



FROM AUTOMATION TO SOCIO-AFFECTIVE LEARNING: A BIBLIOMETRIC ANALYSIS OF ARTIFICIAL INTELLIGENCE IN ENGLISH AS A FOREIGN LANGUAGE EDUCATION

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Abstract

Artificial intelligence (AI) has become a driving force in education. Within English as a Foreign Language (EFL) pedagogy, it is reconfiguring instructional approaches by linking automation with learner-centered and affective learning design. Nevertheless, empirical research remains fragmented across cognitive, affective, and social domains, necessitating a comprehensive approach. Drawing on data from the Web of Science (WoS) Core Collection (2021–2025), this study examines the bibliometric landscape of the field. Following PRISMA-based screening, 281 peer-reviewed publications were analyzed with VOSviewer and CiteSpace. Results demonstrate a sharp rise in publications and a conceptual evolution from performance-driven to socio-affective perspectives. Co-citation analysis delineates three major research domains—conversational AI in pedagogy, AI-based assessment tools, and affective–motivational learning—while co-occurrence mapping identifies four thematic clusters: chatbots and emotions, generative AI and critical thinking, automated writing evaluation and feedback, and technology adoption and motivation. Burst detection indicates a growing focus on positive psychology and communication skills. Building on these results, the study suggests the Affective–Cognitive–Social Integration Model (ACSIM), which extends existing acceptance frameworks to encompass motivation, emotion, and ethics. The model bridges automation-oriented AI research with socio-affective pedagogy and informs emotionally intelligent instruction, AI literacy among teachers, and institutional practices for responsible and sustainable use.

Keywords: artificial intelligence, EFL, bibliometric analysis, socio-affective learning

Introduction

In the era of artificial intelligence (AI), education is witnessing deep and far-reaching transformation. What began as a supplementary digital tool has now become a transformative force in English as a Foreign Language (EFL) education. Since the emergence of ChatGPT and other large language models, AI has introduced new opportunities for personalized learning, adaptive feedback, and interactive communication. Recent studies show that AI-enhanced learning environments encourage students' engagement and emotional experience (Huang &

Zou, 2024) and support gains in language performance, motivation, and self-regulation (Wei, 2023). Earlier research has largely concentrated on the technological capabilities of AI—such as automated writing evaluation, chatbots, and speech-recognition tools—seeking to improve accuracy and efficiency (Gayed et al., 2022). Yet newer studies suggest that AI’s educational potential extends well beyond simple automation. It now fosters learner autonomy, emotional involvement, and creativity, marking a noticeable shift from technology-driven uses toward learner-centered and emotionally attuned pedagogy.

At the theoretical level, scholarly debates surrounding the integration of AI in EFL contexts have shifted from the Technology Acceptance Model (TAM) to encompass wider motivational and socio-affective standpoints. Empirical and mixed-method inquiries have shown that learners’ emotional states, motivational orientations, and perceptions of usefulness serve as critical determinants of their readiness to interact with AI-supported applications (Wu et al., 2024). In a similar vein, classroom studies have demonstrated that AI-supported learning environments tend to enhance enjoyment and encourage learners’ willingness to communicate—especially within speaking and vocabulary instruction (Wang & Reynolds, 2024). Based on existing theoretical and empirical research, prior studies on AI-supported EFL learning have highlighted both its pedagogical potential and inherent limitations.

Nevertheless, these experiences are not universally positive. Some learners experience anxiety and uncertainty alongside enthusiasm, highlighting the intricate emotional dynamics present in AI-integrated classrooms (Xin & Derakhshan, 2025). Beyond these emotional tensions, prior research has indicated that early AI-supported EFL studies often adopted a technology-centric paradigm, emphasizing performance outcomes while marginalizing learners’ experience and emotional involvement (Kasneci et al., 2023). Moreover, despite its widespread application, TAM has been criticized for insufficiently addressing affective, ethical, and motivational dimensions of AI integration (An et al., 2025). In addition, several studies remain confined to adoption-oriented paradigms, overlooking contextual and ethical variables that are crucial for sustained engagement and responsible pedagogical practice (Wang et al., 2023). On the whole, these issues highlight the complex emotional and pedagogical dynamics inherent in AI-integrated EFL classrooms. These findings underscore the significance of constructing a comprehensive framework to illuminate the interconnections among cognitive, emotional, and social dimensions in AI-mediated language learning.

Despite this growing body of research, the field remains theoretically fragmented and thematically dispersed. Existing studies are often confined to isolated pedagogical applications or single theoretical perspectives, lacking a systematic synthesis that integrates cognitive, emotional, and social dimensions of AI-mediated language learning. As a result, a critical research gap lies in the absence of an integrative, evidence-based synthesis that clarifies how AI-supported EFL research has evolved from technology-oriented applications toward learner-centered and socio-affective paradigms. Amid such fragmentation, a rigorous, data-informed synthesis is required to delineate how AI-supported EFL scholarship has developed conceptually and thematically. A bibliometric approach serves as the analytical basis, charting the structural configuration and temporal evolution of the field. By employing co-citation, co-occurrence, and burst-detection analyses, this research uncovers the intellectual foundations, core thematic patterns, and emerging trajectories shaping AI integration in EFL education. Against this backdrop, this study makes a distinct contribution to the literature by providing a critical and integrative bibliometric synthesis of AI-supported EFL research that moves beyond descriptive mapping to highlight evolving research paradigms and persistent theoretical and methodological gaps. Accordingly, this study aims to provide a systematic bibliometric overview of AI-supported EFL research by examining its intellectual structure, thematic landscape, and emerging research trends. To fulfill this aim, the study addresses two guiding questions:

RQ1: What are the intellectual structure and thematic landscape of AI-enhanced EFL education between 2021 and 2025?

RQ2: What emerging research trends and frontiers are identified using burst-detection analysis, and how do they contribute to an integrated model for AI-mediated EFL learning?

Research Methodology

General Background

This study employed a quantitative bibliometric research design to examine the intellectual structure and thematic evolution of AI-supported EFL education. Bibliometric analysis enables the systematic mapping of scientific knowledge by analyzing large-scale bibliographic data and is widely used to identify research trends, intellectual foundations, and thematic developments within a research field (Donthu et al., 2021; Lim et al., 2025). Compared with traditional narrative reviews, bibliometric analysis provides a more objective and visually interpretable approach to examining research structures and their evolution (Öztürk et al., 2024).

The overall research procedure consisted of four main stages. First, relevant publications were retrieved from the Web of Science (WoS) Core Collection using predefined search criteria. Second, a structured screening process based on PRISMA guidelines was applied to refine the dataset and ensure data quality (Page et al., 2021). Third, bibliometric mapping and visualization analyses were conducted using specialized software tools to examine knowledge structures and research themes. Finally, the analytical results were interpreted to address the research questions and identify future research directions in AI-supported EFL education.

Sample Selection

The criteria employed for data collection are outlined in Table 1. All bibliographic records were extracted from the Web of Science (WoS) Core Collection, which was selected owing to its comprehensive disciplinary coverage, established scholarly reputation, and stringent indexing of peer-reviewed journals. Compared with other databases such as Scopus or Google Scholar, WoS offers more standardized metadata and a well-established citation network, making it particularly appropriate for bibliometric research on AI-related studies. In this study, the search was limited to publications examining the application of AI in EFL education, spanning the period from 2021 to 2025. Using Boolean operators, the search was limited to peer-reviewed journal articles indexed in the WoS under the SSCI category. The specific search string used for data retrieval was as follows:

TS = (("artificial intelligence" OR "AI" OR "Generative AI") AND ("English as a Foreign Language" OR "EFL")).

Based on these parameters, the dataset was retrieved in 2025. These selection criteria ensured that the resulting dataset was thematically relevant and suitable for subsequent bibliometric analysis.

Table 1
Data Retrieval and Selection Criteria

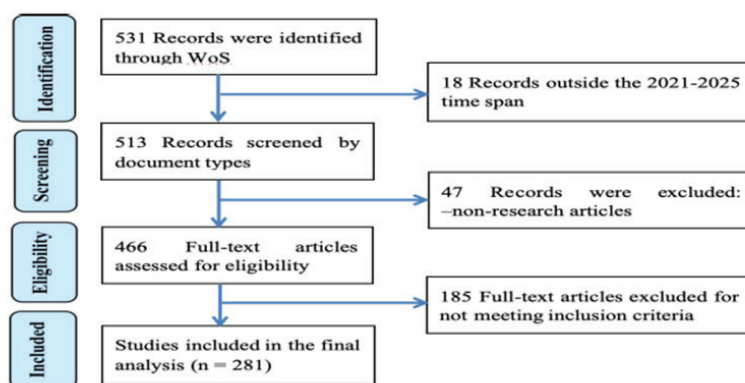
WoS Database	Core Collection
Time period	2021 to 2025
Search field	TS
Search keywords	("artificial intelligence" OR "AI" OR "Generative AI") AND ("English as a Foreign Language" OR "EFL")
Document type	Article
Language	English
Web of Science Index	SSCI

Instrument and Procedures

In this bibliometric study, the primary instruments included the WoS Core Collection as the data source and the PRISMA framework for systematic screening and documentation of the selection process. The overall screening and selection procedure is summarized in Figure 1, which presents the sequential steps of record identification, screening, eligibility assessment, and final inclusion in accordance with the PRISMA flowchart framework.

As illustrated in Figure 1, a total of 531 records were initially retrieved from the WoS Core Collection. After applying the publication year criterion (2021-2025), 18 records were excluded. The remaining 513 documents were then screened by document type, resulting in the exclusion of 47 non-article publications, such as editorials, book reviews, and conference proceedings. Subsequently, 466 full-text articles were assessed for eligibility. During this stage, 185 records were excluded, including 184 articles not indexed in the SSCI and one article not published in English. Following this multi-stage screening procedure, a final dataset of 311 studies was retained for bibliometric analysis.

Figure 1
PRISMA Flowchart



Data Analysis

To systematically investigate the intellectual structure and thematic development of AI-supported EFL education research, bibliometric analyses were conducted using VOSviewer (version 1.6.20) and CiteSpace (version 6.3.R1, 64-bit Advanced). These visualization-based tools are widely recognized for their capacity to construct and interpret scientific knowledge networks by integrating performance indicators with science-mapping techniques.

Descriptive analysis was first performed to examine overall research productivity and citation performance within the field. Key indicators, including annual publication growth, citation frequencies, and h-index values, were analyzed to provide a general overview of the field's research output and academic impact (Donthu et al., 2021). Building on this overview, co-citation analysis was then conducted to explore the intellectual structure of the field by examining how studies are connected through shared references, thereby revealing foundational works and major knowledge clusters (Öztürk et al., 2024).

In addition, keyword co-occurrence analysis was employed to identify thematic patterns and research concentrations by analyzing keyword frequency and co-occurrence relationships, which allowed the principal research themes and their conceptual linkages in AI-supported EFL education to be mapped (Tomaszewski, 2023). Finally, burst-detection analysis was applied to detect keywords exhibiting abrupt increases in occurrence or citation activity, enabling the identification of emerging research themes and shifts in scholarly attention over time (An, 2024).

Research Results

Descriptive Analysis

To set the stage for the subsequent structural analyses, it is first necessary to outline the overall research productivity and impact of the field. To this end, a performance analysis was conducted based on bibliometric data retrieved from the Web of Science (WoS) Core Collection. Figure 2 illustrates the annual distribution of publications and citations between 2021 and 2025, revealing a steady and substantial increase in both research output and academic impact. Early investigations appeared sporadically prior to 2023, however a substantial rise in publication output emerged after 2024, signaling increasing scholarly engagement with AI integration in EFL education. The steady increase in citation activity indicated that recent publications had garnered notable academic interest and were gradually contributing to the development of the field's intellectual structure. All in all, these developments underscored the swift expansion and rising prominence of AI in EFL education, signifying its evolution from an emerging research focus into an interdisciplinary field bridging AI and language education.

Figure 2
Annual publications and citations (Source: WoS database)

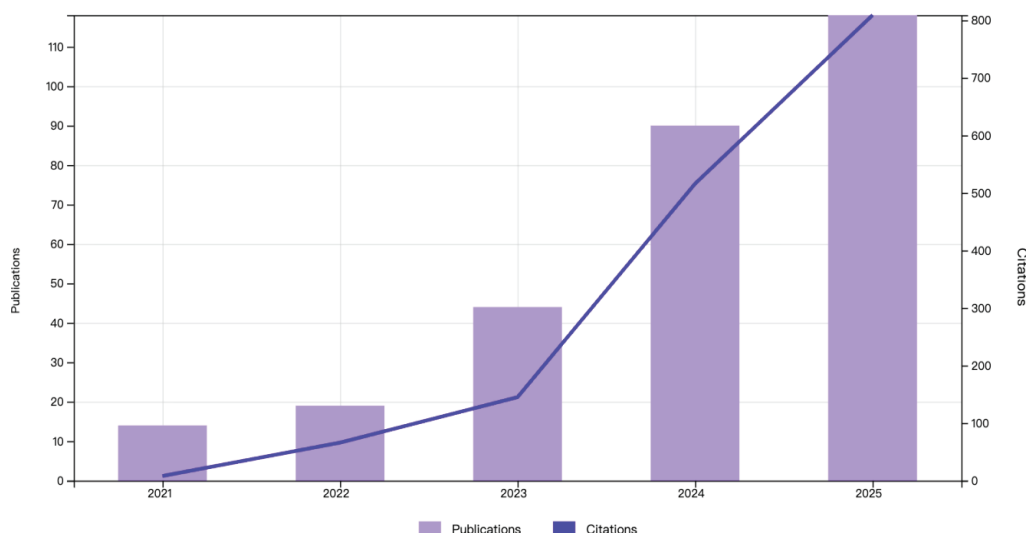


Table 2 presents the general bibliometric indicators derived from the WoS database. A total of 281 records were obtained, yielding 4,074 citations from 2,000 citing works (1,933 after excluding self-citations), with an average of 14.5 citations per publication and an H-index of 33. These bibliometric measures collectively revealed a vibrant and fast-growing research landscape, distinguished by rising productivity, expanding visibility, and strengthening academic influence. In sum, the consistent increase in both publications and citations indicated that AI-assisted EFL education had developed into an emerging yet influential interdisciplinary area spanning applied linguistics and educational technology. Following this descriptive overview, the subsequent sections investigate the field's intellectual foundations, conceptual patterns, and emerging trajectories through co-citation, co-occurrence, and burst analyses.

Table 2
General Bibliometric Indicators from WoS

Metric	Value (2021 to 2025)
Total Publications	281
Total Citing Articles	2,000 (1,933 excluding self-citations)
Total Citations	4,074 (3,400 excluding self-citations)
Average Citations per Item	14.5
H-Index	33

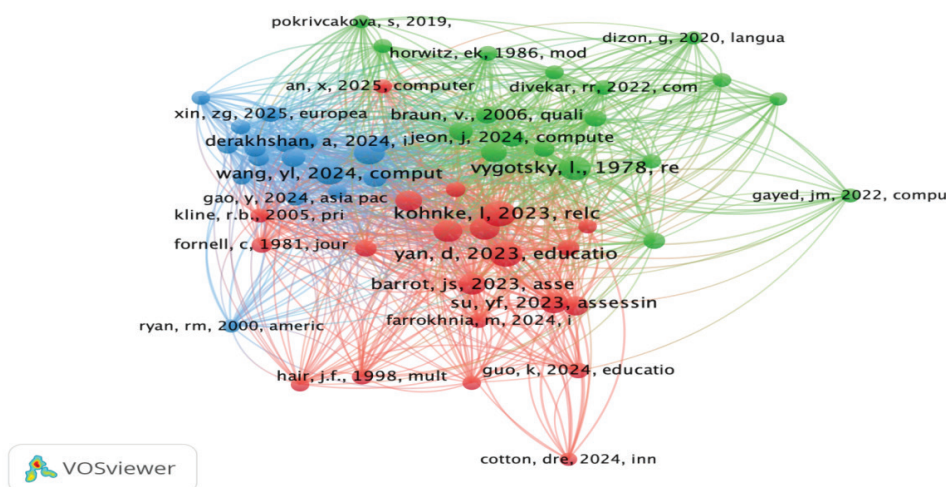
Co-citation analysis by clusters

To reveal the intellectual structure and foundational knowledge of AI-enhanced EFL education, a document co-citation analysis was performed using VOSviewer. The analysis treated cited references as the unit of measurement. A minimum citation threshold of 17 was set, meaning that only references cited at least 17 times were included in the co-citation network. Out of 12,606 cited references, 56 met this criterion. The resulting network comprised 56

items, 1,335 links, and a total link strength of 5,183, which were organized into three major clusters according to co-citation strength. Figure 3 illustrates the document co-citation network produced by VOSviewer, with each color representing a distinct research domain that captures the intellectual relationships within the field. Table 3 offers a summary of the three clusters, listing their representative publications and thematic orientations. Each cluster represents a distinct group of highly co-cited publications, reflecting the major strands of research that underpin AI-enhanced EFL education.

Cluster 1 (Red) includes 21 publications that examine the application of ChatGPT and conversational AI in EFL education. The publications in this cluster mainly address the use of conversational AI in instructional contexts, with particular attention to feedback provision, collaborative learning, and classroom interaction. Early studies within this cluster include systematic reviews that documented the pedagogical applications of conversational AI, especially in supporting classroom feedback and collaborative learning activities (Ji et al., 2023). Subsequent empirical studies concentrated on learner-related outcomes, reporting the use of ChatGPT for providing immediate instructional scaffolding and motivational support, particularly in academic and argumentative writing contexts (Song & Song, 2023). Other studies within this cluster examined the role of ChatGPT from the teacher perspective, addressing its use in feedback delivery and instructional support, alongside reported concerns related to originality and professional roles (Guo & Wang, 2024; Mohamed, 2024). In addition, several studies adopted technology acceptance-based models to examine factors influencing the adoption of ChatGPT in EFL education. These studies emphasized perceived usefulness and perceived ease of use as central variables associated with learners' and teachers' adoption intentions (An et al., 2025). Overall, this cluster represents a body of research that documents instructional applications, stakeholder perspectives, and adoption-related factors associated with ChatGPT and conversational AI in EFL education. However, despite the growing volume of studies in this cluster, existing research remains largely tool-oriented and adoption-focused, with limited critical engagement with underlying learning mechanisms or long-term pedagogical implications of conversational AI use.

Figure 3
Co-citations network (VOSviewer Visualization)



Cluster 2 (Green) comprises 18 studies that concentrate on the use of AI tools and conversational agents in EFL education, particularly in writing, speaking, vocabulary learning, and assessment-related contexts. Studies in this cluster primarily examine the instructional applications of AI technologies across different language skills and learning tasks. At the level of text production, several studies investigate AI-based writing assistants, reporting their use in supporting learners' composing processes through real-time feedback and revision support (Gayed et al., 2022). In speaking and vocabulary learning contexts, conversational agents are examined in multiple instructional roles. Some studies focus on chatbots as conversational partners used to support communicative practice and collaborative dialogue (Yang et al., 2022), while others examine voice assistants in relation to learners' oral engagement and willingness to communicate during speaking activities (Tai & Chen, 2023). Beyond task-specific applications, additional studies explore chatbot-mediated dynamic assessment, reporting the use of adaptive diagnostic feedback to provide individualized vocabulary support and personalized instructional guidance (Jeon, 2023). At a broader level, systematic reviews included in this cluster synthesize empirical findings on AI-supported language learning, documenting both instructional applications and reported constraints related to interaction, contextualization, and implementation (Huang et al., 2022). Although several studies in this cluster report learner engagement or willingness to communicate, these affective variables are typically examined as secondary outcomes of AI-supported instructional tasks, rather than as central analytical constructs. Methodologically, many studies in this cluster rely on short-term instructional interventions and self-reported measures, which limits the strength of evidence regarding sustained language development across diverse EFL contexts. In sum, this cluster represents research that documents diverse instructional uses of AI tools across language skills and assessment contexts in EFL education.

Cluster 3 (Blue) consists of 17 studies that center on affective and motivational aspects of AI-supported EFL education. Research in this cluster primarily examines learners' emotional experiences, motivational factors, and engagement-related variables in AI-mediated learning contexts. In contrast to tool-oriented research, this cluster places affective and motivational variables at the center of analysis, examining how learners' emotional experiences, motivation, and engagement are shaped within AI-mediated learning environments, rather than treating them as by-products of specific instructional tools. Several foundational studies investigate the relationship between AI integration and learner-related outcomes, reporting associations with achievement, self-regulation, and motivation in EFL learning settings (Wei, 2023). Subsequent studies examine emotional responses to AI-supported instruction, documenting both positive emotions and reported concerns related to dependency and uncertainty in AI-mediated classrooms (Xin & Derakhshan, 2025). Additional empirical research focuses on the role of affective variables in sustaining learner motivation and academic engagement, reporting links between emotional experiences and learning persistence (Guo & Wang, 2025). Other studies in this cluster examine interpersonal factors in AI-supported classrooms, including teacher immediacy and rapport, and their associations with learners' attitudes toward AI use and willingness to communicate (Zhi & Wang, 2024). Taken together, this cluster documents research addressing emotional, motivational, and interpersonal dimensions of AI-enhanced EFL education.

Table 3
Co-Citation Cluster on AI in EFL Education

Cluster No. & Color	Cluster Labels	No. of Articles	Representative Publications
Cluster 1 (Red)	ChatGPT and Conversational AI in EFL Education	21	An et al. (2025), Barrot (2023), Liu et al. (2024), Mohamed (2024), Liu & Ma (2024), Song & Song (2023), Yan (2023), Su et al. (2023), Ji et al. (2023), Guo & Wang (2024),
Cluster 2 (Green)	AI Tools and Conversational Agents in EFL Education	18	Divekar et al. (2022), Gayed et al. (2022), Huang et al. (2022), Huang et al. (2023), Jeon (2024), Jeon (2023), Tai & Chen (2023), Zawacki-Richter et al. (2019), Yang et al. (2022)
Cluster 3 (Blue)	Emotions, Motivation, and Engagement in AI-Powered EFL Learning	17	Derakhshan et al. (2025), Guo & Wang (2025), Wei (2023), Wu et al. (2024), Xin & Derakhshan (2025), Wang & Reynolds (2024), Zhi & Wang (2024), Wang et al. (2023), Zhang et al. (2024)

Co-occurrence Analysis by Clusters

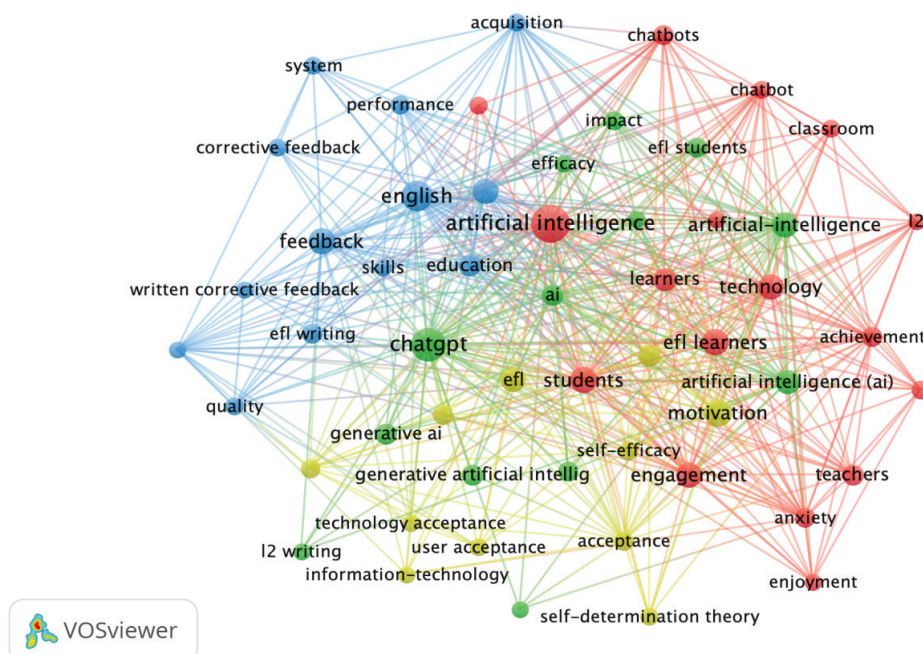
To delineate the major research themes and conceptual structure of technology-enhanced EFL education, a keyword co-occurrence analysis was implemented through VOSviewer. The minimum frequency was set to 8, showing that only keywords appearing eight times or more in the dataset were retained for network generation. Out of 1,217 keywords, 54 met this criterion. The resulting co-occurrence network contained 54 items, 767 links, and a total link strength of 1508, forming four distinct clusters based on their co-occurrence strength. Figure 4 shows the keyword co-occurrence map created in VOSviewer, where different colors mark separate topic clusters related to AI use in EFL education. Correspondingly, Table 4 presents the four clusters, together with their representative keywords and conceptual themes. Each cluster constitutes a thematic area that captures the field’s conceptual emphases and linkages, demonstrating the multidimensional nature of research on AI integration in EFL contexts.

Cluster 1 (Red) comprises 17 keywords, most notably “artificial intelligence,” “chatbot,” “EFL learners,” “engagement,” and “anxiety,” with its thematic focus on how AI chatbots are examined in relation to learners’ emotions and participation in classroom contexts. Research mapped within this cluster center on chatbot use in EFL learning environments, with attention to learner engagement, affective variables, and classroom interaction. Representative studies in this cluster include Jeon (2024), Huang et al. (2022), and Zhang et al. (2024). Research within this cluster examines the role of AI chatbots in relation to learners’ anxiety, motivation, enjoyment, and willingness to communicate during language learning activities. Several studies concentrate on learners’ engagement with AI chatbots in classroom contexts, documenting their interactive use in instructional tasks. Other studies included in this cluster address the emotional dimensions of AI use in EFL speaking, reporting affective responses observed when learners interact with intelligent systems. On the whole, this cluster represents a body of research that documents the examination of AI chatbots in relation to learner emotions, engagement, and participation in EFL classroom contexts.

Cluster 2 (Green) consists of 13 keywords related to the use of generative AI, particularly ChatGPT, in EFL education. Frequently occurring terms such as “EFL students,”

“EFL teachers,” “critical thinking,” “efficacy,” and “impact” reflect a concentration of studies examining instructional applications of generative AI across teaching and learning contexts. Work in this cluster addresses generative AI use in relation to learner engagement, cognitive processes, and instructional practices. In addition, studies in this cluster examine factors associated with learners’ willingness to use AI technologies, as well as applications of generative AI in vocabulary learning and academic writing contexts. The cluster includes empirical and conceptual studies such as Wu et al. (2024), Wang and Reynolds (2024), and Barrot (2023), which collectively illustrate the range of instructional and cognitive issues examined. Collectively, the studies grouped in this cluster document the examination of generative AI applications in EFL education with attention to cognitive and instructional dimensions.

Figure 4
Co-occurrence Network (VOSviewer Visualization)



Cluster 3 (Blue), with 13 keywords, focuses on the incorporation of automated writing evaluation (AWE) and corrective feedback within EFL writing instruction. Key terms, including “corrective feedback,” “performance,” “quality,” and “skills,” highlight a concentration of studies examining AI-mediated evaluation mechanisms in writing contexts. Research in this cluster addresses the application of AWE systems with respect to writing performance, feedback processes, and writing-related skills in EFL learning environments. Some studies center on the use of AI-based feedback tools during writing activities, whereas others examine learners’ responses to automated and corrective feedback in academic writing contexts. Empirical work represented in this cluster includes studies by Yan (2023) and Su et al. (2023), which investigate the use of ChatGPT and AI-supported feedback in EFL writing settings. Taken as a whole, the literature grouped within this cluster documents research on AI-mediated writing evaluation and corrective feedback in EFL writing instruction.

Cluster 4 (Yellow) contains 11 keywords associated with technology acceptance and motivational factors in AI-supported EFL learning. Prominent terms, including technology

acceptance, self-determination theory, motivation, self-efficacy, and user acceptance, indicate that studies grouped in this cluster examine psychological variables related to learners’ adoption of AI-based learning tools. Research represented in this cluster focuses on learners’ motivational orientations, self-beliefs, and acceptance-related perceptions in AI-enhanced language learning environments. Several studies investigate how autonomy, confidence, and achievement-related emotions are associated with learners’ willingness to engage with AI technologies in EFL contexts (Liu & Ma, 2024; Wang et al., 2023). Other work included in this cluster addresses instructional design perspectives, examining how technological affordances and learning environments relate to user acceptance of AI-supported systems (Divekar et al., 2022). Overall, this cluster documents research examining the relationship between motivation, self-efficacy, and technology acceptance in the context of AI-supported EFL learning.

Table 4
Keyword Co-occurrence Cluster of AI in EFL Education

Cluster No & Color	Cluster Label	Number of Keywords	Representative Keywords
1 (Red)	AI Chatbots and Learner Emotions in EFL Classrooms	17	"artificial intelligence" "chatbot" "classroom" "efl learners" "engagement" "anxiety" "teachers" "achievement"
2 (Green)	Generative AI and Critical Thinking in EFL Education	13	"ChatGPT" "generative AI" "EFL students" "EFL teachers" "critical thinking" "efficacy" "impact"
3 (Blue)	Automated Evaluation and Feedback in EFL Writing	13	"automated writing evaluation" "corrective feedback" "EFL writing" "performance" "quality" "skills" "education"
4 (Yellow)	Technology Acceptance and Motivation in EFL Learning	11	"technology acceptance" "self-determination theory" "motivation" "self-efficacy" "user acceptance" "EFL"

Burst Detection Analysis by Keywords

To identify emerging research trends and topics that have attracted sudden scholarly attention over time, a burst detection analysis was conducted using CiteSpace (version 6.3.R1, 64-bit Advanced). The burst detection parameters were set at $\alpha_1/\alpha_0 = 2.0$ and $\alpha_i/\alpha_{i-1} = 2.0$, with two states specified in the model. A one-year minimum burst duration was applied to ensure that only keywords demonstrating sustained and significant increases in citation activity were included.

Table 5
Keywords with strongest bursts (Source: CiteSpace)

Keywords	Year	Strength	Begin	End	Burst timeline (2021 - 2025)
corrective feedback	2022	1.69	2022	2022	
automated writing evaluation	2022	1.68	2022	2025	
instruction	2022	1.44	2022	2025	
efl	2022	1.3	2022	2022	
classroom	2023	1.47	2023	2025	
computer-assisted language learning	2023	1.21	2023	2023	
feedback	2022	1.15	2023	2023	
speaking skills	2023	1.14	2023	2025	
positive psychology	2024	1.89	2024	2025	
willingness to communicate	2024	1.89	2024	2025	
virtual reality	2024	1.51	2024	2025	
metacognitive awareness	2024	1.13	2024	2025	
resilience	2024	1.13	2024	2025	
ai tools	2024	1.13	2024	2025	

Note. The light blue bars represent the full observation period (2021-2025), while the red bars indicate the duration of keyword citation bursts identified by CiteSpace.

The analysis identified a total of fourteen burst keywords related to AI-supported EFL education. As shown in Table 5, these burst terms reflect changes in research attention between 2021 and 2025. Early bursts were primarily associated with instructional and feedback-related topics, such as automated writing evaluation, instruction, and corrective feedback, which emerged around 2022. Several of these keywords exhibited relatively long burst durations, extending to 2025.

Around 2023, keywords related to language skills and learning contexts, such as “speaking skills”, “classroom”, and “computer-assisted language learning”, began to display notable burst activity. In the later stage of the observation period (2024-2025), affective and learner-oriented keywords, including “positive psychology”, “willingness to communicate”, “metacognitive awareness”, “resilience”, and “AI tools”, demonstrated strong burst strengths. The temporal distribution of burst keywords indicates a progression from instructional applications to broader learner-related themes within AI-supported EFL education research.

Discussion

This study adopted a bibliometric approach to examine the intellectual structure and thematic evolution of research on AI-supported EFL education. Through the combined use of co-citation analysis, keyword co-occurrence mapping, and burst-detection techniques, the findings trace how scholarly attention in this field has shifted over time. Overall, the results reveal a clear movement away from technology-oriented and skill-based applications toward learner-centered and socio-affective concerns.

Earlier research was largely concerned with automated writing evaluation, corrective feedback, and instructional efficiency, reflecting a predominant focus on the functional

affordances of AI technologies. In contrast, more recent studies increasingly address speaking skills, emotional engagement, motivation, and willingness to communicate. This shift suggests a broader and more nuanced understanding of AI's role in language learning, extending beyond linguistic accuracy and task performance. The rising prominence of ChatGPT and other conversational AI tools further illustrates this trend. While initial studies tended to conceptualize conversational AI as a supplementary support for instruction, recent work examines its influence on classroom interaction, learner engagement, and instructional roles, positioning it as an active element within pedagogical practice.

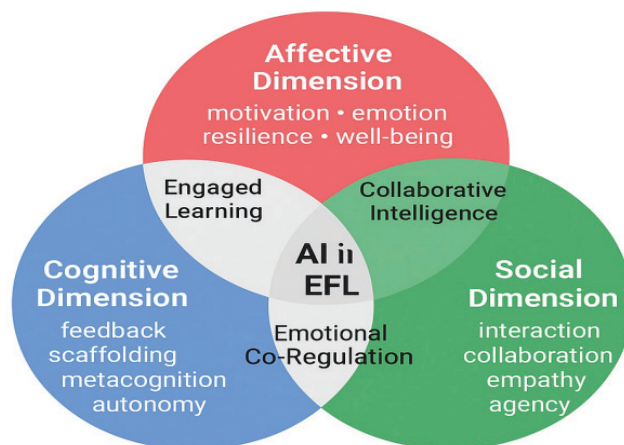
At the same time, growing attention to affective, motivational, and technology acceptance-related themes points to an increasingly holistic view of AI-supported EFL learning. Learners' emotional experiences, psychological readiness, and agency are now recognized as central to effective AI integration. In sum, these patterns suggest that AI-supported EFL education has developed into an interdisciplinary research domain integrating cognitive, affective, and social perspectives, and provides an important basis for the theoretical discussion that follows.

Theoretical Implications

The findings of this study advance theoretical understanding by empirically demonstrating—through co-citation, co-occurrence, and burst-detection analyses—a paradigmatic shift that reconceptualizes AI from a passive instructional tool into an active mediating agent that transforms the cognitive, affective, and social dimensions of EFL learning. This shift signifies a conceptual transition from the technological determinism of early research to a socio-affective mediation paradigm, in which AI enables dynamic interaction among learners, teachers, and digital systems (Barrot, 2023). Based on these trends, a major theoretical development emerges. Such a perspective moves beyond the traditional boundaries of computer-assisted language learning, converging instead with contemporary theories of human–AI collaboration and mediated cognition, which interpret technology as co-constructing meaning and participation in educational contexts.

In this evolving theoretical context, established frameworks such as the TAM and Self-Determination Theory (SDT) provide useful yet constrained perspectives on AI adoption. TAM captures how learners see the usefulness of AI tools, and SDT elaborates how motivation and autonomy support engagement. What these models overlook, however, are the affective and ethical layers that accompany AI-mediated learning (Kasneci et al., 2023). Evidence from recent research suggests that learners' emotional engagement and well-being-related learning experiences significantly influence their adoption and sustained use of AI for language learning (Liu et al., 2024). Overall, these findings point to the need for an ACSIM that brings together motivational, emotional, and sociocultural processes within a unified explanatory framework. Furthermore, the growing importance of constructs such as positive psychology, willingness to communicate, and resilience indicates that affective engagement is being recognized as a crucial moderator of learning outcomes (Guo & Wang, 2025). This trajectory requires a redefinition of AI's educational role, transitioning from an auxiliary tutor to a socially and emotionally attuned collaborator that may foster self-efficacy, empathy, and learner autonomy through AI-mediated interaction and role-play tasks (Derakhshan et al., 2025). This re-envisioning aligns with the concept of AI as a socio-affective scaffold, facilitating cognitive development and emotional control via communicative interaction. Future scholarship should therefore progress toward developing integrative frameworks that capture the dynamic interrelationship among technology, emotion, and social engagement, thereby building a holistic theory of AI-mediated EFL learning grounded in pedagogical and ethical sustainability (Liu & Ma, 2024). Accordingly, Figure 5.1 shows the proposed ACSIM, which theoretically unifies cognitive, affective, and social dimensions to conceptualize AI as a socio-affective scaffold that co-mediate cognition, emotion, and interaction within an ethically sustainable pedagogical framework.

Figure 5
The Affective–Cognitive–Social Integration Model (ACSIM)



Practical Implications

To address the identified gaps, this study outlines several practice-oriented implications derived from the bibliometric findings, with particular attention to classroom practice, teacher professional development, and institutional governance. These implications highlight how AI may be integrated in ways that support learning quality, emotional engagement, and pedagogical coherence, while foregrounding ethical considerations in EFL education.

First, the strong prominence of clusters related to conversational AI, learner engagement, and speaking skills suggests that AI technologies are increasingly positioned as interactive partners rather than as auxiliary tools for error correction. This pattern indicates that effective classroom use of AI should prioritize communicative exploration, idea generation, and dialogic interaction, rather than accuracy-focused remediation alone (Su et al., 2023; Yan, 2023). In practice, AI-supported activities may be integrated into existing EFL curricula to facilitate pre-writing planning, oral rehearsal, and formative feedback, thereby supporting learners' metacognitive awareness and communicative confidence without requiring fundamental curricular restructuring.

Second, the growing emphasis on affective and motivational themes, reflected in co-occurrence clusters and recent keyword bursts, highlights the importance of emotionally responsive AI-supported learning environments. The findings suggest that conversational agents have been reported to support reduced anxiety, increased willingness to communicate, and sustained engagement when used as low-stakes interlocutors, a pattern also reported in recent empirical studies on AI-mediated speaking and affective support (Tai & Chen, 2023; Zhang et al., 2024). From a pedagogical perspective, this implies that AI-mediated activities should be designed not only to support linguistic development but also to foster emotional regulation, reflective learning, and learner autonomy within blended or hybrid instructional contexts.

Third, the bibliometric evidence indicates that teacher agency has been repeatedly emphasized in the literature on sustainable AI integration. The recurring presence of technology acceptance and teacher-related keywords indicates that teachers' perceived competence, ethical awareness, and pedagogical confidence substantially shape how AI is adopted in EFL classrooms. Accordingly, teacher education initiatives should move beyond basic technical training toward

progressive professional development models that integrate ethical reflection, instructional design, and classroom experimentation, echoing prior findings on teacher readiness and ethical confidence in AI-enhanced education (Mohamed, 2024; Farrokhnia et al., 2024).

Finally, the emergence of institutional- and policy-related themes points to the necessity of systemic support for AI-enhanced language education. The findings imply that responsible AI integration depends on coordinated institutional frameworks that address data privacy, transparency, and equitable access. Cross-disciplinary collaboration among educators, technologists, and policymakers appears essential for translating AI innovations into sustainable educational practices (Divekar et al., 2022; Huang et al., 2023). In this respect, institutionally supported pilot programs and monitoring mechanisms may serve as effective means of aligning technological innovation with broader educational goals, including those articulated in UNESCO's Sustainable Development Goal 4, which emphasizes inclusive, equitable, and high-quality education through responsible digital transformation (UNESCO, 2021).

Limitations and Future Research Directions

Although this bibliometric study provides a wide and structured view of the field, a few limitations should be noted. First, the analysis was limited to works indexed in the WoS Core Collection, which may have overlooked relevant research available in other databases such as Scopus or ERIC. Future investigations might employ a multi-database strategy to capture a fuller and more balanced understanding of AI-enhanced EFL scholarship. Second, as a trend-oriented bibliometric analysis, this study primarily focuses on quantitative indicators, including citation counts, keyword co-occurrence, and network structures, and thus captures research trends rather than detailed pedagogical nuances or contextual variations in classroom practice. The integration of bibliometric analysis with systematic reviews, meta-analyses, or detailed case studies would add interpretive richness to subsequent investigations. In addition, citation-based analyses may amplify the visibility of highly cited authors or closely connected research networks, which may partially reflect citation concentration rather than purely intellectual influence. As such, the findings should be interpreted with appropriate caution. Finally, given the rapid pace of generative AI development, longitudinal and mixed-method studies are needed to track emerging directions in AI-mediated EFL education and to test and refine the proposed ACSIM.

Conclusions and Implications

This bibliometric analysis provides a comprehensive and scientifically substantiated overview of the intellectual landscape, theme progression, and new research directions in AI-enhanced EFL education. The results indicate a fundamental transition from technology-focused applications to learner-centered, emotional, and ethically conscious viewpoints. In recent years, scholarship has progressed from examining AI's technical potential to focusing on motivation, self-efficacy, emotional engagement, and social interaction as key components of AI-mediated learning. From a theoretical standpoint, this research enriches current understanding by presenting the ACSIM, which views AI as a socio-affective scaffold that connects cognitive functioning, emotional regulation, and social participation within EFL contexts. From a practical standpoint, the study shows systematic approaches to classroom innovation, tiered AI literacy programs for educators, and institutional governance consistent with UNESCO's SDG 4. These insights underline the significance of integrating AI in ways that are human-centered, ethically responsible, and sensitive to emotional well-being. In essence, this study contributes to a more holistic and sustainable understanding of AI-mediated EFL education by highlighting the need to balance technological innovation with pedagogical soundness, affective well-being, and

ethical responsibility. By integrating cognitive, affective, and social perspectives, the findings offer a grounded basis for future empirical research and pedagogical development in generative AI-supported language learning.

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Declaration of Interest

The authors declare no competing interests.

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