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AI in School EFL Learning: A Systematic Review of Impact Pathways for Engagement, Achievement, and Satisfaction

Arnab Kundu , Tripti Bej 

Institute for Educational Research and Policy, Bankura, India

ABSTRACT

Background: Artificial Intelligence (AI) is increasingly integrated into school-based English as a Foreign Language (EFL) instruction, yet the mechanisms through which it shapes learners' engagement, achievement, and satisfaction remain insufficiently theorised. Although prior studies report positive effects, they rarely explain how AI influences learning processes within authentic classroom conditions.

Purpose: This systematic review synthesizes empirical evidence to explain how and under what conditions AI technologies shape engagement, achievement, and satisfaction in school EFL contexts. Specifically, it aims to identify the mediating cognitive, affective, and behavioural mechanisms through which AI operates, examine contextual moderators influencing its effectiveness, and develop an integrative AI Impact Pathways Framework to guide theory-driven research and context-sensitive pedagogical design.

Method: A comprehensive search across seven databases yielded 99 records; following PRISMA 2020 procedures, 23 empirical studies involving direct AI use by K–12 EFL learners were retained. Thematic synthesis was employed to identify cross-study patterns and inductively develop a multi-pathway explanatory framework.

Findings: AI tools—including NLP-based feedback systems, intelligent tutoring systems, conversational agents, gamified applications, and adaptive learning platforms—enhanced engagement by increasing interactivity, reducing anxiety, and sustaining time-on-task. Achievement gains were associated with personalised scaffolding, iterative feedback loops, and opportunities for authentic language use across speaking, reading, writing, and vocabulary learning. Satisfaction improved when AI supported autonomy, emotional reassurance, and perceptions of usefulness. Three interrelated pathways—cognitive, affective, and behavioural—mediated these outcomes, while teacher readiness, digital infrastructure, cultural–linguistic fit, student digital literacy, and cognitive load served as five significant contextual moderators.

Implications: The review advances theoretical understanding by proposing the AI Impact Pathways Framework in School EFL Learning, which clarifies how AI affordances interact with pedagogical processes and contextual conditions to shape learner outcomes. The findings provide guidance for designing equitable, context-sensitive AI integration in schools and highlight the need for longitudinal, cross-cultural, and theory-driven research.

KEYWORDS

Artificial Intelligence; EFL Learning; engagement; academic achievement; learning satisfaction; impact pathways; school education; systematic review

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Correspondence:

Arnab Kundu,
arnabkundu5@gmail.com

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INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) has catalysed substantial changes in education systems worldwide, reshaping instructional design, learner support, and assessment practices (Li &

Chan, 2024). Within English as a Foreign Language (EFL) education, AI technologies, including intelligent tutoring systems, natural language processing (NLP) applications, conversational agents, and automated speech recognition, are increasingly recognised for their potential to enhance instructional adaptability,

interaction quality, and the development of core communicative competencies (Kundu & Bej, 2025a; Wang & Xue, 2024; Chiu, 2023). As these tools become more prevalent in schools, understanding how they shape learner experiences and outcomes has become a pressing research priority.

Longstanding challenges in school EFL classrooms, such as limited opportunities for individualisation, delayed feedback, and difficulty sustaining learner motivation, have been well documented (Kundu & Bej, 2025b; Kundu, 2025). AI offers promising responses by enabling personalised learning pathways, real-time feedback, adaptive practice opportunities, and low-anxiety environments for oral and written production (Li & Chan, 2024; Hsu et al., 2023). Emerging evidence suggests that such AI-supported conditions can improve student participation, accuracy, fluency, and overall learning attitudes (Kundu & Bej, 2025c; Wang & Wang, 2024; Al-Ansi et al., 2023).

Yet despite these developments, the integration of AI in school-based EFL contexts remains uneven and insufficiently theorised. Much of the existing evidence comes from higher education and commercial platforms, offering limited insight into how AI operates within the pedagogical, infrastructural, and sociocultural conditions of primary, middle, and secondary schools (Neumann et al., 2023; Tai, 2022; Kohn & Hoffstaedter, 2017). Meanwhile, studies consistently highlight barriers to implementation, including inadequate teacher preparedness, infrastructural disparities, student digital literacy gaps, and cultural-linguistic misalignment (Kundu et al., 2025; Ghamrawi, Shal & Ghamrawi, 2024; Su, Lin & Lai, 2023).

A critical blind spot concerns impact pathways—the pedagogical, cognitive, affective, behavioural, and contextual mechanisms through which AI produces its effects on learner engagement, achievement, and satisfaction. Understanding these pathways is vital for school EFL pedagogy, as the effectiveness of AI depends not on the technology alone but on how learners interpret AI-driven feedback, how teachers orchestrate AI-supported tasks, and how contextual conditions enable or constrain their use. Without a pathway-level explanation, schools risk adopting AI tools in ways that do not translate into meaningful learning gains and may inadvertently reinforce existing inequalities.

To address these gaps, this systematic review synthesises empirical evidence on AI use in school-level EFL education, with a specific focus on how AI influences student engagement, academic achievement, and learning satisfaction through mediating mechanisms and contextual moderators. By analysing pedagogical, technological, and contextual patterns across diverse school settings, the review advances theoretical understanding of how AI mediates learning processes and identifies the conditions necessary for effective and equitable implementation. These insights provide guidance for teachers, school leaders, policymakers,

and researchers seeking to leverage AI in ways that support both pedagogical innovation and learner wellbeing. Guided by this objective, the study addresses the following research questions:

- RQ1: What types of AI technologies and tools are used in school-based EFL teaching?
- RQ2: How does AI influence students' engagement in EFL learning?
- RQ3: What impact do AI applications have on students' academic achievement?
- RQ4: How does AI shape students' learning satisfaction in school EFL contexts?
- RQ5: What mediating mechanisms and contextual moderators constitute the impact pathways of AI-supported EFL learning in schools?

LITERATURE REVIEW

AI Impacts on Different Learning Dimensions of EFL

Artificial Intelligence has rapidly expanded its role in EFL education, with a strong body of empirical evidence demonstrating improvements across multiple language-learning dimensions. AI-supported tools, including conversational agents, Natural Language Processing (NLP) applications, automated writing evaluators, speech-recognition systems, intelligent tutoring systems (ITS), and adaptive learning platforms, have been found to enhance speaking, reading, writing, and vocabulary acquisition. Studies indicate that AI promotes speaking fluency and pronunciation accuracy through dialogic interactions, low-anxiety practice environments, and instantaneous oral feedback (Kundu & Bej, 2025b, Hadi & Junor, 2022; Han, 2020). Reading comprehension improves when AI-generated or AI-curated texts align with learners' proficiency levels, enabling more personalised engagement with texts (Lee, Shin & Noh, 2023). Similarly, AI-supported writing tools support writing fluency and accuracy by providing real-time corrective feedback, structural scaffolding, and iterative revision guidance (Woo et al., 2024; Utami et al., 2023). Vocabulary learning is strengthened through adaptive repetition, multimodal cues, and dynamic assessment, which facilitate deeper retention and flexible application (Zhang & Huang, 2024; Jeon, 2023; Lin et al., 2022). Across these learning dimensions, AI consistently enhances engagement, achievement, and satisfaction, suggesting its potential as a transformative instructional resource in school-based EFL contexts.

Pedagogy as the Mediator of AI's Influence

Although AI provides powerful instructional affordances, its role in school EFL learning is best understood as *supportive rather than enabling*. AI tools rarely function as autonomous

drivers of learning; instead, they operate as pedagogical supports whose impact depends on how teachers integrate them within instructional practices (Kundu & Bej, 2025b). AI does not automatically improve learning; rather, its influence is mediated through pedagogical decisions that shape how learners engage with, interpret, and act upon AI-generated inputs. This distinction underpins the present study's use of the term *AI-supported EFL learning*, which reflects empirical evidence that AI augments existing pedagogical processes instead of constituting the primary condition that enables learning. Research consistently shows that personalised scaffolding, adaptive task sequencing, feedback loops, collaborative meaning-making, and multimodal instructional designs are central to translating AI's technical affordances into meaningful learning opportunities (Kundu & Bej, 2025c; Su, Lin & Lai, 2023; Tai & Chen, 2020). For example, conversational agents increase engagement not inherently, but only when teachers design tasks that purposefully structure iterative speaking practice and reflective interaction (Jeon & Lee, 2023). Automated writing evaluators enhance writing development when their feedback is pedagogically embedded within guided drafting, revision, and teacher-led feedback cycles rather than used in isolation (Woo et al., 2024). Similarly, vocabulary-learning tools are effective when integrated into rich instructional contexts that emphasise meaningful use, semantic networks, and contextual reinforcement, rather than surface-level recognition alone (Jeon, 2023). These patterns indicate that AI functions as a pedagogical support and mediating artefact rather than an enabling or deterministic force. Thus, pedagogy operates as the primary mechanism through which AI's technical affordances are transformed into learning affordances, shaping learners' cognitive (e.g., processing and strategy use), affective (e.g., motivation and anxiety), and behavioural (e.g., participation and persistence) processes that ultimately lead to improved student engagement, achievement, and satisfaction (Kundu & Bej, 2025a).

Context as the Catalyst that Shapes AI Impact

AI-mediated learning takes place within the complex ecosystem of school environments, where contextual conditions significantly influence students' experiences and outcomes. Studies consistently show that infrastructure, teacher readiness, student digital literacy, and cultural-linguistic appropriateness critically shape the implementation and success of AI tools (Kundu et al., 2025; Ghamrawi et al., 2024; Su, Lin & Lai, 2023). For instance, inadequate bandwidth or device availability can undermine the benefits of speech-recognition tools or VR-based applications (Zhang & Huang 2024). Teachers lacking AI-related pedagogical knowledge (AI-TPK) may struggle to integrate AI feedback into instruction, limiting students' ability to interpret automated assessments (Celik, 2022). Students with low digital literacy may experience heightened cognitive load or emotional discomfort, reducing engagement and satisfaction (Woo et al., 2024). Likewise, tools not aligned with learners' linguistic or cultur-

al contexts can create misrecognition errors or disengagement (Jeon, 2022). The evidence indicates that context does not merely enable or constrain AI use; rather, it can "catalyse" or dampen the pathways through which AI produces its effects. Effective AI integration therefore requires not only technological capacity but also pedagogical and socio-cultural alignment.

Research Gap

Although existing studies consistently show that AI enhances multiple dimensions of EFL learning, including speaking, reading, writing, and vocabulary, the mechanisms that generate these improvements remain insufficiently theorised, particularly in school settings. Most research reports positive outcomes without explaining how AI affordances interact with classroom pedagogy and school conditions to shape engagement, achievement, and satisfaction. Little is known about how teachers mediate AI outputs, how learners interpret and respond to AI feedback, or how contextual factors such as infrastructure, teacher readiness, and digital literacy enable or hinder AI's influence. As a result, the field lacks an integrated explanation of why AI works in some classrooms but not others and how its benefits materialise across diverse school environments. This review addresses this gap by examining not only whether AI improves learning, but how, why, and under what conditions its impact emerges—providing the pathway-level understanding needed for effective and equitable AI integration in school EFL pedagogy.

Conceptual Framework

To address the identified theoretical gap, this study proposes the AI Impact Pathways Framework, which serves both as an analytic lens and an integrative outcome of the systematic review. The framework guides the synthesis of empirical findings by organising how AI influences school-based EFL learning through the interaction of technological affordances, pedagogical mediation, and contextual conditions. During the review process, AI tools, including NLP-based feedback systems, intelligent tutoring systems, conversational agents, and adaptive learning platforms, were examined in terms of the instructional affordances they provide, such as personalised feedback, multimodal input, and opportunities for authentic language use. The framework enabled the review to systematically trace how these affordances are transformed into learning outcomes through pedagogical processes, including scaffolding, structured practice, feedback integration, and learner participation. The framework also structured the identification of contextual moderators, such as digital infrastructure, teacher expertise, students' digital literacy, and cultural-linguistic fit, that explain variability in reported outcomes across studies. By foregrounding these moderators, the framework helps explain why similar AI tools produce divergent effects across school contexts, moving the review beyond outcome

aggregation toward mechanism-based explanation. As an outcome of the synthesis, the AI Impact Pathways Framework provides a coherent, theory-informed explanation of how AI’s potential is realised in school EFL environments. It clarifies the mediating cognitive, affective, and behavioural pathways linking AI use to learner engagement, academic achievement, and learning satisfaction. In doing so, the framework strengthens the review’s explanatory power, supports principled interpretation of heterogeneous findings, and offers a grounded basis for designing effective, equitable, and context-sensitive AI-supported EFL pedagogy, as well as for guiding future empirical research.

METHOD

Research Design

This study adopted a qualitative hermeneutic systematic review design to enable an interpretive, context-sensitive synthesis of empirical evidence on AI use in school-based EFL learning. A hermeneutic approach is well suited to reviews that aim to uncover the *processes* and *mechanisms* through which educational interventions exert influence, as it emphasises iterative interpretation, contextualisation, and the integration of researcher judgement (Chang, 2022). In educational research, hermeneutic enquiry facilitates deeper understanding of how pedagogical intentions, learner experiences, and technological affordances interact to shape teaching and learning (Lueger & Vettori, 2015). Aligned with the *Frascati Manual* classification¹, this study constitutes applied research, synthesising existing evidence to generate new theoretical and pedagogical insights into AI-supported EFL learning in K-12 contexts.

Search Strategy

A systematic search was conducted across seven major databases, namely Scopus, Google Scholar, PsycInfo, PubMed,

Web of Science, ScienceDirect, and ERIC, to identify empirical studies investigating AI use in school-based EFL instruction. Boolean operators (e.g., AI AND EFL AND school; AI OR artificial intelligence AND language learning) were applied to ensure both precision and breadth. The initial search returned 99 records. All citations were imported into *Rayyan*, which supported duplicate detection and initial screening (Ouzzani et al., 2016). After removing 41 duplicates, 58 studies underwent title and abstract screening. Eleven were excluded for not addressing AI-supported school EFL pedagogy. A full-text review of 47 articles was then performed using predefined inclusion and exclusion criteria. Ultimately, 23 empirical studies published between January 2020 and March 2025 were retained. Focusing on recent literature ensured coverage of contemporary AI developments, pedagogical innovations, and evolving policy contexts (Hooda et al., 2022; Luckin et al., 2016).

Inclusion and Exclusion Criteria

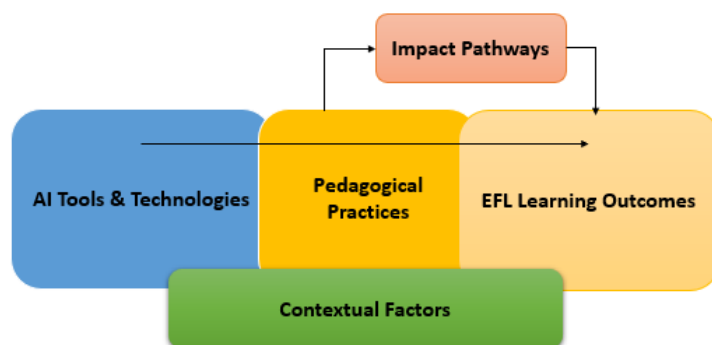
Studies were eligible if they met the criteria summarised in Table 1. Only peer-reviewed empirical studies focusing on AI-supported EFL learning in K-12 school contexts were included. Non-empirical papers, reviews, editorials, and studies centred on higher or adult education were excluded. Full-text availability in English was required.

Data Extraction

A structured four-stage data-extraction procedure was employed. First, study characteristics were recorded, including authorship, publication year, country, school level (primary, middle, or secondary), and research design. Second, AI tools and technologies were documented through the categorisation of applications such as conversational agents, natural language processing systems, virtual reality environments, intelligent tutoring systems, and AI-assisted writing tools. Third, pedagogical approaches and learning processes were extracted with attention to teaching strategies, personalisa-

Figure 1

AI Impact Pathways Framework



¹ 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>

tion mechanisms, feedback formats, task types, and interactional structures. Fourth, learning outcomes and contextual factors were captured, including effects on engagement, achievement, and learner satisfaction, as well as moderating conditions such as infrastructure, teacher readiness, and cultural-linguistic fit. Extracted data were organised into comparative tables to support cross-study interpretation. Using a hermeneutic synthesis approach, findings were interpreted iteratively to identify convergences, contradictions, and emerging conceptual patterns. This method was particularly appropriate for theorising the AI Impact Pathways Framework by integrating diverse empirical insights.

PRISMA Flow Process

Study selection followed the PRISMA 2020 guidelines (Page et al., 2021) to ensure transparency and replicability. In the

identification stage, 99 records were retrieved from seven databases. During screening, 41 duplicates were removed and 11 studies were excluded on the basis of title and abstract. The eligibility assessment comprised 47 full-text articles, of which 24 were excluded due to a non-empirical focus (n=13), non-English language (n=3), inaccessibility (n=2), insufficient methodological detail (n=3), or limited pedagogical relevance (n=3). Ultimately, 23 studies met all inclusion criteria and were retained for synthesis.

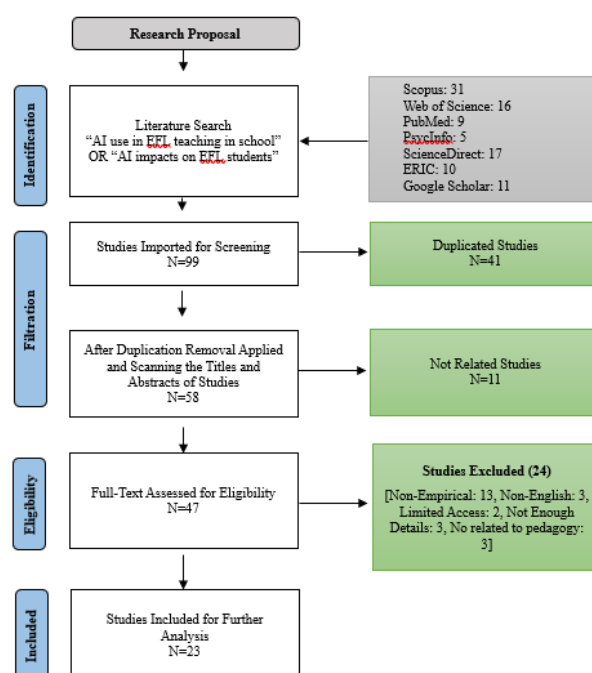
RESULTS

Guided by the *AI Impact Pathways Framework* (Figure 1), the 23 reviewed studies were synthesized across four analytical dimensions: (1) AI tools and affordances, (2) pedagogical practices and mediating mechanisms, (3) learner outcomes (engagement, achievement, and satisfaction, and (4) con-

Table 1
Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Article Topic	AI use in school-based EFL teaching/learning	AI used in non-school contexts
Article Type	Empirical studies	Editorials, reviews, commentaries, conference abstracts
Publication Status	Published, peer-reviewed	Unpublished, preprints, under review
Availability	Full-text accessible online	Not accessible
Language	English	Non-English
Population	K-12 learners	Higher education, adult learners
Focus	AI-supported EFL tools, strategies, outcomes	Not related to AI in school EFL contexts

Figure 2
PRISMA Flow Diagram of Study Selection Process



textual moderators shaping impact pathways) (Table 2). The studies were conducted primarily in East and Southeast Asia (South Korea, Taiwan, China, Indonesia, Hong Kong), reflecting regional momentum in AI-supported language education. They spanned preschool (n=1), elementary (n=11), and secondary schooling (n=11), capturing variation across developmental stages and curricular conditions. Across this diverse evidence base, five coherent themes emerged that map directly onto the research questions and extend existing literature by clarifying *how* AI operates in school EFL settings.

AI Tools and Technologies

Across the studies, AI technologies included conversational agents, voice assistants (e.g., Google Assistant, EchoDot), VR applications, educational robots, intelligent tutoring systems, NLP-driven writing tools, AI content generators, and adaptive learning platforms (Table 3). Despite technological diversity, three pedagogical affordances were consistent: (a) personalisation, via adaptive task sequencing and diagnostic feedback; (b) interactivity, through conversational practice, immersion, and multimodal engagement; and (c) feedback richness, delivered instantaneously and often with fine-grained linguistic detail. These affordances activated the cognitive, affective, and behavioural pathways within the Impact Framework. For example, adaptive vocabulary repetition (Zhang & Huang, 2024; Jeon, 2023) engaged cognitive pathways through improved encoding; conversational agents reduced affective barriers to participation (Hadi & Junor, 2022; Han, 2020); and multimodal robotics systems sustained behavioural engagement (Lin et al., 2022). These findings refine earlier claims that AI merely “personalises learning” by demonstrating *how* personalisation is experienced in school settings through iterative feedback loops, tailored prompts, and context-sensitive scaffolds.

AI’s Influence on Engagement

Across the studies summarised in Table 4, a range of AI tools supported student engagement in different ways. In Han (2020), the EchoDot chatbot increased learners’ willingness to speak by reducing anxiety. Immersive VR tasks in Tai, Chen and Todd (2020) fostered high enjoyment, while Google Assistant in Tai and Chen (2020) enhanced participation through interactive game-based activities. Gamified vocabulary learning in Tlili et al. (2021) sustained students’ attention and motivation, and Google Assistant again supported active speaking in Hadi and Junor (2022) by building confidence. Multimodal cues provided by the robot and IoT 3D book in Lin et al. (2022) increased oral interaction, whereas the Google Nest Hub/Mini in Tai and Chen (2022) made listening tasks more enjoyable and engaging. Dialog-flow chatbots in Jeon (2022) encouraged active participation through continued dialogue cycles, and voice-controlled agents in Lee and Jeon (2022) supported socio-emotional engagement. ChatGPT in Agustini (2023) facilitated collabora-

tive dialogue that heightened learner involvement, while ChatGPT in Jeon and Lee (2023) deepened participation through teacher-AI co-scaffolding. AI-generated reading materials in Lee, Shin and Noh (2023) helped students experience positive reading emotions, and the AI learning support system in Lee, Kim and Sung (2023) promoted self-driven engagement through increased autonomy. Writing tools such as AI-NLG in Woo et al. (2024) reduced disengagement among struggling writers, and ChatGPT in Woo, Wang, Guo et al. (2024) enhanced motivation through prompt-based writing. Frequent interaction with the LLM chatbot in Zhang and Huang (2024) supported incidental vocabulary learning, while AI-mediated instruction in Yang and Zhao (2024) heightened emotional engagement through novelty. Finally, AI-supported speaking tools combined with teacher professional development in Yang, Tseng and Lai (2024) contributed to increased learner confidence and active participation.

AI’s Impact on Academic Achievement

Achievement gains were reported across multiple language skills, including vocabulary development, pronunciation accuracy, speaking fluency, reading comprehension, and writing quality (Table 5). Beyond corroborating these established patterns, the present review contributes a pathway-oriented account of how AI supports achievement outcomes. Across the included studies, three mechanisms consistently emerged. First, real-time feedback loops were enabled by tools such as Lyra Virtual Assistant, Google Assistant, and AI-assisted writing systems, which delivered immediate corrective input and allowed learners to refine their output iteratively (Kim, 2025; Utami et al., 2023; Junaidi et al., 2020). Second, error-awareness mechanisms were facilitated through diagnostic assessment embedded in chatbots and intelligent tutoring systems, strengthening learners’ metalinguistic awareness and supporting more deliberate self-correction (Woo, Susanto, Yeung et al., 2024; Jeon, 2023). Third, adaptive scaffolded practice was realised through gamified vocabulary tasks and multimodal cues, which enhanced comprehensibility and retention by calibrating task difficulty to learners’ proficiency levels (Lin et al., 2022; Tlili et al., 2021).

AI’s Influence on Learning Satisfaction

Learner satisfaction tended to be higher when AI tools alleviated anxiety, provided supportive practice conditions, and enabled greater autonomy with respect to pacing and task selection (Table 6). The evidence suggests that satisfaction is generated through three recurring pathways. First, emotional support was fostered through AI-supported low-stakes speaking opportunities, which reduced fear of negative judgement and encouraged participation (Han, 2020; Hadi & Junor, 2022). Second, cognitive ease was facilitated when feedback was clear and structurally organised and when pacing was adaptively regulated, thereby lowering cognitive load during task completion (Utami et al.,

No.	Study / Country	AI Tools & Technologies	Pedagogical Mediators	Learning Outcomes Observed	Outcome Focus	Impact Pathways	Contextual Moderators
1	Han (2020), South Korea	EchoBot (voice chatbots)	Low-anxiety conversational practice	Speaking fluency, confidence	Engagement & Satisfaction	Affective pathway	+ Motivation ↑; - No data
2	Tai, Chen & Todd (2020), Taiwan	Mondly VR	Immersive VR vocabulary tasks	Vocabulary retention	Engagement	Cognitive pathway	+ Enjoyment ↑; - Distraction
3	Tai & Chen (2020), Taiwan	Google Assistant	Personalised speaking tasks	Speaking & communication	Engagement & Satisfaction	Affective + behavioural	+ Safe practice; - Cultural readiness
4	Juncidi et al. (2020), Indonesia	Lyra Virtual Assistant	Pronunciation & grammar feedback	Speaking accuracy	Achievement	Cognitive pathway	+ Effective tool; - Not reported
5	Tilji et al. (2021), China	AI vocabulary game	Gamified adaptive tasks	Vocabulary performance	Engagement & Achievement	Behavioural pathway	+ Motivation ↑; - Needs institutional support
6	Hadi & Junor (2022), Indonesia	Google Assistant	Scaffolding & self-paced speaking	Speaking fluency	Engagement & Satisfaction	Affective pathway	+ Confidence ↑; - Teacher readiness
7	Lin et al. (2022), Taiwan	Robot + IoT 3D book	Multimodal elicitation cues	Vocabulary learning	Engagement & Achievement	Cognitive + behavioural	+ Multimodal benefits; - Matching learning styles
8	Tai & Chen (2022), Taiwan	Google Nest Hub/Mini	Inquiry-based listening	Listening comprehension	Engagement & Satisfaction	Cognitive pathway	+ Authentic input; - Not reported
9	Jeon (2022), South Korea	Dialogflow chatbot	Task-based dialogues	Speaking proficiency	Engagement & Satisfaction	Behavioural pathway	+ Speaking ↑; - Misrecognition anxiety
10	Lee & Jeon (2022), South Korea	Voice-Controlled Agents	Competency-based speaking	Speaking	Engagement & Achievement	Social-affective	+ Interaction gains; - Digital divide
11	Agustini (2023), Indonesia	ChatGPT	Collaborative drafting	Vocabulary, writing, speaking	Engagement & Achievement	Cognitive pathway	+ Autonomy ↑; - Teacher training needed
12	Jeon (2023), South Korea	Dialogflow	Dynamic assessment for vocabulary	Vocabulary gains	Achievement	Cognitive pathway	+ Effective DA; - Not reported
13	Jeon & Lee (2023), South Korea	ChatGPT	Teacher-AI collaborative mediation	Interaction quality, ethics awareness	Engagement & Satisfaction	Pedagogical pathway	+ Better pedagogical decisions; - Need AI expertise
14	Lee, Shin & Noh (2023), South Korea	AI content generator	Personalised reading support	Reading enjoyment	Engagement & Satisfaction	Affective pathway	+ Positive effect; - Infrastructure issues
15	Utami et al. (2023), Indonesia	AI writing software	Drafting & revision scaffolds	Academic writing	Achievement	Cognitive pathway	+ Flexible support; - AI literacy needs
16	Lee, Kim & Sung (2023), South Korea	AI learning support system	Learner-generated contexts	Overall learning experience	Engagement & Satisfaction	Autonomy pathway	+ Autonomy ↑; - Social/tech support required

No.	Study / Country	AI Tools & Technologies	Pedagogical Mediators	Learning Outcomes Observed	Outcome Focus	Impact Pathways	Contextual Moderators
17	An et al. (2023), South Korea	Not specified	AI-supported teaching	Teacher-mediated learning	Engagement & Satisfaction	Pedagogical pathway	+ Teacher intention key; - AI-TPK indirect
18	Woo, Susanto, Yeung et al. (2024), Hong Kong	AI-NLG tools	PBL writing with AI scaffolds	Writing performance	Achievement	Cognitive pathway	+ Helps weaker writers; - Differentiation needed
19	Woo, Wang, Guo et al. (2024), Hong Kong	ChatGPT	Prompt-based collaborative writing	Writing motivation	Engagement & Satisfaction	Cognitive load pathway	+ Motivation ↑; - Cognitive load
20	Zhang & Huang (2024), China	LLM chatbot	PBL vocabulary tasks	Vocabulary retention	Achievement	Behavioural pathway	+ Incidental learning; - Digital divide
21	Yang & Zhao (2024), China	AI-mediated instruction	Blended learning tasks	Emotional & learning experiences	Engagement & Satisfaction	Affective pathway	+ Novelty motivation; - Low AI literacy
22	Yang, Tseng & Lai (2024), Taiwan	AI speaking + PD	PD-supported blended AI teaching	Speaking & teacher efficacy	Engagement & Satisfaction	Pedagogical pathway	+ PD ↑ confidence; - Need transition support
23	Kim (2025), South Korea	AI-assisted learning system	Individualised adaptive learning	English proficiency	Achievement	Cognitive pathway	+ Benefits motivated learners; - Risk of inequity

Table 3*AI Tools Used in the Reviewed Studies and Their Contributions to EFL Learning*

AI Tool Type	Representative Tools / Studies	Key Pedagogical Functions (Mediators)	Contributions to EFL Learning (Outcomes)	Dominant Impact Pathways
1. Chatbots & Conversational Agents	Google Dialogflow (Jeon 2022, 2023); LLM Chatbots (Zhang & Huang 2024); ChatGPT (Agustini 2023; Jeon & Lee 2023)	Conversational scaffolding; dynamic assessment; collaboration support	↑ Speaking fluency, ↑ vocabulary, ↑ confidence, ↑ autonomy	Affective pathway (reduced anxiety), Behavioural pathway (increased practice)
2. Voice-Based Assistants	Google Assistant, Google Nest (Tai & Chen 2020; Hadi & Junor 2022); EchoDot (Han 2020)	Immediate corrective feedback; personalised prompts; low-threat speaking practice	↑ Pronunciation accuracy, ↑ communication confidence, ↑ engagement	Affective + cognitive pathways
3. Virtual Reality (VR) Systems	Mondly VR (Tai, Chen & Todd 2020)	Immersive, contextualised tasks; embodied learning	↑ Vocabulary retention, ↑ motivation, ↑ engagement	Cognitive immersion pathway
4. Educational Robots & IoT Systems	Robot + IoT 3D book (Lin et al. 2022)	Multimodal learning cues; gamified vocabulary elicitation	↑ Vocabulary gains, ↑ oral interaction	Behavioural pathway (time-on-task)
5. Intelligent Tutoring Systems (ITS)	Dynamic assessment chatbots (Jeon 2023); adaptive speaking tutors	Adaptive hints; tailored exercises; error diagnosis	↑ Vocabulary accuracy, ↑ grammar control	Cognitive pathway (diagnosis → correction)
6. AI Writing Tools (NLG / NLP)	AI-NLG tools (Woo et al. 2024); AI-based writing software (Utami et al. 2023)	Automated drafting; revision scaffolds; coherence feedback	↑ Writing quality, ↑ idea development, ↑ satisfaction	Cognitive pathway (iterative refinement)
7. AI Content Generators	AI reading-content generator (Lee, Shin & Noh 2023)	Personalised reading materials; adaptive difficulty	↑ Reading enjoyment, ↑ comprehension	Affective pathway
8. Adaptive Learning Platforms	AI-mediated emotional instruction (Yang & Zhao 2024); AI learning support system (Lee, Kim & Sung 2023)	Personalised pathways; analytics-driven instruction	↑ Autonomy, ↑ engagement, ↑ holistic learning experience	Autonomy pathway
9. Speech-Recognition Tools	LLM chatbot speech tools (Zhang & Huang 2024)	Pronunciation evaluation; real-time correction	↑ Pronunciation accuracy, ↑ fluency	Cognitive pathway (feedback → improvement)

Table 4*AI Tools and Their Contributions to Student Engagement in School-Based EFL Learning*

No.	Study	AI Tools / Technologies	How AI Enhanced Engagement (Mechanisms)	Notes on Constraints
1	Han (2020)	EchoDot (chatbots)	Reduced anxiety → increased willingness to speak	None reported
2	Tai, Chen & Todd (2020)	Mondly VR	Immersive, interactive tasks → high enjoyment	Potential distraction
3	Tai & Chen (2020)	Google Assistant	Interactive games → higher motivation and participation	Cultural readiness required
4	Tlili et al. (2021)	AI vocabulary game	Gamification → sustained attention & motivation	Needs institutional support
5	Hadi & Junor (2022)	Google Assistant	Confidence-building → more active speaking	Teacher readiness issues
6	Lin et al. (2022)	Robot + IoT 3D book	Multimodal cues → increased oral interaction	Must match learner styles
7	Tai & Chen (2022)	Google Nest Hub/Mini	Authentic listening tasks → enjoyment & engagement	None reported

2023; Kim, 2025). Third, experiential value was enhanced by immersive environments and personalised materials

No.	Study	AI Tools / Technologies	How AI Enhanced Engagement (Mechanisms)	Notes on Constraints
8	Jeon (2022)	Dialogflow chatbot	Interactive dialogue cycles → active participation	Anxiety from misrecognition
9	Lee & Jeon (2022)	Voice-controlled agents	Social-affective engagement via anthropomorphic interaction	Digital divide concerns
10	Agustini (2023)	ChatGPT	Collaborative dialogue → higher involvement	Requires teacher training
11	Jeon & Lee (2023)	ChatGPT	Teacher-AI co-scaffolding → deeper participation	Need AI-pedagogical expertise
12	Lee, Shin & Noh (2023)	AI content generator	Positive reading emotions → increased engagement	Infrastructure issues
13	Lee, Kim & Sung (2023)	AI learning support system	Autonomy → self-driven engagement	Requires technical/social support
14	Woo et al. (2024)	AI-NLG writing tools	Writing support → reduced disengagement for struggling learners	Needs differentiated strategies
15	Woo, Wang, Guo et al. (2024)	ChatGPT	Prompt-based writing → higher motivation	High cognitive load
16	Zhang & Huang (2024)	LLM chatbot	Frequent interaction → incidental vocabulary learning	Digital divide limits
17	Yang & Zhao (2024)	AI-mediated instruction	Novelty → emotional engagement	Low AI literacy
18	Yang, Tseng & Lai (2024)	AI-supported speaking + PD	Increased confidence → active participation	Need transition support

Table 5
AI Applications and Their Impacts on Students' Academic EFL Achievement

No.	Study	AI Tools / Technologies	Achievement Gains (EFL Skills Improved)	Mechanisms Supporting Achievement	Constraints / Moderators
1	Junaidi et al. (2020)	Lyra Virtual Assistant	Speaking accuracy, grammar, vocabulary, fluency	Real-time corrective feedback; repetitive oral practice	None reported
2	Tlili et al. (2021)	AI vocabulary game	Vocabulary performance	Gamified repetition; LA-supported difficulty adjustment	Institutional support needed
3	Tai, Chen & Todd (2020)	Mondly VR	Vocabulary retention	Immersive contextualised exposure	Distraction risks
4	Lin et al. (2022)	Robot + IoT 3D book	Vocabulary and oral production	Multimodal cues; elicitation for oral practice	Must fit learning styles
5	Jeon (2023)	Dialogflow chatbot	Vocabulary acquisition	Dynamic assessment; personalised scaffolds	None reported
6	Lee & Jeon (2022)	Voice-controlled agents	Speaking proficiency	Interactive modelling; anthropomorphic engagement	Digital divide
7	Hadi & Junor (2022)	Google Assistant	Speaking competence	Guided oral practice across varied contexts	Teacher readiness
8	Jeon (2022)	Dialogflow chatbot	Speaking fluency	Repetitive conversation cycles; active production	Misrecognition errors
9	Tai & Chen (2022)	Google Nest Hub/Mini	Listening comprehension	Authentic, flexible listening tasks	None reported
10	Lee, Shin & Noh (2023)	AI content generator	Reading comprehension	Improved reading motivation and textual engagement	Weak infrastructure
11	Utami et al. (2023)	AI writing software	Academic writing quality	Automated drafting, revising, and feedback	AI literacy needed

No.	Study	AI Tools / Technologies	Achievement Gains (EFL Skills Improved)	Mechanisms Supporting Achievement	Constraints / Moderators
12	Woo et al. (2024)	AI-NLG writing tools	Writing accuracy and structure	Generative scaffolds; error detection	Varies by student ability
13	Woo, Wang, Guo et al. (2024)	ChatGPT	Writing development	Prompt-driven idea support; iterative refinement	High cognitive load
14	Zhang & Huang (2024)	LLM chatbot	Vocabulary retention & incidental learning	Frequent interaction; spaced exposure	Digital divide
15	Lee, Kim & Sung (2023)	AI learning support system	Comprehensive language performance	Autonomous task creation; personalised pathways	Requires technical support
16	Kim (2025)	AI-assisted English learning system	English proficiency scores	Individualised tasks; progress tracking	AI alone insufficient; equity concerns

that increased enjoyment and strengthened perceptions of authenticity in language use (Lee, Shin & Noh, 2023; Tai & Chen, 2022). Importantly, these findings extend prior work that has primarily treated satisfaction as a general affective outcome by demonstrating that it emerges through interconnected cognitive, affective, and behavioural pathways and is shaped by feedback design, interactional support, and learner autonomy.

Mediating Mechanisms and Contextual Moderators

A key contribution of this review lies in clarifying the impact pathways through which AI shapes engagement, achievement, and satisfaction. Across the included studies, three recurrent categories of mediating processes were identified (Table 7). First, pedagogical mediators operated through personalised scaffolding, adaptive sequencing, multimodal supports, and conversational practice, which collectively enhanced instructional quality and increased task clarity (Jeon & Lee, 2023; Lin et al., 2022). Second, cognitive-affective mediators included reduced anxiety, greater learner autonomy, heightened error awareness, motivational gains, and more sustained attention, all of which were repeatedly implicated in explaining observed learning improvements (Yang & Zhao, 2024; Lee & Jeon, 2022; Han, 2020). Third, behavioural mediators were evident in increased time-on-task, more frequent cycles of language production, and stronger self-regulation, which in turn supported deeper engagement with learning activities (Woo, Wang, Guo et al., 2024; Agustini, 2023; Tlili et al., 2021).

However, these mediating processes functioned effectively only when supported by favourable contextual conditions. The review identified five moderators that recurrently shaped the strength and stability of AI-related effects, namely technological infrastructure (Zhang & Huang, 2024; Lee, Shin & Noh, 2023), teacher readiness and AI-related technological pedagogical knowledge (AI-TPK) (Yang, Tseng & Lai, 2024; An et al., 2023), students' digital literacy and familiarity with AI tools (Yang & Zhao, 2024), the cultural-linguistic fit

of AI-generated or AI-mediated content (Tai & Chen, 2020), and the cognitive load associated with the use of generative AI systems (Woo, Wang, Guo et al., 2024). Collectively, these conditions determined whether the proposed pathways were activated or disrupted, underscoring that AI does not enhance learning uniformly but rather operates in interaction with a complex educational ecology.

DISCUSSION

This review synthesized 23 empirical studies to clarify how AI influences engagement, achievement, and satisfaction in school-based EFL learning and to theorize the mechanisms and contextual moderators that constitute AI's impact pathways. While earlier work established AI's potential benefits (Li & Chan, 2024; Wang & Xue, 2024), this review advances the field by demonstrating *how* AI produces these effects through interconnected pedagogical, cognitive-affective, and behavioural processes embedded in school environments.

AI Affordances and the Transformation of School EFL Pedagogy

The analysis confirms that AI tools, particularly NLP-driven systems, provide substantial pedagogical affordances, including granular feedback, adaptive sequencing, and personalised modelling (AI-Ansi et al., 2023). At the same time, this review advances the literature by specifying how personalisation is operationalised in school-based settings. Across the included studies, personalisation was enacted through adaptive vocabulary repetition (Zhang & Huang, 2024; Jeon, 2023), tailored conversational scaffolding (Han, 2020; Tai & Chen, 2020), and performance-sensitive support that adjusted guidance in response to learner output (Utami et al., 2023; Junaidi et al., 2020). These patterns indicate that AI's pedagogical value derives less from automation per se and more from its capacity to deliver feedback that is immediate, iterative, and contextually responsive, thereby linking technological affordances to pathway-level learning

Table 6

AI Tools and Their Effects on Students' Learning Satisfaction in School EFL Contexts

No.	Study	AI Tool / Technology	How AI Shaped Satisfaction	Mechanisms Enhancing Satisfaction	Constraints / Moderators
1	Han (2020)	EchoDot (voice chatbot)	Reduced anxiety, increased comfort in speaking	Non-judgmental oral practice; personalised prompts	None reported
2	Tai, Chen & Todd (2020)	Mondly VR	High enjoyment during immersive learning	Gamified immersion; authentic scenarios	Easy distraction
3	Tai & Chen (2020)	Google Assistant	Increased confidence and comfort	Supportive conversational interaction	Cultural readiness required
4	Hadi & Junor (2022)	Google Assistant	Higher self-confidence; lower speaking anxiety	Repetitive oral practice in many contexts	Teacher readiness
5	Tai & Chen (2022)	Google Nest Hub/Mini	Enjoyable and flexible listening practice	Authenticity; learner choice	None reported
6	Jeon (2022)	Dialogflow chatbot	Satisfaction mixed: enjoyment but frustration	Natural conversation flow	Misrecognition errors
7	Lee & Jeon (2022)	Voice-controlled agents	Positive socio-emotional learning experience	Anthropomorphic interaction	Digital divide
8	Agustini (2023)	ChatGPT	Higher motivation and autonomy	Instant ideas, feedback, and supportive tone	Requires teacher training
9	Jeon & Lee (2023)	ChatGPT	Enhanced involvement and ethical awareness	Multi-role collaboration (interlocutor, evaluator)	AI pedagogical expertise required
10	Lee, Shin & Noh (2023)	AI content generator	Increased enjoyment in reading tasks	Adaptive engagement with text	Weak digital infrastructure
11	Utami et al. (2023)	AI writing software	Satisfaction through easier drafting and planning	Automated scaffolding; flexible access	AI literacy needed
12	Woo, Susanto, Yeung et al. (2024)	AI-NLG tools	Mixed satisfaction; helps struggling writers	Writing support; reduced cognitive load	Varies by student ability
13	Woo, Wang, Guo et al. (2024)	ChatGPT	Higher motivation but cognitive load during prompting	Real-time generative assistance	High cognitive load
14	Zhang & Huang (2024)	LLM chatbot	Enjoyable vocabulary learning	Incidental learning; interactive tasks	Digital divide
15	Yang & Zhao (2024)	AI-mediated instruction	Mixed emotional satisfaction: positive novelty, some uncertainty	Novelty effect; new opportunities for mastery	Low AI familiarity
16	Yang, Tseng & Lai (2024)	AI for speaking instruction	Increased confidence and satisfaction	Teacher PD improved AI use quality	Need for transition support
17	Kim (2025)	AI-assisted English learning system	Satisfaction linked to personalised support	Individualised pathways; transparent data	Risk of inequity without mediation

processes that earlier work has not articulated explicitly. Although immersive applications such as VR and educational robots have been associated with increased learner motivation (Lin et al., 2022; Tai, Chen & Todd, 2020), the present findings suggest that their effectiveness is contingent on sustained cognitive engagement, refining prior claims that novelty effects alone account for learning gains.

Learner Experience Pathways

The review corroborates evidence that AI can enhance learner engagement across behavioural, emotional, and cognitive dimensions (Tlili et al., 2021; Han, 2020). At the same time, it offers a more fine-grained account by demonstrating the mediating role of affective processes, particularly anxiety reduction (Hadi & Junor, 2022; Han, 2020) and increased learner autonomy (Lee, Kim & Sung, 2023), in shaping participation and sustained involvement. Achievement gains, which have been widely reported in prior re-

Table 7*Mediating Mechanisms and Contextual Moderators in AI-supported School EFL Learning*

No.	Study	AI Tool	Mediating Mechanisms (Impact Pathways)	Contextual Moderators (Enablers / Constraints)
1	Han (2020)	EchoDot chatbot	Reduced speaking anxiety; repetitive oral practice; safe communication	Enabler: Emotional comfort; Constraint: None reported
2	Tai, Chen & Todd (2020)	VR system	Immersion; experiential vocabulary learning	Enabler: High motivation; Constraint: Easy distraction
3	Tai & Chen (2020)	Google Assistant	Conversational scaffolding; confidence building	Enabler: Motivational interaction; Constraint: Cultural readiness
4	Junaidi et al. (2020)	Lyra Assistant	Pronunciation-feedback loop; structured practice	Constraint: Limited reporting
5	Tlili et al. (2021)	AI vocabulary game	Gamification; adaptive challenge level	Enabler: Institutional support needed
6	Hadi & Junor (2022)	Google Assistant	Affective reassurance; confidence gain	Constraint: Teacher readiness
7	Lin et al. (2022)	Robot + IoT Book	Multimodal scaffolding; cue-based learning	Constraint: Matching learner styles
8	Tai & Chen (2022)	Google Nest	Authentic listening experiences; flexibility	Enabler: Enjoyable multimodal input
9	Jeon (2022)	Dialogflow chatbot	Dynamic conversational practice; motivation ↑	Constraint: Misrecognition breaks flow
10	Lee & Jeon (2022)	VCA	Anthropomorphism → social engagement	Constraint: Digital divide
11	Agustini (2023)	ChatGPT	Idea generation; autonomy support	Constraint: Need for teacher training
12	Jeon (2023)	Dialogflow	Diagnostic feedback; personalised assessment	Constraint: Not reported
13	Jeon & Lee (2023)	ChatGPT	Teacher-AI co-scaffolding; ethical awareness	Constraint: AI pedagogical expertise
14	Lee, Shin & Noh (2023)	Content generator	Increased reading enjoyment; creative stimulation	Constraint: Poor digital infrastructure
15	Utami et al. (2023)	Writing software	Drafting support; structural scaffolding	Constraint: AI literacy; missing features
16	Lee, Kim & Sung (2023)	AI support system	Autonomy; learner-generated contexts	Constraint: Need socio-technical support
17	An et al. (2023)	AI pedagogy tools	Teacher expectancy → learner engagement	Constraint: Indirect effects of AI-TPK
18	Woo et al. (2024a)	AI-NLG	Writing scaffolds; reduced cognitive effort	Constraint: Varies by writing ability
19	Woo et al. (2024b)	ChatGPT	Motivation through generative support	Constraint: High cognitive load
20	Zhang & Huang (2024)	LLM chatbot	Incidental vocabulary learning; repetition cycles	Constraint: Digital divide
21	Yang & Zhao (2024)	AI-mediated instruction	Emotional activation; novelty effects	Constraint: Low AI familiarity
22	Yang, Tseng & Lai (2024)	AI for speaking	Increased confidence via PD-supported implementation	Constraint: Need transition support
23	Kim (2025)	AI-assisted system	Personalised pathways; performance analytics	Constraint: Inequity without teacher mediation

search (Su, Lin & Lai, 2023), are shown here to be generated through identifiable mechanisms, including iterative feedback loops (Utami et al., 2023), enhanced error awareness (Woo et al., 2024; Jeon, 2023), and adaptive scaffolded practice (Lin et al., 2022). While these mechanisms are consistent with formative assessment theory (Luckin et al., 2016), the present synthesis extends that framework by clarifying how AI tools operationalise formative principles in developmentally appropriate ways for younger learners. Learner satisfaction emerged through emotional reassurance, cognitive ease, and experiential value (Yang & Zhao, 2024; Lee, Shin & Noh, 2023), suggesting that satisfaction functions as an integrated outcome shaped by engagement and achievement processes rather than as a standalone affective construct.

Mediating Mechanisms within the Impact Pathways Framework

A primary contribution of this review is the identification of three interrelated categories of mediators, namely cognitive, affective, and behavioural processes, which constitute the core of the proposed *Impact Pathways Framework*. Cognitive mechanisms, including personalised instruction, dynamic assessment, and multimodal scaffolding (Jeon, 2023; Junaidi et al., 2020; Tai et al., 2020), respond to recent calls for data-informed pedagogy by specifying how AI-supported adaptations are enacted within learning tasks (Neumann et al., 2023). Affective mechanisms, most notably anxiety reduction and increased self-efficacy (Jeon, 2022; Han, 2020), refine established accounts such as the affective filter hypothesis by demonstrating that AI can actively shape learners’ emotional conditions for participation. Behavioural mechanisms, including increased practice, persistence, and self-regulation (Agustini, 2023; Jeon, 2022), further illuminate the behavioural and cognitive feedback loops through which engagement is translated into measurable achievement gains. Collectively, these findings reposition the field away from largely outcome-based claims and toward a process-oriented, theoretically integrated explanation of

AI-mediated EFL learning. Figure 3 presents the detailed *AI Impact Pathways Framework* derived from this synthesis and integrates cognitive, affective, behavioural, and contextual mechanisms to explain how AI affordances shape engagement, achievement, and satisfaction in school-based EFL instruction.

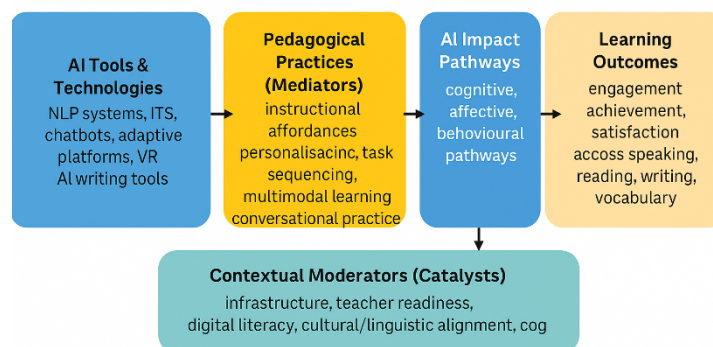
Contextual Moderators Shaping AI Effectiveness

In line with prior concerns regarding the conditional nature of AI-related effects (Ghamrawi et al., 2024; Su, Lin & Lai, 2023; Celik, 2022), the review indicates that the effectiveness of AI is strongly dependent on contextual conditions. Variations in digital infrastructure influenced both access to AI tools and the quality of learner engagement (Zhang & Huang, 2024; Lee & Jeon, 2022), whereas teacher readiness moderated implementation fidelity as well as learners’ capacity to interpret and act on AI-generated feedback (Agustini, 2023; Utami et al., 2023). Students’ digital literacy further shaped affective responses and reported satisfaction (Yang & Zhao, 2024), and elevated cognitive load associated with generative-AI tasks at times reduced participation and task persistence (Woo et al., 2024). Taken together, these findings extend earlier accounts (Celik, 2022) by showing that contextual moderators do not simply constrain adoption; rather, they condition the operation of the mediating mechanisms themselves and should therefore be treated as integral to any theoretical explanation of AI’s educational impact.

Theoretical Extension

This review proposes a multi-pathway explanatory model, the *AI Impact Pathways Framework*, which integrates pedagogical, cognitive-affective, behavioural, and contextual processes. The framework delineates the mechanisms through which AI shapes core EFL outcomes, specifies the contextual conditions that enable or inhibit the activation of

Figure 3
AI Impact Pathways Framework in School EFL Learning



these mechanisms, and foregrounds emotional and learner-experience dimensions that have often been underrepresented in prior research on AI-mediated language learning. In doing so, the model advances theorisation in the field by moving beyond descriptive outcome reporting toward a process-oriented account of how AI reconfigures school-based EFL learning and why its effects are heterogeneous across educational contexts.

Limitations and Further Research

Despite the breadth of the synthesis, several limitations should be acknowledged. First, the evidence base is geographically concentrated in East and Southeast Asia, which constrains the transferability of the findings to settings characterised by different sociocultural norms, institutional arrangements, and levels of technological provision. Second, the exclusive reliance on published empirical studies raises the possibility of publication bias, insofar as null, mixed, or unfavourable findings may be underrepresented. Third, most of the reviewed interventions were short term, limiting the extent to which conclusions can be drawn about the durability of AI-related effects on engagement, achievement, and satisfaction. Fourth, a number of mediating mechanisms and moderating conditions within the proposed *Impact Pathways Framework* were inferred on the basis of study descriptions rather than being directly measured or modelled, and therefore require explicit empirical validation. Finally, heterogeneity in AI tools, school contexts, and outcome operationalisations complicates direct cross-study comparison and reduces the precision of aggregate claims. Taken together, these constraints underscore the need for longitudinal, cross-cultural, and methodologically robust research that can test and refine the proposed pathways and strengthen theory-driven approaches to AI integration in school-based EFL instruction.

CONCLUSION

The present review synthesises evidence on AI use in school-based EFL instruction and demonstrates that AI can enhance engagement, achievement, and learner satisfaction, while also showing that these effects are not automatic but are produced through identifiable pedagogical, cognitive-affective, and behavioural mechanisms operating under specific contextual conditions. Drawing on 23 empirical studies, the synthesis indicates that AI-supported personalisation and adaptive feedback can strengthen instructional clarity and learner progression, whereas reduced anxiety and opportunities for sustained, low-stakes practice contribute to more stable participation and improved performance over time. On this basis, the study advances an *AI Impact Pathways Framework* that extends educational technology theorisation by specifying how AI affordances translate into

learning outcomes through mediating processes and by identifying the contextual moderators that amplify or attenuate these processes in K-12 EFL settings. At the same time, the reviewed evidence highlights persistent implementation constraints, including unequal digital infrastructure, limited teacher readiness, and cultural-linguistic misalignment of AI content, which can disrupt pathway activation and generate heterogeneous effects across schools. Overall, the review provides a conceptual foundation for more effective and equitable integration of AI into school EFL pedagogy and delineates priorities for future research, particularly longitudinal and cross-cultural designs capable of empirically testing, refining, and validating the proposed impact pathways.

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ETHICS STATEMENT

This study is a systematic review of previously published research and did not involve human participants, primary data collection, or identifiable personal data. Therefore, ethical approval and informed consent were not required.

DECLARATION OF COMPETING INTEREST

None declared.

AI USE DISCLOSURE STATEMENT

AI-based tool-ChatGPT- was used solely for language editing, literature search, and improving clarity and structure in parts of the manuscript. All substantive content, analysis, interpretation, and final decisions were made by the authors, who take full responsibility for the work.

AUTHORS' CONTRIBUTIONS

Arnab Kundu: conceptualisation; methodology; data curation; formal analysis; investigation; validation; visualisation; writing – original draft; writing – review & editing; project administration.

Tripti Bej: conceptualisation; methodology; data curation; investigation; validation; writing – original draft; writing – review & editing.

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, Article 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), Article 100532. <https://doi.org/10.1016/j.ssa-ho.2023.100532>.
- An, X., Chai, C., Li, Y. et al. (2023). Modeling English teachers' behavioural intention to use artificial intelligence in middle schools. *Education and Information Technology*, 28, 5187-5208 (2023). <https://doi.org/10.1007/s10639-022-11286-z>
- Celik, I. (2022). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behaviour*, 138, Article 107468. <https://doi.org/10.1016/j.chb.2022.107468>
- Chang, Q. (2022). The contribution of a hermeneutic approach to investigate psychological variables in second language acquisition. *Frontiers in Psychology*, 13, Article 1055249. <https://doi.org/10.3389/fpsyg.2022.1055249>
- 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*, 32(10), 1-17. <https://doi.org/10.1080/10494820.2023.2253861>
- Ghamrawi, N., Shal, T. & Ghamrawi, N.A. (2024). Exploring the impact of AI on teacher leadership: regressing or expanding? *Education and Information Technology*, 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. <http://dx.doi.org/10.47116/ap-jcri.2020.07.07>
- 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. <http://dx.doi.org/10.1155/2022/5215722>
- Hsu, T. C., Chang, C., & Jen, T. H. (2024). 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*, 32(6), 3060-3078. <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>
- Kim, E. (2025). AI-assisted English learning: A tool for all or only a select few? *Language Learning & Technology*, 29(1), 1-22. <https://doi.org/10.64152/10125/73633>
- 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. (2025a). 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>
- Kundu, A. & Bej, T. (2025b). Transforming school EFL teaching with AI: A systematic review of empirical studies. *International Journal of Artificial Intelligence in Education*, 35, 2281-2314 (2025). <https://doi.org/10.1007/s40593-025-00470-0>

- Kundu, A. & Bej, T. (2025c). Empowering students autonomy in EFL learning: AI innovations in schools of the Global South. *The Electronic Journal of Information Systems in Developing Countries*, 91(6). <http://dx.doi.org/10.1002/isd2.70041>
- Kundu, A., Bej, T., & Mondal, R. (2025). Exploring teachers' AI literacy: cognitive, pedagogical, ethical, and contextual insights from Indian schools. *Teaching Education*, 1–21. <https://doi.org/10.1080/10476210.2025.2570227>
- Kundu, A. (2025). *Teaching English grammar and expression: A pedagogical approach*. Shipra Publications.
- Lee, D., Kim, Hh. & Sung, SH. (2023). 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. (2023). 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>
- Lee, S., & Jeon, J. (2024). Visualizing a disembodied agent: young EFL learners' perceptions of voice-controlled conversational agents as language partners. *Computer Assisted Language Learning*, 37(5–6), 1048–1073. <https://doi.org/10.1080/09588221.2022.2067182>
- 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.
- Lueger, M., & Vettori, O. (2015). Finding meaning in higher education: a social hermeneutics approach to higher education research. In M. Tight & J. Huisman (Eds.), *Theory and method in higher education research*. Emerald Group Publishing.
- 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>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Thomas, J., Tricco, A., Welch, V., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Ouzzani, M., Hammady, H., Fedorowicz, Z. et al. (2016). Rayyan - A web and mobile app for systematic reviews. *Systematic Reviews*, 5, 1-10. <https://doi.org/10.1186/s13643-016-0384-4>
- 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., & Kumar, D. P. (2020). Design of online intelligent English teaching platform based on artificial intelligence techniques. *Computational Intelligence*, 37(3), 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*, 37(5–6), 1281–1310. <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, 1485-1502. <https://doi.org/10.1080/10494820.2020.1841801>
- 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>
- 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>
- 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), Article ep450. <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*, 159, 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>

-
- 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. (2024). 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. (2024). Teaching EFL students to write with ChatGPT: Students' motivation to learn, cognitive load, and satisfaction with the learning process. *Education and Information Technology, 29*, 24963–24990. <https://doi.org/10.1007/s10639-024-12819-4>
- Yang, L., & Zhao, S. (2024). AI-induced emotions in L2 education: Exploring EFL students' perceived emotions and regulation strategies. *Computers in Human Behaviour, 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>
- Zhang, R., & Zou, D. (2022). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Computer Assisted Language Learning, 35*(4), 696–742. <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), Article e25370. <https://doi.org/10.1016%2Fj.heliyon.2024.e25370>