamic assessment (CA-DA) for L2 vocabulary learning and diagnosis. *Computer Assisted Language Learning, 36*(7), 1338–1364. https://doi.org/10.1080/09588221.2021.1987272

Jeon, J., & Lee, S. (2023). Large language models in education: A focus on the complementary relationship between human teachers and ChatGPT. *Education and Information Technologies, 28*(12), 15873–15892. https://doi.org/10.1007/s10639-023-11834-1

Junaidi, B. H., Julita, K., Rahman, F., & Derin, T. (2020). Artificial intelligence in EFL context: Rising students' speaking performance with Lyra virtual assistance. *International Journal of Advanced Science and Technology Rehabilitation, 29*(5), 6735–6741. https://doi.org/10.3969/j.issn.2005-4238.2020.29.005

Kirkpatrick, A., & Sussex, R. (2012). *English as an International Language in Asia: Implications for Language Education*. Springer.

Kohn, K., & Hoffstaedter, P. (2017). Learner agency and non-native speaker identity in pedagogical lingua franca conversations: Insights from intercultural tele collaboration in foreign language education. *Computer Assisted Language Learning, 30*(5), 351–367. https://doi.org/10.1080/09588221.2017.1304966

Kundu, A., Bej, T., & Rice, M. (2020). Time to engage: Implementing math and literacy blended learning routines in an indian elementary classroom. *Education and Information Technologies, 26*, 1201–1220. https://doi.org/10.1007/s10639-020-10306-0

Kundu, A., & Betal, A. K. (2022). Indian EFL teachers' reflections on sudden E-adoption vis-a-vis COVID-19. *International Journal of Technology Diffusion, 13*(1), 1–15. https://doi.org/10.4018/IJTD.317114

Kundu, A., & Bej, T. (2024a). A moderated mediation model of the relationship between Indian elementary school teachers' autonomy and perceived ease of ICT use. *Future in Educational Research, 2*(3). https://doi.org/10.1002/fer3.42

Kundu, A. & Bej, T. (2024b). Psychological impacts of AI use on school students: A systematic scoping review of the empirical literature. *Research and Practice in Technology Enhanced Learning, 20*, 030. https://doi.org/10.58459/rptel.2025.20030

Kurni, M., Mohammed, M.S., spsampsps Srinivasa, K.G. (2023). Natural Language Processing for Education. In *A Beginner's Guide to Introduce Artificial Intelligence in Teaching and Learning*. Springer. https://doi.org/10.1007/978-3-031-32653-0_3

Lee, S., & Jeon, J. (2022). Visualizing a disembodied agent: Young EFL learners' perceptions of voice-controlled conversational agents as language partners. *Computer Assisted Language Learning*, 1–26. https://doi.org/10.1080/09588221.2022.2067182

Lee, D., Kim, Hh., & Sung, S. H. (2023a). Development research on an AI English learning support system to facilitate learner-generated-context-based learning. *Educational Technology Research and Development, 71*, 629–666. https://doi.org/10.1007/s11423-022-10172-2

Lee, J. H., Shin, D., & Noh, W. (2023b). Artificial intelligence-based content generator technology for young English-as-a-foreign-language learners' reading enjoyment. *RELC Journal, 54*(2), 508–516. https://doi.org/10.1177/00336882231165060

Li, Q., & Chan, K. K. (2024). Test takers' attitudes of using exam-oriented mobile application as a tool to adapt in a high-stakes speaking test. *Education and Information Technologies, 29*(1), 219–237. https://doi.org/10.1007/s10639-023-12297-0

Lin, V., Yeh, H. C., Huang, H. H., & Chen, N. S. (2022). Enhancing EFL vocabulary learning with multimodal cues supported by an educational robot and an IoT-Based 3D book. *System, 104*, 102691. https://doi.org/10.1016/j.system.2021.102691

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An Argument for AI in Education*. Pearson Education.

Maxwell, J. A. (2013). *Qualitative Research Design: An Interactive Approach*. Sage.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Neumann, M., Niessen, A. S. M., & Meijer, R. R. (2023). Predicting decision-makers' algorithm use. *Computers in Human Behavior, 145*, 1–9. https://doi.org/10.1016/j.chb.2023.107759

OECD (2015). *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing. https://doi.org/10.1787/9789264239012-en.

Ouzzani, M., Hammady, H., Fedorowicz, Z., et al. (2016). Rayyan—a web and mobile app for systematic reviews. *Systematic Reviews, 5*, 210. https://doi.org/10.1186/s13643-016-0384-4

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical research ed.)*, *372*, n71. https://doi.org/10.1136/bmj.n71

Qiao, H., & Zhao, A. (2023). Artificial intelligence-based language learning: Illuminating the impact on speaking skills and self-regulation in Chinese EFL context. *Frontiers in Psychology, 14*, 1255594. https://doi.org/10.3389/fpsyg.2023.1255594

Rao, P. S. (2019). The role of English as a global language. *Research Journal of English, 4*(1), 65–79. https://www.rjoe.org.in/Files/vol4issue1/new/OK%20RJOE-Srinu%20sir(65-79).pdf.

Richards, J. C., & Rodgers, T. S. (2014). *Approaches and methods in language teaching* (3rd ed.). Cambridge University Press.

Su, Y., Lin, Y., & Lai, C. (2023). Collaborating with chat GPT in argumentative writing classrooms. *Assessing Writing, 57*, 100752. https://doi.org/10.1016/j.asw.2023.100752

Sun, Z., Anbarasan, M., & Praveen Kumar, D. J. C. I. (2021). Design of online intelligent English teaching platform based on artificial intelligence techniques. *Comput. Intell., 37*, 1166–1180. https://doi.org/10.1111/coin.12351

Tai, T. Y. (2022). Effects of intelligent personal assistants on EFL learners' oral proficiency outside the classroom. *Computer Assisted Language Learning*, 1–30. https://doi.org/10.1080/09588221.2022.2075013

Tai, T. Y., & Chen, H. H. (2020). The impact of Google Assistant on adolescent EFL learners' willingness to communicate. *Interactive Learning Environments, 31*, 1–18. https://doi.org/10.1080/10494820.2020.1841801

Tai, T. Y., & Chen, H. H. J. (2022). The impact of intelligent personal assistants on adolescent EFL learners' listening comprehension. *Computer Assisted Language Learning, 37*(3), 433–460. https://doi.org/10.1080/09588221.2022.2040536

Tai, T. Y., Chen, H. H. J., & Todd, G. (2020). The impact of a virtual reality app on adolescent EFL learners' vocabulary learning. *Computer Assisted Language Learning, 35*(4), 892–917. https://doi.org/10.1080/09588221.2020.1752735

Tlili, A., Hattab, S., Essalmi, F., Chen, N., Huang, R., Kinshuk, Chang, M., & Burgos, D. (2021). A smart collaborative educational game with learning analytics to support English vocabulary teaching. *International Journal of Interactive Multimedia and Artificial Intelligence, 6*(6), 215–224. https://doi.org/10.9781/ijimai.2021.03.002

Utami, S. P. T., Andayani, Winarni, R., & Sumarwati. (2023). Utilization of artificial intelligence technology in an academic writing class: How do Indonesian students perceive? *Contemporary Educational Technology, 15*(4), 450. https://doi.org/10.30935/cedtech/13419

Wang, Y., & Xue, L. (2024). Using AI-driven chatbots to foster Chinese EFL students' academic engagement: An intervention study. *Computers in Human Behavior*, 108353. https://doi.org/10.1016/j.chb.2024.108353

Wang, X., & Wang, S. (2024). Exploring Chinese EFL learners' engagement with large language models: A self-determination theory perspective. *Learning and Motivation, 87*, 102014. https://doi.org/10.1016/j.lmot.2024.102014

Warschauer, M. (2013). The digital divide and the future of language education. *Language Learning & Technology, 17*(1), 3–11. https://doi.org/10.1016/j.chb.2012.10.020

Wei, L. (2023). Artificial intelligence in language instruction: Impact on English learning achievement, L2 motivation, and self-regulated learning. *Frontiers in Psychology, 14*, 1261955. https://doi.org/10.3389/fpsyg.2023.1261955

Woo, D. J., Susanto, H., & Guo, K. (2023). EFL Students' Attitudes and Contradictions in a Machine-in-the-loop Activity System. *arXiv preprint* arXiv:2307.13699. *https://doi.org/10.48550/arXiv.2307.13699*

Woo, D. J., Susanto, H., Yeung, C. H., Guo, K., & Fung, A. K. Y. (2024a). Exploring AIGenerated text in student writing: How does AI help? *Language Learning & Technology, 28*(2), 183–209. https://hdl.handle.net/10125/73577.

Woo, D. J., Wang, D., Guo, K., et al. (2024b). Teaching EFL students to write with ChatGPT: Students' motivation to learn, cognitive load, and satisfaction with the learning process. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-12819-4

Xu, X., Dugdale, D. M., Wei, X., & Mi, W. (2022). Leveraging artificial intelligence to predict young learner online learning engagement. *Am. J. Dist. Educ., 37*, 185–198. https://doi.org/10.1080/08923647.2022.2044663

Yang, L., & Zhao, S. (2024). AI-induced emotions in L2 education: Exploring EFL students' perceived emotions and regulation strategies. *Computers in Human Behavior, 159*, 108337. https://doi.org/10.1016/j.chb.2024.108337

Yang, Y.-F., Tseng, C. C., & Lai, S.-C. (2024). Enhancing teachers' self-efficacy beliefs in AI-based technology integration into English speaking teaching through a professional development program. *Teaching and Teacher Education, 144*, 104582. https://doi.org/10.1016/j.tate.2024.104582

Yongjun, X., et al. (2021). Artificial intelligence: A powerful paradigm for scientific research. *The Innovation, 2*(4), 100179. https://doi.org/10.1016/j.xinn.2021.100179

Zhang, R., & Zou, D. (2020). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Comput. Assist. Lang. Learn., 33*, 1–47. https://doi.org/10.1080/09588221.2020.1744666

Zhang, Z., & Huang, X. (2024). The impact of chatbots based on large language models on second language vocabulary acquisition. *Heliyon, 10*(3), e25370. https://doi.org/10.1016/j.heliyon.2024.e25370