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Unveiling Technology Integration in K-12 EFL/ESL Teaching: A Bibliometric Study Incorporating Cognitive and Affective Insights

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ABSTRACT

This bibliometric analysis offers a comprehensive review of studies concerning technology integration into English as a Foreign/Second Language instruction within K-12 settings from 2000 to 2025. Drawing on 251 peer-reviewed journal articles extracted from the Web of Science Core Collection, this study utilizes VOSviewer and Biblioshiny to examine publishing trends, citation impact, author productivity, institutional and geographic distribution, and topic evolution. Findings indicate a permanent rise in academic productivity, especially significant post-2020, primarily due to the worldwide shift to remote learning during the COVID-19 pandemic. China emerged as the foremost contributor, succeeded by the United States and Spain, with significant institutional engagement in East Asia. The primary themes encompass digital storytelling, mobile-assisted learning, augmented/virtual reality, blended/flipped learning, and artificial intelligence. A comprehensive content analysis of article abstracts indicated a changing pedagogical focus with early focus on cognitive outcomes, such as vocabulary acquisition and reading comprehension, whereas recent years have demonstrated an increasing emphasis on affective aspects, including motivation, engagement, and learner enjoyment. This tendency indicates a growing adoption of more comprehensive and learner-focused methodologies with cognitive and emotional dimensions of language acquisition. The results highlight the necessity for expanded international cooperation and broader global representation, while providing an evidence-based basis for future research and pedagogical advancements in K-12 technology-assisted language instruction.

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Realized in nearly every facet of life (Wang & Kabilan, 2024), the exponential growth of Information and Communication Technologies (ICT) has gained significant ground in the field of applied linguistics (Zhang & Zou, 2022), transforming not only how knowledge is presented but also how it is acquired and comprehended. Amid this digital transformation, generational differences regarding how individuals engage with content have become more pronounced. Specifically, the "digital natives" of today tend to process and interpret information differently from "digital immigrants" (Prensky, 2001), largely due to their continuous exposure to digital media in both academic and everyday contexts. As these differences underscore the importance of aligning instructional design and learning materials with learners' cognitive preferences and habits, technology has increasingly been adopted to foster language development both inside and outside the classroom across all levels of education. Among these, the K-12 context, spanning from kindergarten to the end of secondary education, represents a particularly critical period, as learners in this stage exhibit different developmental and cognitive characteristics compared to those in tertiary education (Song & Vermunt, 2021).

Given the unique needs of K-12 learners, researchers have sought to identify suitable conditions, modes, instructional materials, teaching-learning activities, and tools for promoting sustainable language learning environments. In this pursuit, several studies have explored the impact of technology on specific language skills such as reading (Lee et al., 2022; Ni et al., 2022), listening (Chen et al., 2022; Li, 2023), writing (Lam et al., 2018; Topacio, 2018), and speaking (Chen et al., 2016; Fathi et al., 2024), as well as on vocabulary acquisition and retention (Alfadil, 2020; Okumuş-Dağdeler, 2023), and learner motivation (Golanka et al., 2014; Jin, 2018). As a result, a large body of research has accumulated regarding the use of

Computer-assisted Language Learning (CALL), Mobile-Assisted Language Learning (MALL), Augmented Reality (AR), Gamified Learning, Virtual Reality (VR), flipped or blended learning, Artificial Intelligence (AI), chatbots, speech-to-text recognition along with a considerable number of language learning/teaching platforms/applications. Furthermore, systematic reviews and meta-analyses were conducted to consolidate the findings and summarize the impacts of these technologies on the teaching/learning of language skill(s). However, systematic reviews and meta-analyses often focus on isolated types of educational technology (Zhang & Zhou, 2022) and, therefore, fall short of providing a comprehensive picture of overarching trends, influential sources, seminal works, contributing countries, and the relationships among them, including shifts in research focus over time, thus highlighting the need for a bibliometric study. Furthermore, although a small number of bibliometric studies have focused on the tertiary level (e.g., Wang & Kabilan, 2024), to the best of the authors' knowledge, no such study has examined the K-12 context. To address this gap, the present study aims to map the conceptual, intellectual, and social structure of the research landscape on technology integration in K-12 language education from 2000 to 2025, with particular attention to studies emphasizing cognitive and affective learning outcomes. Accordingly, this study seeks to answer the following research questions:

1. What is the current research status of technology use in EFL/ESL learning in the K-12 context?
2. Which studies, authors, institutions, countries, and sources have been most influential in shaping the field?
3. How has the scholarly focus on technology integration in K-12 EFL/ESL teaching evolved over time between 2000 and 2025?
4. How are cognitive and affective learning perspectives represented in this body of literature?

2. Literature Review

As English has been widely accepted as a lingua franca, offering individuals opportunities such as improved (inter)national job prospects, academic advancement, and social prestige (Bolton et al., 2023); an increasing number of people are motivated to learn or acquire it due to both intrinsic and extrinsic factors. In such an increasingly competitive world, the importance of English has grown even further, prompting stakeholders/individuals to seek more effective ways of learning/teaching it. As a result, in parallel with advancing technology, a growing body of research has emerged in the field, exploring how English can be taught and learned more efficiently by adopting/adapting recent technological innovations both inside and outside language classrooms, some of which are summarized below.

Coşgun-Demirdağ et al. (2025) investigated how AR-supported English activities affected preschoolers' color vocabulary development compared to traditional activities. Findings from this mixed-methods study with 44 students revealed that AR activities not only enhanced vocabulary acquisition but also supported cognitive, affective, and social development. Chen et al. (2025) investigated the effect of a mobile AR software with a pedagogical agent on EFL vocabulary acquisition among 60 third-grade students. Emphasizing the advantages of emotionally responsive agents in language acquisition, the study found that students using the agent-supported application had more vocabulary gains, motivation, and enjoyment than those utilizing non-agent AR or conventional approaches. Hoang and Hoang (2024) investigated the influence of Google Docs-based collaborative writing on the academic writing skills of EFL high school students in an online course. Using a sequential mixed-methods design with 24 Vietnamese learners, the study revealed notable improvements in task response and lexical acquisition, while gains in grammar and coherence were limited. Furthermore, students highlighted the platform's usefulness for idea generation, peer feedback, and essay organization, though they expressed mixed feelings about enjoyment and reported challenges such as screen fatigue and limited interactivity. Benlaghrissi and Ouahidi (2024) found that combining MALL with Project-Based Learning (PBL) significantly improved Moroccan secondary students' speaking skills compared to PBL alone or traditional teaching as the MALL-PBL group showed greater gains in fluency, vocabulary, grammar, and pronunciation, and reported highly positive attitudes toward the lessons. Hsieh and Lee (2023) examined the impacts of robot-assisted digital storytelling compared to PowerPoint-assisted digital storytelling on EFL middle school students. The robot-assisted group had superior storytelling performance, increased pleasant emotions, and enhanced perseverance. Students indicated increased engagement and satisfaction, highlighting the advantages of socially interactive technologies in language acquisition.

In response to the increasing volume of empirical research, scholars have also adopted meta-analytical approaches to draw overarching conclusions regarding the efficacy of technology-enhanced language learning. Meta-analyses compile results from several primary investigations, providing significant insights into impact sizes and moderating variables, thereby enhancing our comprehension of effective interventions, target populations, and contextual factors (Oswald & Plonsky, 2010). Lin and Lin (2019) conducted a meta-analysis of 33 (quasi-) experimental studies published between 2005 and 2018, examining the effects of mobile technologies on vocabulary retention. Their findings revealed a strong positive effect of mobile-assisted interventions on vocabulary retention. Additionally, the learning context, duration of intervention, and the level of learner autonomy were identified as significant moderating variables influencing the outcomes. In their meta-analysis of 84 studies spanning from 1990 to 2015, Chang and Hung (2019) explored the effectiveness of technology-enhanced instruction in ESL. The analysis revealed a large overall effect size,

underscoring the positive influence of technology in language education. Furthermore, the effectiveness of technology use was significantly moderated by factors such as working with small groups of learners at the tertiary level and employing general-purpose applications rather than language-specific learning tools. Chen et al. (2022) conducted a meta-analysis of 21 studies to examine the effects of VR on language education. The results demonstrated a moderate positive impact of VR on both language learning outcomes and affective gains, with hardware type identified as the only significant moderating variable.

Despite the expanding corpus of empirical and meta-analytical studies about technology's application in language education, a significant portion of this literature remains fragmented, frequently concentrating on particular technologies and language skills. Systematic reviews and meta-analyses, however beneficial, generally focus on specific variables or interventions and seldom offer a comprehensive perspective of the research landscape (Ma et al., 2023). Furthermore, they predominantly focus on university education, resulting in a relative neglect of the K-12 context. This disparity is especially significant considering the distinct developmental, cognitive, and emotional requirements of non-tertiary level learners, who may react differently to technology-enhanced education. In order to bridge these gaps and provide a thorough overview of prevailing trends, key contributions, collaborative dynamics, and shifting research emphases, as well as an evidence-based framework for future studies, conducting a bibliometric analysis is both timely and necessary and constitutes the scope of the current study.

3. Methodology

3.1. Research Design

The current study adopts bibliometric analysis in order to unveil how technology integration has evolved both in scope and direction in K-12 context spanning from 2000 to 2025. Bibliometric analysis plays a critical role in interpreting and delineating the cumulative body of scientific knowledge and the evolutionary dynamics of established research fields (Donthu et al., 2021). By systematically analyzing large volumes of unstructured bibliographic data, bibliometric studies offer scholars a comprehensive overview of the intellectual landscape. Such analyses can reveal research trends, identify knowledge gaps, generate novel research questions, and assist researchers in positioning their future contributions within the broader scholarly discourse (Donthu et al., 2021).

3.2. Data Collection and Analysis

The data for this bibliographic study were retrieved from the Web of Science (WoS) Core Collection, a widely recognized database for high-impact scholarly works. The search was confined to peer-reviewed journal articles published in English from 2000 to 2025 to ensure relevance and consistency. A comprehensive search strategy was implemented utilizing Boolean operators, which are logical connectors (AND, OR, NOT) that filter search results by combining or eliminating phrases, thereby improving search precision (Gusenbauer & Haddaway, 2020).

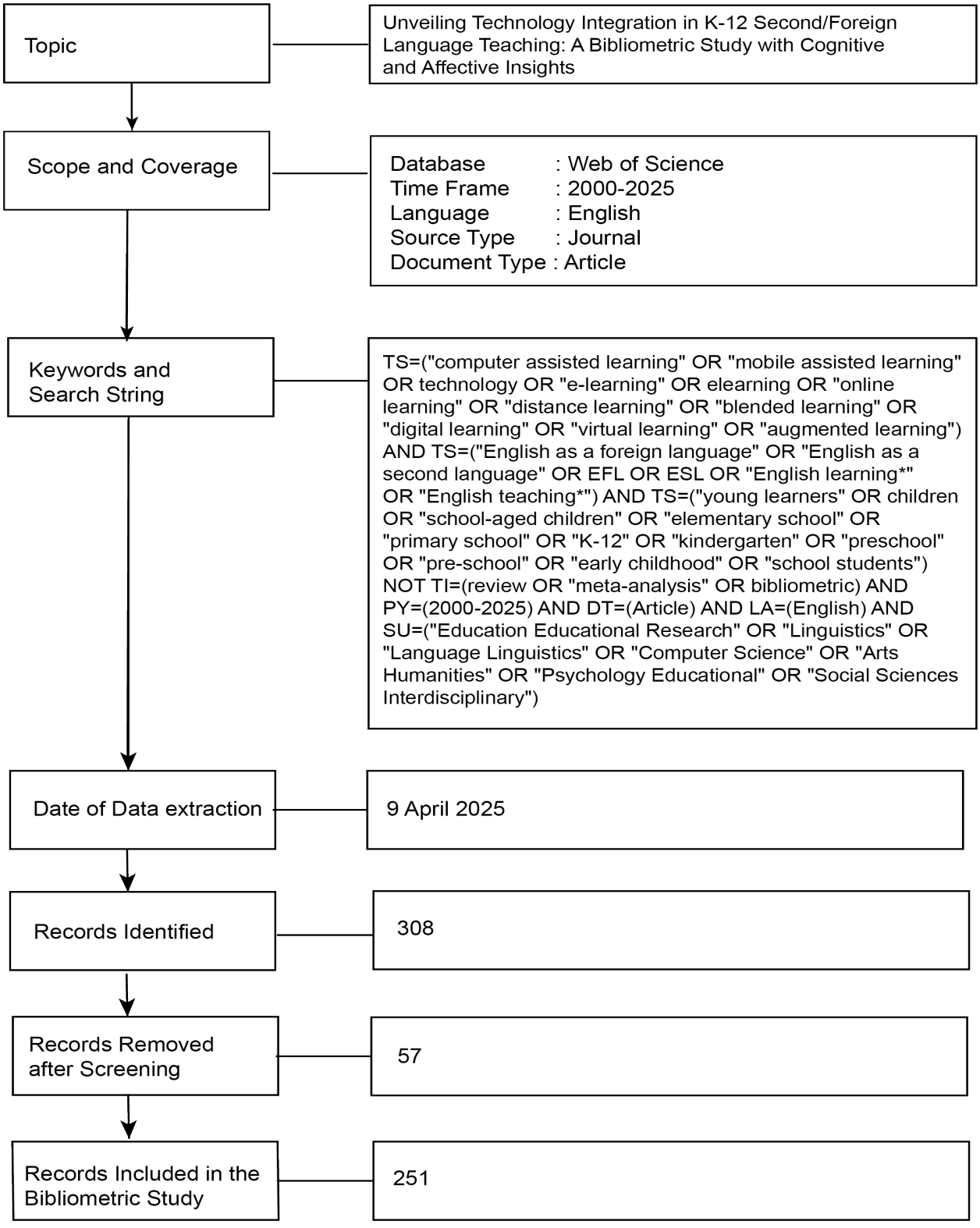

Figure 1
The flow diagram for data retrieval, screening, and selection

The carefully formulated string integrated three dimensions: technology use in education (e.g., "computer-assisted learning," "mobile-assisted learning," "online learning"), (2) language learning contexts (e.g., "English as a second language," "EFL," "ESL"), and (3) target population (e.g., "young learners," "primary school," "K-12"). Figure 1 illustrates the comprehensive search string and provides the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram. PRISMA is a standardized framework that visually illustrates the sequential phases of article identification, screening, eligibility evaluation, and final inclusion to ensure transparency and replicability in the review process (Moher et al., 2009).

To ascertain article eligibility, the titles and abstracts of all retrieved records were manually reviewed according to the following inclusion and exclusion criteria. Studies were included if they (a) concentrated on K-12 context, (b) incorporated any form of technology in language education, and (c) were directly related to EFL or ESL instruction and learning. Studies were rejected if they (a) exclusively addressed tertiary or higher education contexts, (b) lacked the incorporation of technology in the instructional methodology, or (c) concentrated solely on educator perspectives without considering learner-oriented findings. Following the application of these criteria, 57 papers were removed, resulting in a final dataset of 251 publications for analysis.

Two bibliometric tools were utilized to analyze the dataset. VOSviewer was employed to create visual representations of co-authorship networks, co-citation patterns, and keyword co-occurrences, facilitating the identification of significant research clusters and collaboration frameworks. Furthermore, Biblioshiny, the web-based interface of the R software Bibliometrix, was employed to undertake descriptive and performance-based analyses, including publication trends over time, identification of the most influential sources and authors, country-level contributions, and thematic evolution. These tools enabled both quantitative and qualitative insights into how technology integration in K-12 EFL/ESL education has been conceptualized, studied, and evolved over the past twenty-five years.

4. Findings

Before presenting the findings, it is essential to provide a descriptive overview of the dataset to establish a contextual foundation for the analysis. Table 1 presents a summary of the dataset retrieved from WoS. The dataset comprises 251 journal articles published in English between 2005 and 2025, averaging 5.12 documents per year. These publications were authored by a total of 648 scholars. Of these, 44 authors contributed to single-authored publications, which account for 47 documents. Notably, 17.13% of the articles resulted from international collaborations.

Table 1
Basic Information about the Data

Description	Results
Timespan	2005:2025
Source type	Journals
Sources (Journals)	120
Documents	251
Annual growth rate %	11.61
Average citation per doc	16.08
Document average age	5.12
Authors	648
Authors of single-authored docs	44
Single-authored docs	47
Internal co-authorship %	17.13

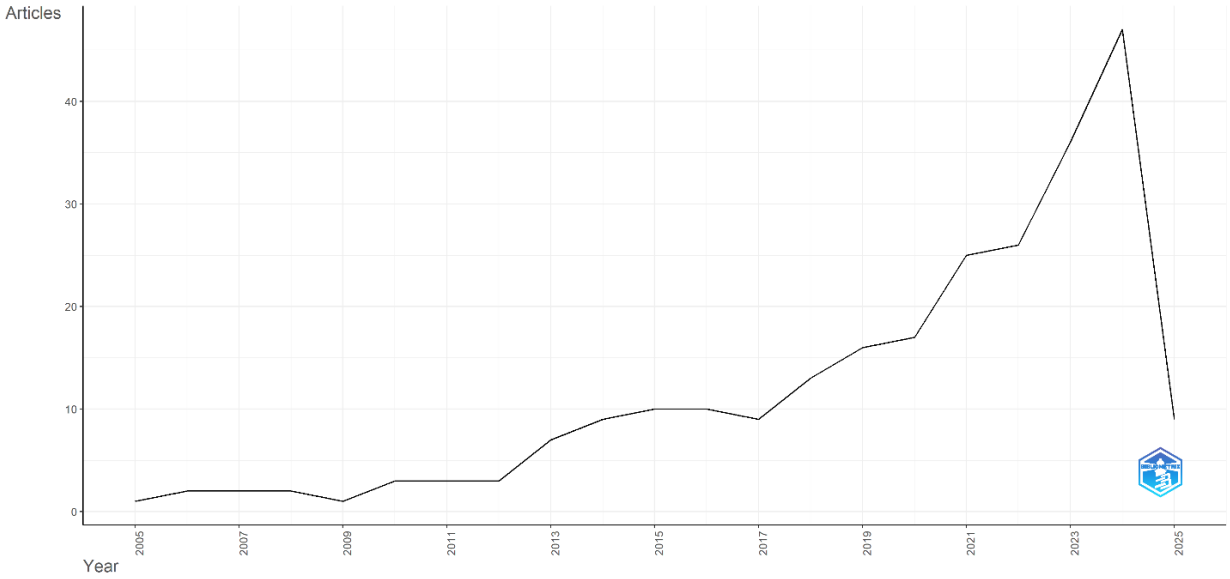

Figure 2
Annual scientific production

Figure 2 illustrates the annual scientific production concerning technology integration in K-12 EFL/ESL instruction, consistent with the scope of this bibliometric analysis. The data indicates a consistent increase in academic production from 2005, marking the year the first article on the topic indexed in WoS, with a significant rise commencing in 2020. This increase indicates an intensified scholarly focus on the convergence of technology and language education during and subsequent to the COVID-19, possibly propelled by the worldwide transition to digital learning platforms. Although a sharp drop is observed in 2025, this decline does not reflect an actual decrease in research activity. Rather, it is due to the fact that the data for this study were extracted at the beginning of April 2025 and does not cover the prospective articles in the relevant topic.

Table 2
Top 10 Most Cited Articles

Author(s)	Title	Source Title	TC	C/Y
Liu, F., Chen, M. C., Sun, Y. S., Wible, D. & Kuo, C. -H. (2010)	Extending the TAM model to explore the factors that affect Intention to use an online learning community	Computers and Education	451	28.19
Yang, Y. -T. & Wu, W. -C. I. (2012)	Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study	Computers and Education	329	23.50
Sandberg, J., Maris, M., de Geus, K. (2011)	Mobile English learning: An evidence-based study with fifth graders	Computers and Education	198	13.20
Yang, J. C., Chen, C. H. & Jeng, M. C. (2010)	Integrating video-capture virtual reality technology into a physically interactive learning environment for learning English	Computers and Education	130	8.13
Tsou, W., Wang, W. & Tzeng, Y. (2006)	Applying a multimedia storytelling website in foreign language learning	Computers and Education	127	6.35
Han, J. -H., Jo, M. -H., Jones, V. & Jo, J. -H. (2008)	Comparative study on the educational use of home robots for children	Journal of Information Processing Systems	113	6.28
Jeon, J. (2022).	Exploring AI chatbot affordances in the EFL classroom: Young learners' experiences and perspectives	Computer Assisted Language Learning	112	56
Verdugo, D. R. & Belmonte, I. A. (2007)	Using Digital Stories to Improve Listening Comprehension with Spanish Young Learners of English	*Language Learning and Technology*	103	5.42
Chen, M. -P., Wang, L. -C., Zou, D., Lin, S. -Y., Xie, H. & Tsai, C. -C. (2020)	Effects of captions and English proficiency on learning effectiveness, motivation and attitude in augmented-reality-enhanced theme-based contextualized EFL learning	Computer Assisted Language Learning	86	21.50
Lee, J. S. & Lee, K. (2020)	The role of informal digital learning of English and L2 motivational self system in foreign language enjoyment	Computer Assisted Language Learning	78	15.16

Note. T/C refers to Total Citation, C/Y refers to Citation per Year

4.1. Papers with the Highest Citation Counts

The analysis conducted in Biblioshiny provides information about the citation counts of each article in the dataset, with the top 10 most highly cited articles presented in Table 2. The article with the highest citation count, i.e. 451 citations, averaging 28.19 citations per year, *Extending the TAM model to explore the factors that affect intention to use an online learning community,* is authored by Liu et al. (2020). This study expands the Technology Acceptance Model (TAM) by incorporating additional variables to investigate high school students' intentions to use an online English learning community (IWiLL) in Taiwan. Utilizing Structural Equation Modeling (SEM) with data from 436 students, the study demonstrates a strong model fit, supporting the extended framework. The findings suggest that course design, user-friendly interfaces, and interactive features can enhance engagement and the perceived acceptability of technology in online language learning contexts.

The second most cited article, *Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study*, was conducted by Yang and Wu (2012), with 329 citations and an average of 23.50 citations each year. This research examines how digital storytelling facilitates language acquisition by enhancing academic performance and student motivation. The results reveal that digital storytelling enhanced students' comprehension of course material, eagerness to investigate, and capacity for critical thinking.

The third most cited article is by Sandberg et al. (2011), entitled *Mobile English learning: An evidence-based study with fifth graders* with 198 citations and an annual citation rate of 13.20. This study examines MALL in elementary environments and provides empirical evidence for the utilization of mobile technology to improve English learning in young learners, indicating that mobility and interaction can yield substantial educational advantages.

Integrating video-capture virtual reality technology into a physically interactive learning environment for learning English by Yang et al. (2010) is the fourth most cited article. Having 130 citations which translates into a rate of 8.13 per year, this study demonstrated that immersive technologies significantly contribute to second-grade young learners' language achievement and motivation.

The fifth article by Tsou, Wang, and Tzeng (2006), entitled *Applying a multimedia storytelling website in foreign language learning*, has received 127 citations, averaging 6.35 citations annually. Conducted with fifth graders in an elementary school in Taiwan, the study revealed that the multimedia storytelling website enhances learners' comprehension, retention and creative reproduction significantly.

Han et al. (2008) occupies the sixth place with their work *Comparative study on the educational use of home robots for children*. Having 113 citations, with an average rate of 6.28 citations per year, this study emphasizes the novel application of robots in education, particularly for young learners, demonstrating how interactive agents can assist with language-related activities.

The seventh article by Jeon (2022), titled *Exploring AI chatbot affordances in the EFL classroom: Young learners' experiences and perspectives* has garnered 112 citations, averaging 56 citations annually, indicating its current significance. The research examines the role of chatbots in assisting young EFL learners, offering insights into the interactional and motivational aspects of AI-enhanced educational settings.

Ranked eighth, Verdugo and Belmonte (2007) authored *Using digital stories to improve listening comprehension with Spanish young learners of English* with 103 citations and an average of 5.42 citations per year. This study underscores the advantages of digital storytelling, notably in enhancing listening comprehension abilities among young EFL learners.

Receiving 86 citations with an average of 21.50 citation each year, the study by Chen et al. (2020) titled *Effects of captions and English proficiency on learning effectiveness, motivation, and attitude in augmented-reality-enhanced theme-based contextualized EFL Learning* is the nineth most cited article. The

study investigates the convergence of captioning, learner proficiency, and the application of AR in EFL settings with high school students. The results highlight the capacity of AR-enhanced instruction to cultivate more engaging and successful language learning experiences, particularly when customized to learners' ability levels and supplemented with visual aids such as captions.

Finally, *The role of informal digital learning of English and L2 motivational self-system in foreign language enjoyment* by Lee and Lee (2021) is cited 78 times yielding an average citation score of 15.16 per year. This study examines the influence of informal digital learning experiences on learners' satisfaction in foreign language settings, specifically through the framework of the L2 motivating self-system. The findings indicate that informal, technology-mediated learning can substantially enhance sustained interest and emotional involvement in EFL situations.

4.2. Most Productive Authors

Figure 3 and Table 3 demonstrate the most productive authors in the dataset. Figure 3 illustrates each author's active publishing span through horizontal lines, while blue circles depict the number of articles published annually. The size of each circle corresponds to publication volume, and the depth of the blue shading indicates the relative citation impact for that year. Accordingly, the most prolific contributor is Chen, N. S., who maintained scholarly work for a long time (2011-2023), with a particularly high level of engagement around 2020. This continued engagement corresponds with Table 3, which indicates that Chen, N. S. produced six papers, 2.39% of the overall dataset.

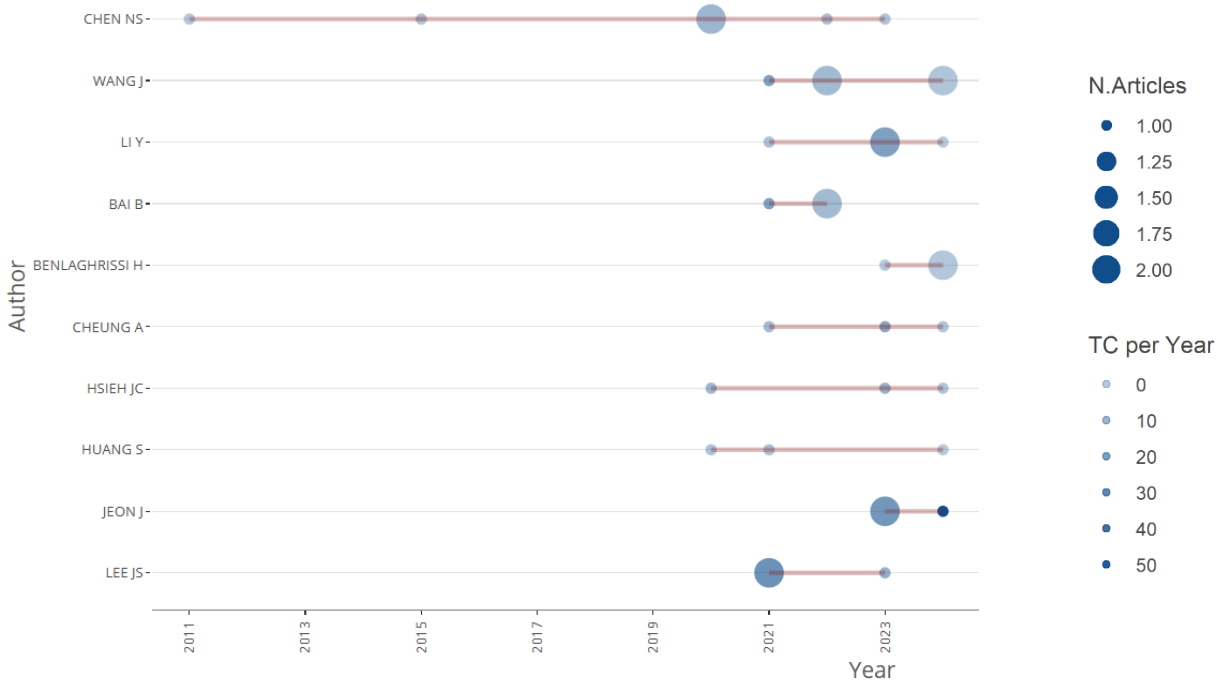

Figure 3
Publication timeline of the most productive authors

Table 3
Most Productive Authors

Author Name	TP	%
Chen, N. S.	6	2.39
Wang, J.	5	1.99
Li, Y.	4	1,09
Bai, B.	3	1.59
Benlaghrissi, H.	3	1.19
Cheung, A.	3	0.75
Hsieh J. C.	3	0.67
Huang, S.	3	0.92
Jeon, J.	2	0.42
Lee, J. S.	2	0.67

Additional significant contributors are Wang, J. (5 publications; 1.99%), Li, Y. (4 publications; 1.09%), and Bai, B. (3 publications; 1.59%), all of whom have demonstrated increased production, especially after 2020. Li, Y. stands out not just for publishing frequently, but also for having highly cited work, as shown by the large and dark citation bubbles in Figure 3. The emergence of recent active contributors like Benlaghrissi, H., Jeon, J., and Lee, J. S., each with two or three publications, signifies the dynamic and growing landscape of scholarly involvement in this field. These findings indicate a dynamic research landscape, characterized by the ongoing contributions of established writers and the rise of new voices in the area.

A three-field plot was also created to examine the correlation among author keywords, contributing authors, and their associated countries within the realm of technology-enhanced English language learning. Figure 4 illustrates both the dominant study themes and the geographical distribution of academic contributions. Primary study areas encompass EFL, language learning, e-learning, digital storytelling, vocabulary learning, blended learning and artificial intelligence, indicating an increasing interest in the incorporation of educational technologies into language teaching. Authors such Wang, J., Chen, N. S., and Li, Y., from China, make contributions to fields in digital storytelling, motivation, and artificial intelligence within EFL contexts. Wang, F. and Yang, Y. concentrate on EFL and vocabulary acquisition, whereas Ogata, H. from Japan is linked to technology and blended learning. Other authors, including Yeh, H. C. and Hsieh, J. C., investigate areas such as reading and ESL, demonstrating varied interests across different geographies. China is the foremost contributor, succeeded by Japan, Spain, Korea, and Malaysia, indicating a significant presence from Asia and partially from Europe. Reading and vocabulary acquisition seems to be the primary focus of technology integration in language skills, perhaps due to their compatibility with scalable, personalized digital interventions. Productive abilities, including writing and speaking, are less represented in the current dataset, probably due to the technical difficulties associated with automated feedback and assessment in these domains. The analysis reveals a thematically diverse yet geographically concentrated research landscape, with China as a pivotal player.

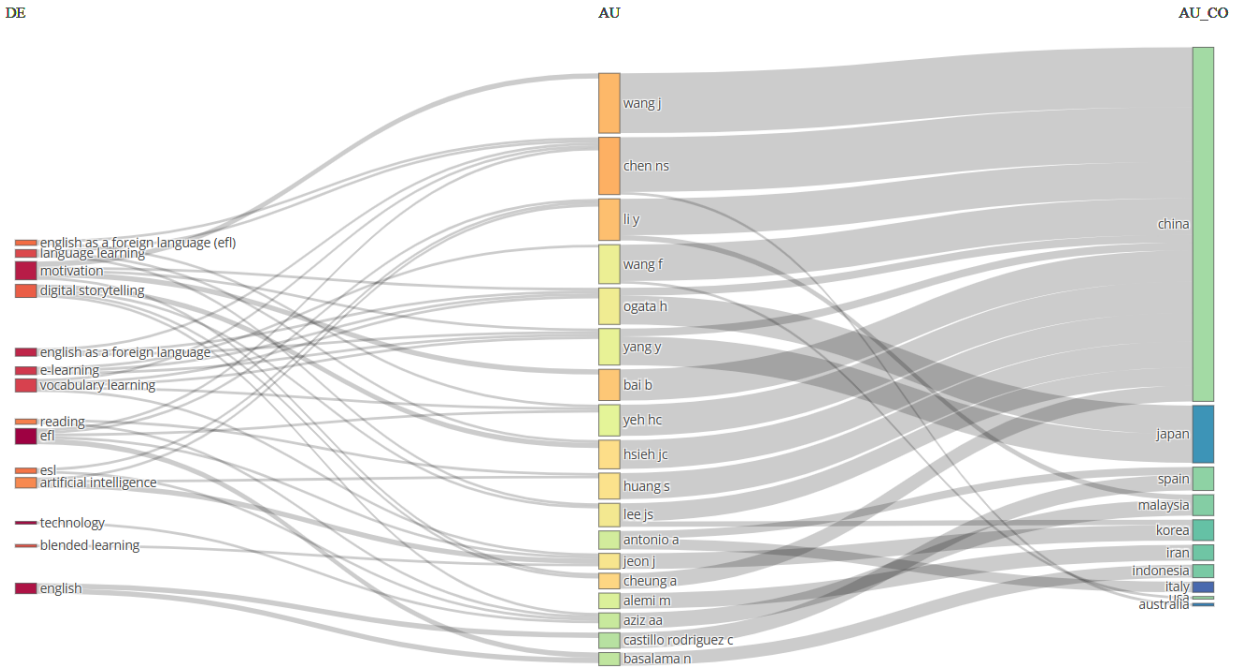

Figure 4
Three-field plot of author's keywords (DE), authors (AU) and authors' countries (AU_CO)

4.3. The Most Productive Universities

Table 4 demonstrates the ten most productive universities making contributions to the field of study. The findings indicates that Universiti Kebangsaan Malaysia tops the list with 21 publications, representing 8.36% of the total output. National Central University (Taiwan) and The Chinese University of Hong Kong follow, with 16 (6.37%) and 14 (5.57%) publications, respectively. Institutions from East Asia prominently feature on the list, encompassing multiple universities from Taiwan, Hong Kong, and Japan. This regional concentration indicates a significant academic focus and investment in the subject within this area. Türkiye located in the intersection of Asia and Europe is the only country standing out of the East Asia cluster.

Table 4
Top 10 Most Productive Universities

University Name	TP	%
Universiti Kebangsaan Malaysia	21	8.36
National Central University (in Taiwan)	16	6.37
The Chinese University of Hong Kong	14	5.57
Beijing Normal University	12	4.78
The Education University of Hong Kong	11	4.38
National Taiwan Normal University	11	4.38
Asia University (in Taiwan)	10	3.98
National Yunlin University of Science and Technology (in Taiwan)	10	3.98
Kyoto University (in Japan)	8	3.18
Atatürk University (in Türkiye)	7	2.78

4.4. The Most Productive Countries

Table 5 illustrates the ten most productive countries. China is the foremost contributor with 79 articles, accounting for 31.47% of the total, underscoring its dominance in the field. The United States has 26 publications (10.35%), followed by Spain with 18 publications (7.17%). The inclusion of nations like Malaysia, Iran, Indonesia, Türkiye and Saudi Arabia signifies an increase in research endeavors within developing and non-Western countries. Overall, the information shows a variety of research contributions at the global level as well as regional productivity clusters.

Table 5
Top 10 Most Productive Countries

Country Name	TP	%
China	79	31.47
The USA	26	10.35
Spain	18	7.17
Malaysia	14	5.57
Iran	13	5.17
Indonesia	10	3.98
Korea	10	3.98
Türkiye	8	3.18
The UK	8	3.18
Saudi Arabia	6	2.39

The geographical distribution of research on technology integration in K-12 EFL and ESL instruction from 2000 to 2025 indicates considerable global differences in academic production. Figure 5 indicates that China leads the field with 260 articles, representing a significant share of global research. Subsequently, the United States (72), Spain (44), Malaysia (42), and Indonesia (31) follow, indicating that a significant portion of research activity is centralized in East Asia, North America, and certain regions of Europe and Southeast Asia. Simultaneously, moderate contributions from nations including the UK, Iran, Türkiye, and Australia indicate an increasing but regionally diverse involvement with the subject. Significantly, extensive regions of Africa and Central Asia are either inadequately represented or entirely excluded from the research domain, underscoring a considerable deficiency in global academic engagement.

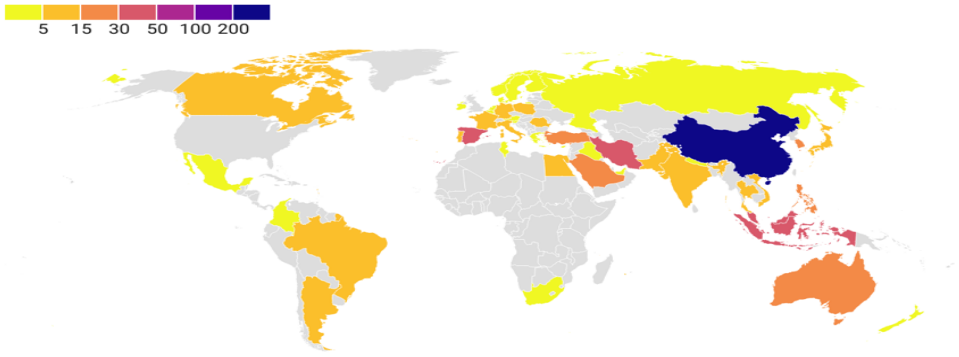

Figure 5
Global research map: Technology in K-12 EFL/ESL (2000-2025)

4.5. The Collaboration between Countries

The bar chart in Figure 6 depicts the quantity of articles generated by top 20 countries, differentiating between Single Country Publications (SCP) and Multiple Country Publications (MCP), emphasizing both national and international collaborative endeavors. China stands out as the foremost contributor, with a significant majority of its papers classified under the SCP category, reflecting a strong domestic research foundation and minimal foreign collaboration in relation to its overall output. Chinese researchers appear to work together primarily within national borders. Despite having a lower total productivity than China, the United States has a comparatively higher percentage of MCPs highlighting its proactive involvement in foreign research collaborations. The third most productive country is Spain, which exhibits balanced output with a noticeable percentage of MCPs. Malaysia and Iran are significant contributors with research mostly focused on SCPs, indicating local research initiatives with minimal international engagement. Countries like Indonesia, Korea, Turkey, and the United Kingdom demonstrate modest output levels, accompanied by differing extents of international collaboration. Countries lower on the list such as Saudi Arabia, and Australia exhibit a presence with comparatively lesser volumes while showcasing international cooperation. This demonstrates how smaller research communities are strategically involved in international collaborations. At the lowest end of the range, nations such as Colombia, Greece, Morocco, Finland, and Italy have the least contributions to the global research landscape. Notably, even within the lowest end of the list, there is evidence of MCPs in Japan, Germany, and Iraq, highlighting the progressively interconnected nature of academic publication, even for nations with diminished productivity. The data reveal a global trend in which nations with heightened scientific output primarily rely on domestic collaboration, while countries with moderate or developing research profiles more often engage in international collaborations to improve visibility.

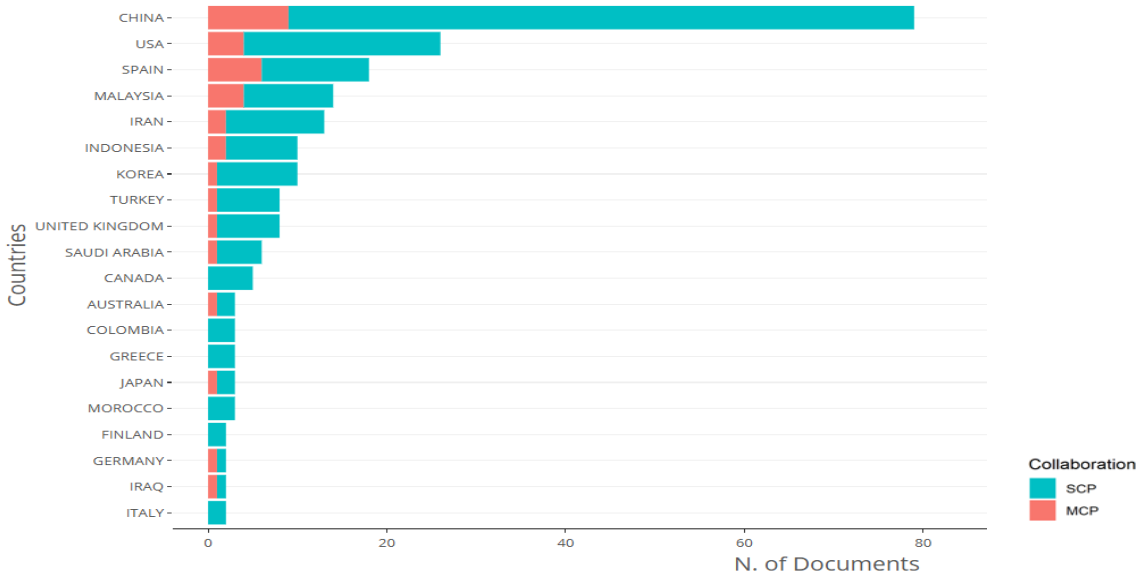

Figure 6
The single country and multiple country publications of top twenty countries

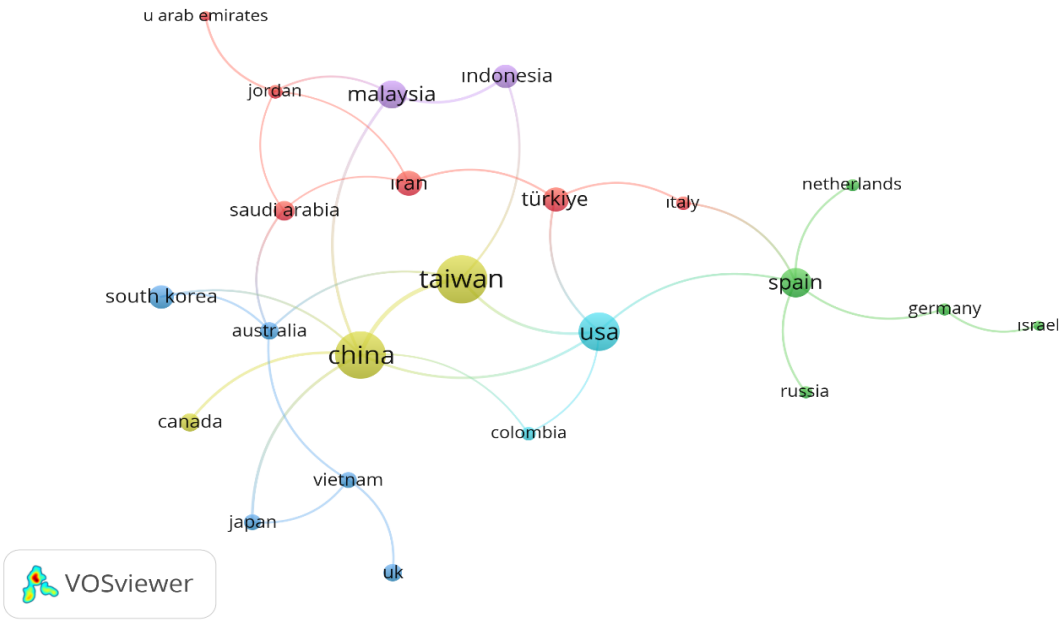

Figure 7
The map of collaborating countries

In order to have a better grasp of the collaborating counties, a VOSviewer visualization was also performed and presented in Figure 7. The map illustrates a moderately interconnected global research landscape, with certain prominent countries acting as principal centers of international collaboration, while others seem more peripheral or isolated. China, the USA, Taiwan, and Spain are major nodes characterized by a significant number of international co-authorship connections. China is notably significant, acting as a principal country linking several regions, including Asia (e.g., Japan, South Korea, Vietnam), and North America (e.g., Canada, the USA). Similarly, the USA is also central, engaging in collaboration with nations in both Europe (e.g., Spain, Italy) and Latin America (e.g., Colombia), underscoring its position as a worldwide research partner. Spain is a prominent European center, engaging in strong collaborations with Germany, the Netherlands, Russia, and Israel, indicating a robust intra-European research network. Conversely, nations such as Türkiye, Iran, Malaysia, and Indonesia are present in the network but exhibit limited and more localized partnerships. The map indicates that international collaboration in this domain is primarily propelled by a few groups of prominent nations, although numerous others exhibit predominantly localized or regional co-authorship trends.

4.6. Trend Topic Evolution

The trend topic analysis chart provided in Figure 8 depicts the progressive development of research topics in the K-12 education over time. The analysis conducted in Biblioshiny indicates that initial research from approximately 2006 to 2012 concentrated on fundamental pedagogical methodologies, including interactive learning, enhancement of classroom instruction, and primary education. These topics underscore a focus on improving classroom experiences and essential teaching methodologies. Beginning in 2014, the field experienced a diversification of subjects, marked by a growing interest in discussion, instructional methodologies, and teacher education, indicating a transition towards

pedagogical efficacy and professional development for educators. The use of terminology such as attitude and assessment indicates an increasing focus on learner perspective and evaluative methods.

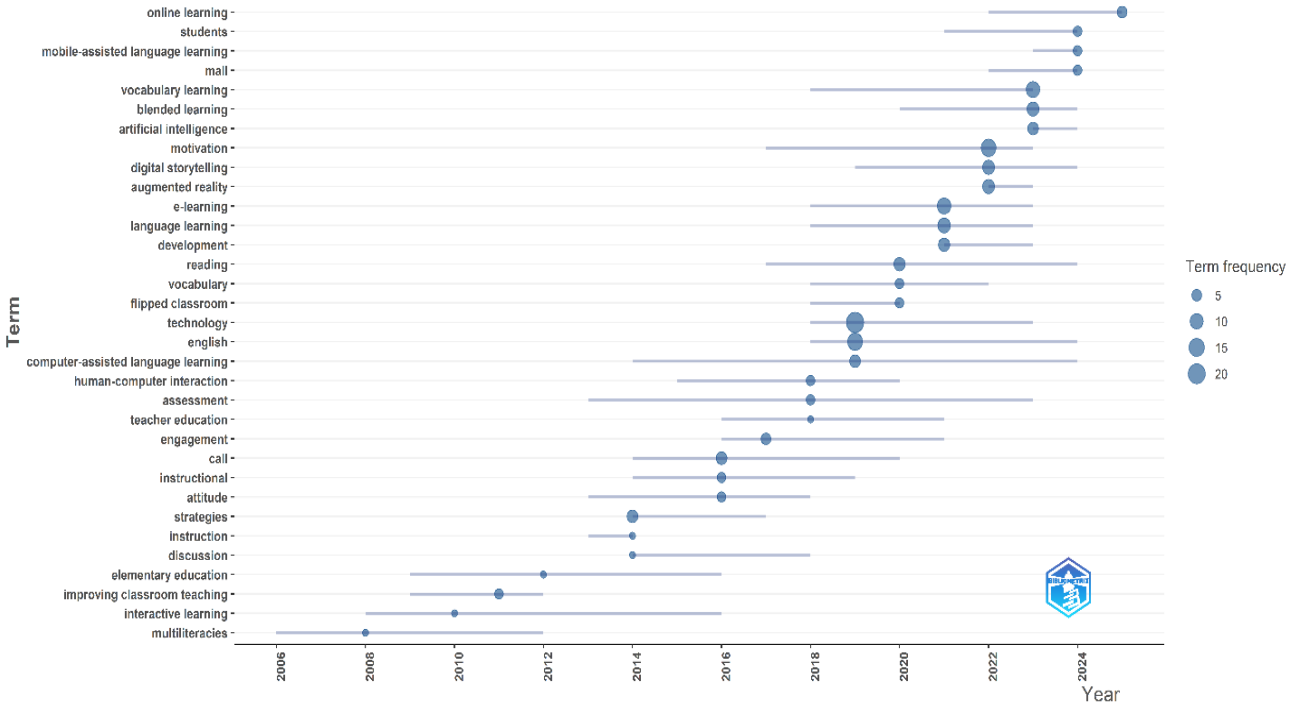

Figure 8
Trend topics (authors' keywords)

Starting from 2016, the impact of technology became increasingly significant. Terms such as CALL, technology, and flipped classroom have emerged, reflecting worldwide educational trends and the incorporation of digital instruments in classrooms. The most notable transition emerged from 2019 onwards, characterized by a pronounced increase in technology-driven and creative pedagogical approaches. Subjects such as artificial intelligence, augmented reality, digital storytelling, and MALL have gained significant prominence. The recent topics signify a transition towards personalized, interactive, and immersive learning experiences in K-12 education. Significantly, the keyword "online learning" has emerged, especially post-2020, presumably because of COVID-19 and the immediate shift to remote education. Moreover, concepts like motivation, engagement, and blended learning suggest that, despite the prominence of technology, learner-centered methodologies continue to be essential. The simultaneous increase in vocabulary acquisition and language learning indicates that language education remains a significant emphasis in K-12 studies. The evolution of subjects demonstrates a distinct progression from conventional instructional issues to sophisticated, technology-enhanced, and student-centered learning methodologies

4.7. Keyword Co-occurrence by Authors' Keywords

The keyword co-occurrence network depicted in Figure 9 illustrates a well-organized and topically varied research landscape in the field of technology-enhanced EFL/ESL instruction in the K-12 context.

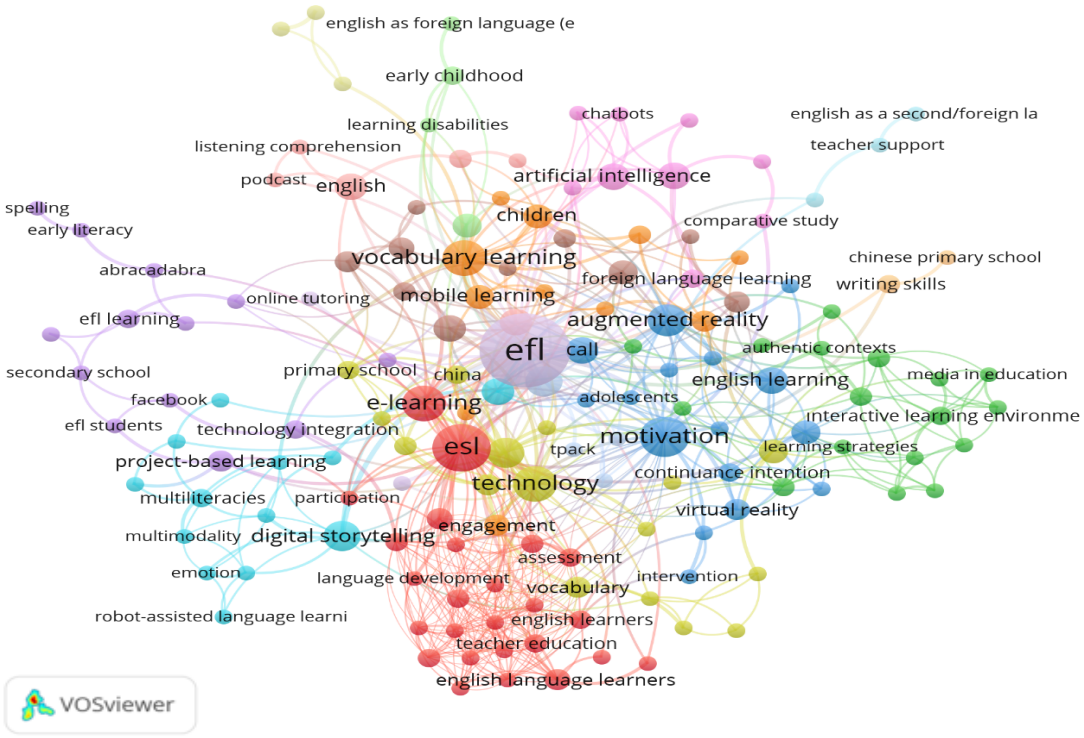

Figure 9
Keyword co-occurrence (by author's keywords)

Core terms like "EFL", "ESL," and "technology" underpin the network, signifying their essential relevance across several study domains. The clusters correspond to topic areas, such as early literacy and school-based EFL interventions (purple cluster), pedagogical techniques and teacher development in ESL environments (red cluster), and learner motivation and engagement with digital technologies (blue cluster). Additional clusters emphasize the incorporation of immersive and interactive learning environments (green), vocabulary enhancement via mobile and augmented reality applications (orange), and the implementation of new technologies like artificial intelligence and chatbots (pink). The existence of overlapping and interconnected nodes indicates a significant level of interdisciplinarity, with educational technology acting as a facilitator across various learner demographics and instructional environments. This image highlights the dynamic progression of the discipline and the increasing focus on learner-centered, technology-enhanced language teaching.

4.8. The Co-authorship by Authors

The co-authorship networks summarized in Figure 10a and 10b demonstrate a significant pattern of dispersed collaboration across the discipline. Despite the substantial number of contributors, the network in 10a reveals only a restricted number of well-connected author clusters, with a considerable number of researchers standing as lone nodes or in small, disconnected groupings. This indicates that a significant number of authors either published independently or collaborated within limited networks, leading to a small inter-group interaction. The principal collaborative group is centered on Wang J., who is associated with multiple co-authors, including Bai

B., Chai C. S., and Zhou H., creating a dense subnetwork. Nevertheless, most of the remaining authors belong to loosely affiliated or completely separated nodes, signifying low overall network coherence. This pattern suggests that academics in this field have a tendency to work inside certain institutional or national contexts rather than frequently collaborating across institutions or disciplines.

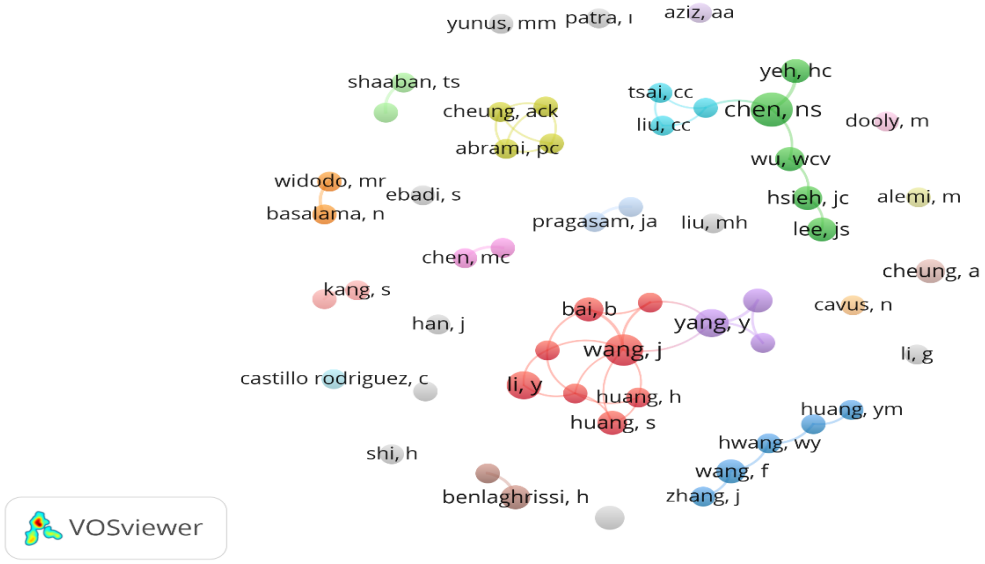

Figure 10a
Co-authorship by authors (All authors)

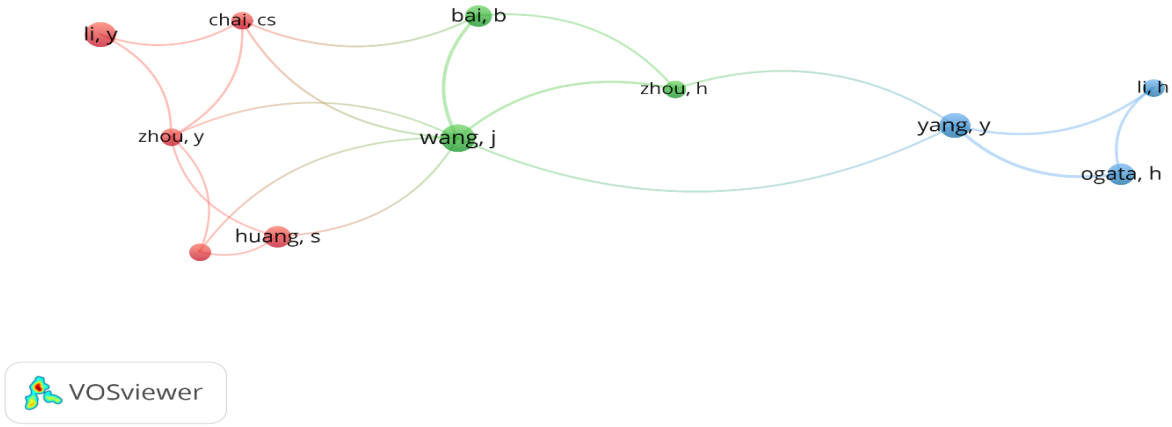

Figure 10b
Co-authorship by authors

The representation of only a small subset of the 648 authors in the primary network cluster in Figure 10b reinforces the notion that collaboration is not a prevalent method of research output in this field. Overall, although there are instances of robust co-authorship, the dominant structure indicates a fragmented and loosely connected academic community, highlighting the opportunity for enhanced integration and collaboration among research groups in the future.

4.9. Co-citation of Cited Authors

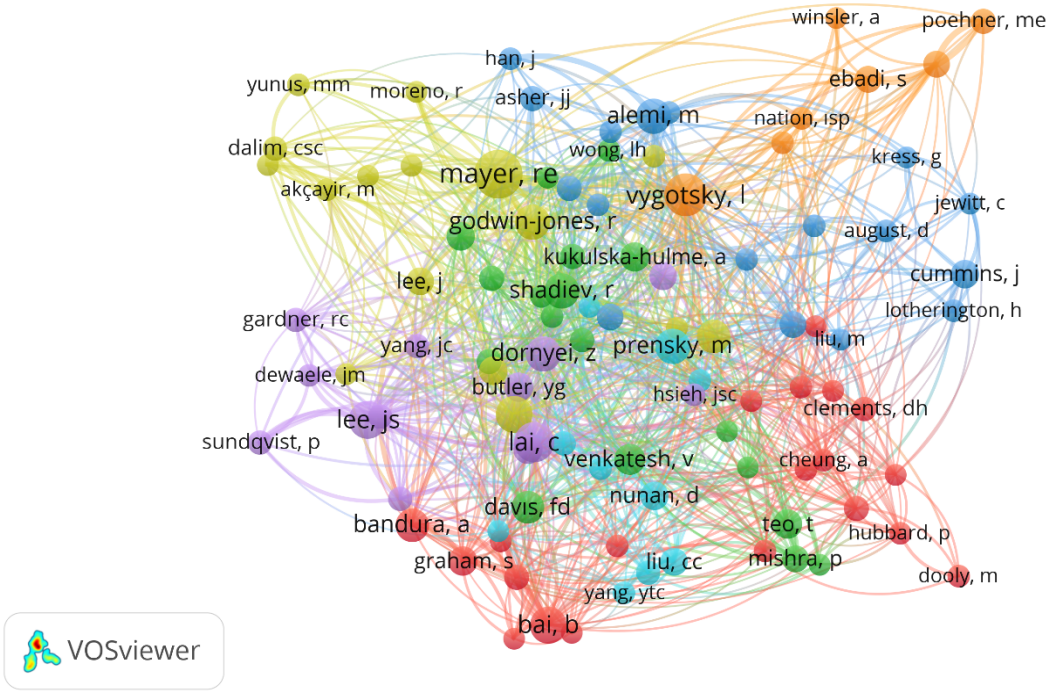

Figure 11
Co-citation of cited authors

The co-citation map of cited authors illustrated in Figure 11 reveals a complex intellectual framework within the study domain. Mayer R. E. is prominently recognized as a significant researcher, especially within the light green cluster, which emphasizes cognitive and multimedia learning. The red cluster, with writers such as Bai B., Dooly M., and Bandura A., indicates a focus on teacher education, technology-enhanced language acquisition, and instructional methodologies. The dark blue cluster includes individuals like Alemi M. and Cummins J., indicating research related to bilingual education, second language acquisition, and digital resources in language learning. The purple cluster emphasizes researchers like Gardner, R. C., Dewaele, J. M., and Lee, J. S., who have made substantial contributions to emotional factors and individual differences in language acquisition. This co-citation network highlights the interdisciplinary and interrelated aspects of research in language acquisition and educational technology.

4.10. Co-citation of Cited Sources

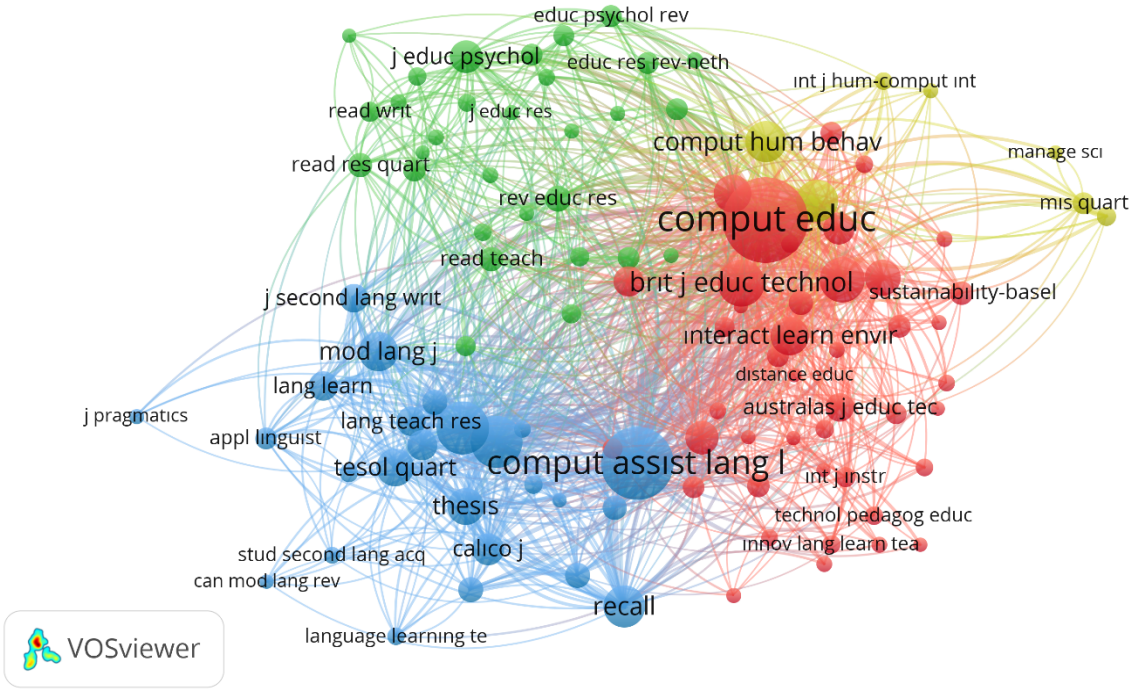

Figure 12
Co-citation of cited sources

The co-citation map of cited sources illustrates the foundational literature and predominant publication venues in the discipline. *Computers and Education* serves as the primary source, especially within the red cluster, which includes journals such as *The British Journal of Educational Technology* and *Interactive Learning Environments*, all reflecting an emphasis on digital learning, instructional design, and educational innovation. The blue cluster, focused on *Computer Assisted Language Learning*, *TESOL Quarterly*, and *Language Teaching Research*, underscores a significant concentration on applied linguistics, pedagogical approaches to language instruction, and technology-enhanced language acquisition. The dark green cluster comprises journals relating to psychology and education, including *Educational Psychology Review Journal of Educational Psychology, and Reading Research Quarterly*, reflecting a cognitive and developmental viewpoint on learning. The light green cluster, supported by sources such as *Computers in Human Behavior* and *MIS Quarterly*, indicates a convergence of behavioral science, user experience, and extensive human-computer interaction research. This image clearly illustrates the interdisciplinary base of the field, integrating language education, psychology, and information technology.

4.11. Cognitive Affective Perspective of the Publications

Understanding the cognitive and affective engagement of learners through technology integration in K-12 EFL/ESL environments is essential for the progression of both theoretical and practical applications in applied linguistics. Recent bibliometric studies mostly concentrate on publishing trends, author networks, or citation patterns, frequently neglecting the pedagogical orientations inherent in the research. This study

provides a thorough content analysis of 251 research articles published from 2000 to 2025, all incorporating technology in K-12 EFL/ESL instructional contexts. Crucially, instead of depending exclusively on metadata or automatic classification, the abstract of each article was meticulously analyzed to see if its major focus was cognitive, affective or incorporated both aspects and summarized in the bar chart in Figure 13.

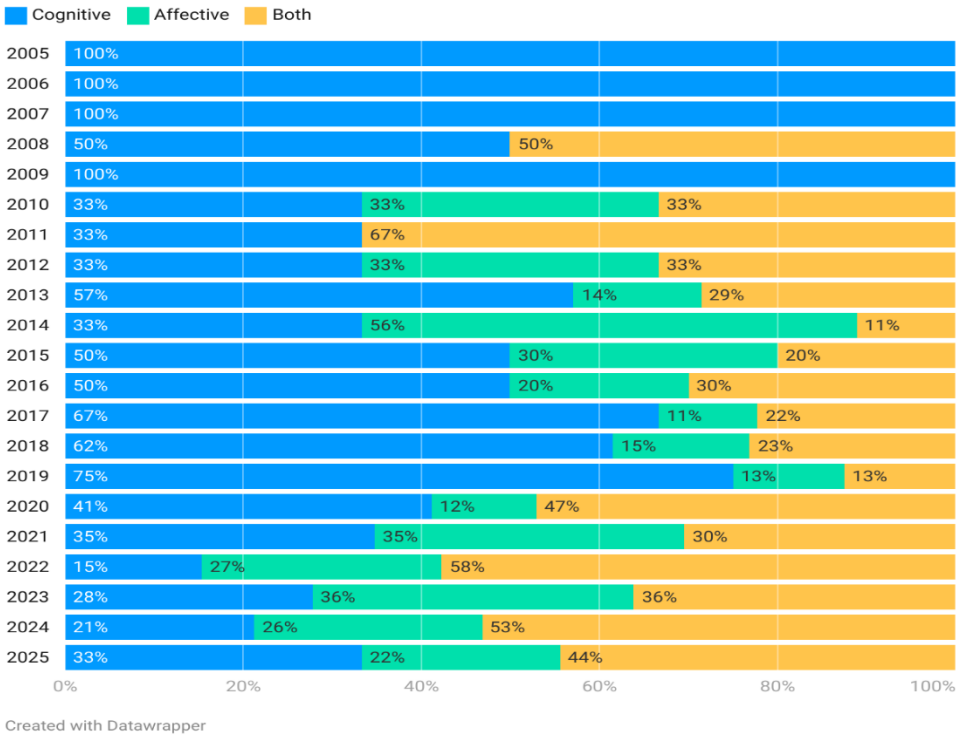

Figure 13
Articles published with a cognitive, affective or cognitive and affective perspective

The data extracted from WoS concerning the incorporation of technology in K-12 EFL/ESL settings between 2000-2025 indicate a significant trend in the prioritization of cognitive and affective elements in academic research. Figure 13 shows that the initial papers (2005-2007) demonstrate a predominant cognitive focus (100%), highlighting the early pedagogical priority on learning outcomes, including vocabulary development, grammar proficiency, and reading comprehension. Beginning in 2010, a slight yet notable shift appears. The emergence of dual-perspective studies (33%) in both 2010 and 2012, along with the progressive rise in affective-focused research (56% in 2014), signifies a rising interest in learner emotions, motivation, and well-being. This tendency corresponds with the increasing impact of Positive Psychology in language instruction (Dewaele & MacIntyre, 2014). Additionally, the era starting from 2022 onwards, signifies a paradigm shift towards dual-dimensional frameworks. In 2022, dual-focus research reaches 58%, indicating the field's growing dedication to a comprehensive understanding of factors stemming from learners and learning in EFL/ESL settings.

5. Discussion

The present bibliometric study provides a comprehensive overview of the integration of educational technology in K-12 EFL/ESL situations from 2000 to 2025, emphasizing cognitive and affective learning outcomes. The results not only validate the increasing worldwide interest in technology-enhanced language learning but also reveal regional, thematic, and methodological discrepancies in scholarly contribution.

The first research question was: *"What is the current research status of technology use in EFL/ESL learning in the K-12 context?"* The findings revealed a steady increase in studies on technology integration in the K-12 context between 2005, the year the earliest article was indexed in the WoS database, and 2025. The marked increase in publications post-2020 can be attributed to the COVID-19 pandemic, which markedly increased the exploration and implementation of technology in language education. This observation corresponds with Alakrash and Razak (2021), who highlighted the increasing significance of digital learning tools in mitigating the effects of disrupted face-to-face education. The pandemic seems to have acted as a catalyst, accelerating the adoption and academic investigation of digital platforms and technology in language instruction (Chen & Abdullah, 2024).

The second research question was: *"Which studies, authors, institutions, and countries have been most productive in the field?"* The findings indicate that although a considerable number of authors have been productive in the field, new contributors are emerging, signifying an increasing interest in the intersection of technology and language education. The most prolific institutions are located in Malaysia, China, and Taiwan, with Japan and Türkiye also contributing, albeit with comparatively fewer publications.

China unequivocally leads the field, with a publication count surpassing that of the United States, the second-highest contributor, by at least threefold. A substantial portion of China's production arises from intra-national collaboration, consistent with Ma et al. (2023) who highlighted the strong domestic research ecosystems in East Asia. Conversely, nations with more moderate research output, including the USA, Australia, and Spain, demonstrated higher levels of international collaboration. The findings underscore that there is a need for larger international collaboration. Regions like Africa are markedly underrepresented, likely due to limited technological infrastructure and a lack of educators comfortable with incorporating technology into language instruction (Crompton et al., 2021), as well as the dominance of English and the marginalization of non-Western epistemologies (Kubota, 2022).

The third research question was *"How has the focus of this literature evolved over time?"* An analysis of trending topics and their evolution indicates a dynamic and expanding research focus. Initial research mostly concentrated on general digital technologies and fundamental methodologies, including CALL, MALL, blended learning, and flipped learning. Over time, however, more innovative tools and methods, such as AI, AR, VR, social networking applications, and neural networks have been included in the research topics. Recent studies indicate an increasing focus on the affective and cognitive aspects of learning, with the keywords such as motivation, engagement, and self-efficacy frequently appearing alongside language proficiency, speaking, writing, and computer literacy. This signifies a more comprehensive approach to language learning research, a trend that aligns with the growing influence of Positive Psychology in language education (Dewaele & MacIntyre, 2014; Lee & Lee, 2021).

The final research question was *"How are cognitive and affective learning perspectives represented in this body of literature?"* The analysis of abstracts indicated a promising transition from exclusively cognitive research to dual-perspective methodologies that incorporate both cognitive and affective elements. This transition signifies a more holistic understanding of language acquisition, recognizing the relation of cognition and emotion

in maintaining engagement and promoting deep learning in EFL and ESL contexts (Song & Vermunt, 2021).

5. Conclusion

This bibliometric analysis investigated the intellectual, conceptual, and social landscape of technology integration in K-12 EFL/ESL education from 2000 to 2025. The results indicated a dynamic and rapidly advancing field, characterized by a significant surge in academic production, especially in the aftermath of the COVID-19. The findings revealed significant contributors, nations, organizations, and individual scholars, who have influenced the discipline, alongside prominent research topics. Thematic evolution illustrates a shift from traditional educational issues to more sophisticated, interactive, and learner-focused technological implementations. The analysis highlighted an increasing focus on emotive variables in addition to conventional cognitive outcomes, indicating a trend towards more holistic, student-centered research frameworks. The restricted collaboration among nations and writers indicates that the discipline is largely isolated necessitating more inclusive and globally integrated research endeavors.

Although this study offers a thorough bibliometric investigation of technology integration in K-12 EFL/ESL education, it is not without limitations. First, the dataset was exclusively derived from the WoS database. While WoS is a highly regarded and reputable index, exclusive reliance on it may have led to the omission of relevant research indexed in other significant databases such as Scopus, ERIC, or Google Scholar. Future studies could integrate multiple databases to ensure more comprehensive coverage of the literature. Second, the analysis included only peer-reviewed journal publications written in English. As a result, potentially significant contributions published in other languages or in alternative formats such as book chapters, conference proceedings, or dissertations were excluded. Finally, the analysis was conducted based on titles, abstracts, and keywords rather than full texts. While this approach facilitates the identification of large-scale trends, it may overlook nuanced debates or emerging ideas not explicitly reflected in metadata fields. Incorporating full-text data in future studies may offer a more in-depth understanding of thematic development and methodological diversity. As a concluding remark, future research should promote cross-regional collaboration, particularly with underrepresented regions, and place greater emphasis on the development of productive language skills through technological integration.

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