

From ICT to artificial intelligence: The evolution of TPACK research in language education

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Abstract

The rapid advancement of Artificial Intelligence (AI) has transformed technology integration practices in language education and expanded the development of the Technological Pedagogical and Content Knowledge (TPACK) framework. This study aims to analyze the evolution of TPACK research in language education from ICT-oriented pedagogy toward AI-supported learning environments through a bibliometric perspective. The data were retrieved from Google Scholar using Publish or Perish, covering publications from 2018 to 2026. From the initial search of 1000 documents, a final dataset of 720 relevant publications was analyzed using Microsoft Excel and VOSviewer. The findings revealed a substantial increase in publication trends, with the highest number of publications identified in 2025 (364 publications), while the lowest publication frequency appeared between 2018 and 2019 with only one publication each year, indicating the rapid expansion of AI-integrated language education research in recent years. Citation analysis showed that highly cited studies were dominated by themes related to generative AI, AI-assisted writing, automated feedback, and AI literacy. Furthermore, the co-occurrence, overlay, and density visualizations demonstrated that recent TPACK research increasingly emphasizes themes such as AI integration, generative AI, AI-TPACK, and intelligent language learning environments. Overall, the findings indicate that TPACK research has evolved significantly from conventional ICT integration toward AI-supported pedagogy in language and literacy learning contexts.

Keywords: TPACK, artificial intelligence, language education, EFL, bibliometric analysis

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Contribution to Literature: This study provides a bibliometric overview of the evolution of TPACK research in language education, highlighting the transition from ICT-oriented pedagogy toward AI-supported learning environments. It also identifies emerging themes, dominant research trends, and future directions related to AI-integrated language and literacy education.

1. Introduction

The rapid advancement of digital technology has significantly transformed educational practices across various disciplines, including language education. Educational institutions are increasingly expected to prepare learners with digital competencies that are relevant to the demands of the twenty-first century learning environment. The integration of technology into teaching and learning has therefore become an essential component of modern pedagogy, particularly in language and literacy education contexts where digital interaction, multimodal communication, and online learning environments continue to evolve rapidly. Previous studies emphasized that technology integration plays an important role in creating more effective and engaging learning environments for learners in digitally oriented educational settings (Altun & Akyildiz, 2017; Tinio, 2003). Similarly, Aslan and Zhu (2016) argued that teachers' competence in integrating Information and Communication Technology (ICT) into instructional practice is a critical factor influencing the quality of teaching and learning processes.

The growing implementation of technology in education has also transformed the role of teachers from conventional knowledge transmitters into facilitators capable of integrating pedagogy, content, and technology simultaneously. In language education, this transformation becomes increasingly important because language learning involves interactive, communicative, and multimodal processes that are closely connected with digital environments. Mishra & Koehler (2006) introduced the Technological Pedagogical and Content Knowledge (TPACK) framework as a conceptual model describing the interconnected relationship between technological knowledge, pedagogical knowledge, and content knowledge in teaching practice. The framework was inspired by Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), which highlighted the importance of integrating subject matter expertise with pedagogical understanding. Since then, TPACK has become one of the most influential frameworks in educational technology research, particularly in studies examining teachers' readiness and competence in integrating digital technologies into classroom instruction (Chai et al., 2010; Mouza et al., 2014).

In language education settings, TPACK has been widely associated with technology-supported instructional practices such as online learning, digital literacy development, multimedia instruction, and interactive language teaching approaches. Previous studies demonstrated that teachers' technological competence contributes significantly to effective language instruction and supports the development of innovative teaching practices in English language classrooms (Altun & Akyildiz, 2017; Khan, 2014). Furthermore, technology integration in language teaching has been reported to facilitate access to learning resources, improve communication and interaction, and support students' engagement in literacy-based learning activities (Pujiyanto et al., 2014; Tinio, 2003). These findings indicate that TPACK plays an important role in supporting teachers' professional development and instructional effectiveness in language education.

Despite the extensive development of TPACK research, most earlier studies primarily focused on general ICT integration and conventional digital learning environments. Previous research commonly examined teachers' self-perceived technological competence, pedagogical readiness, and classroom technology use through survey-based approaches (Ammade et al., 2020; Schmidt et al., 2009). In many cases, technologies

discussed in TPACK studies were limited to basic digital tools such as presentation software, online materials, and learning management systems. As educational technology continues to evolve rapidly, the emergence of Artificial Intelligence (AI) has introduced a new paradigm in digital pedagogy that extends beyond traditional ICT-based instruction. AI technologies such as intelligent tutoring systems, automated feedback platforms, adaptive learning systems, and generative AI applications including ChatGPT have increasingly influenced language teaching and literacy learning practices in contemporary educational contexts.

The emergence of AI in education has gradually shifted the orientation of digital pedagogy from simple technology integration toward more intelligent, adaptive, and personalized learning systems. In language education, AI technologies are increasingly utilized to support writing instruction, automated assessment, feedback generation, vocabulary learning, and conversational language practice. This transformation indicates that TPACK research is also evolving from ICT-oriented integration toward AI-supported pedagogical practices. However, studies specifically examining the evolution of TPACK research in relation to Artificial Intelligence within language education remain limited. Existing studies tend to focus either on general educational technology integration or on isolated AI applications without comprehensively mapping the intellectual development, thematic trends, and emerging research directions of AI-integrated TPACK in language and literacy learning contexts.

In addition, bibliometric studies investigating TPACK research have generally explored broader educational domains without specifically focusing on language education and the transition from ICT-based pedagogy to AI-supported pedagogy. As a result, there is still limited understanding regarding how TPACK research in language education has evolved over time, which themes have become dominant, and how emerging AI-related concepts are shaping future research directions. Understanding these developments is important not only for identifying current research trends but also for providing future directions for researchers, educators, and practitioners in language and literacy learning environments.

Therefore, this study aims to analyze the evolution of TPACK research in language education through a bibliometric perspective. Specifically, the study investigates publication trends, influential authors and countries, thematic developments, and emerging research directions related to the transformation of TPACK from ICT-based instruction toward Artificial Intelligence-supported pedagogy. By mapping global research trends, this study is expected to provide a comprehensive overview of the intellectual structure and future trajectory of TPACK research in language and literacy education.

2. Literature Review

2.1 Technological Pedagogical and Content Knowledge (TPACK)

The Technological Pedagogical and Content Knowledge (TPACK) framework was introduced by [Mishra and Koehler](#) as an extension of [Shulman's](#) Pedagogical Content Knowledge (PCK) theory, emphasizing the integration of technology, pedagogy, and content in effective teaching practices ([Mishra & Koehler, 2006](#); [Shulman, 1986](#)). TPACK consists of three primary domains, namely Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), which interact to support technology-enhanced learning environments ([Chai et al., 2010](#); [Schmidt et al., 2009](#)). In language education, the framework has been widely applied to examine teachers' readiness and competence in integrating digital technologies into instructional practices,

particularly in supporting innovative language teaching, digital literacy, and interactive learning activities (Altun & Akyildiz, 2017; Ammade et al., 2020).

2.2 Artificial Intelligence in Language Education

The rapid advancement of Artificial Intelligence (AI) has transformed educational practices by introducing adaptive, interactive, and personalized learning environments. In language education, AI technologies are increasingly utilized to support writing feedback, grammar correction, conversational practice, vocabulary learning, and automated assessment systems. The emergence of generative AI platforms has further shifted digital pedagogy from conventional ICT-based instruction toward AI-supported learning environments that emphasize personalization and real-time interaction. Consequently, educators are increasingly required to develop competencies in integrating AI technologies pedagogically and ethically within language and literacy learning contexts, which further expands the relevance of the TPACK framework in contemporary education.

2.3 TPACK Research in Language Education

Table 1 presented several previous studies have examined TPACK, technology integration, and Artificial Intelligence in educational contexts from different perspectives. Earlier studies mainly focused on teachers' technological competence, pedagogical readiness, and ICT integration in language teaching environments (Muslimin et al., 2024; Tseng et al., 2022). More recent studies have increasingly explored the integration of Artificial Intelligence into TPACK frameworks and language learning environments, including AI-TPACK and Intelligent-TPACK models that emphasize AI literacy and competency in digital pedagogy (Chiu, 2026; Karataş & Ataç, 2025). In addition, bibliometric studies on AI in language teaching have highlighted the rapid growth of AI-supported learning research and its emerging influence on language and literacy education (Ma et al., 2024). However, limited studies have specifically mapped the evolution of TPACK research from ICT-oriented pedagogy toward AI-supported language education through a comprehensive bibliometric perspective. Therefore, the present study attempts to fill this gap by analyzing global research trends and thematic developments related to TPACK and Artificial Intelligence in language education.

Table 1. TPACK research in language education.

No	Title	Reference
1	A critical review of research on technological pedagogical and content knowledge (TPACK) in language teaching	Tseng et al. (2022)
2	Bibliometric analysis of technological pedagogical content knowledge framework in English language teaching (TPACK-ELT)	Muslimin et al. (2024)
3	A bibliometric analysis of artificial intelligence in language teaching and learning (1990–2023): Evolution, trends and future directions	Ma et al. (2024)
4	When TPACK meets artificial intelligence: Analyzing TPACK and AI-TPACK components through structural equation modelling	Karataş & Ataç (2025)
5	Human-Centric Artificial Intelligence Pedagogy (HCAP) framework developed from TPACK through integration of artificial intelligence literacy and competency	Chiu (2026)

3. Research Method

3.1. Research Design

This study employed a bibliometric analysis design to examine the development and evolution of TPACK research in language education. Bibliometric analysis is widely used

to identify publication trends, influential studies, research collaborations, citation structures, and thematic developments within a specific research field. In this study, the bibliometric approach was utilized to map the transformation of TPACK research from ICT-oriented pedagogy toward Artificial Intelligence-supported language education.

3.2.Data Sources

The data were retrieved using Publish or Perish connected to the Google Scholar database. The search process focused on publications related to TPACK, Artificial Intelligence, and language education published between 2018 and 2026. Several keywords and keyword combinations were used during the search process, including “TPACK,” “technological pedagogical content knowledge,” “Artificial Intelligence,” “AI,” “language education,” “EFL,” and “English language learning.”

The initial search 1000, identified approximately 720 publications related to the topic. These publications consisted primarily of journal articles relevant to language and literacy learning contexts. The bibliographic data retrieved from Publish or Perish were exported in RIS and CSV formats to facilitate citation analysis, data organization, and visualization processes in bibliometric software applications.

3.3.Procedure of Data Collection

The data collection procedure was conducted in several stages. First, publications were identified and retrieved through keyword searches using Publish or Perish connected to Google Scholar. Second, the retrieved publications were screened based on title relevance, abstracts, keywords, publication type, and research focus. Duplicate records and publications unrelated to language education or TPACK were excluded from the dataset. Third, the selected data were organized and exported into RIS and CSV file formats for further bibliometric processing and visualization.

After the screening process, the bibliographic information including authors, publication year, source titles, citations, abstracts, and keywords was compiled into a final dataset. From the overall dataset, the 25 most cited articles were selected and presented in the citation analysis table to identify the most influential studies in the development of TPACK research within language education contexts.

3.4.Data Analysis

The data analysis was conducted using Microsoft Excel and VOSviewer. Microsoft Excel was used to analyze descriptive bibliometric data, including annual publication trends, citation frequencies, and the list of the most cited publications presented in tables and charts. Meanwhile, VOSviewer was utilized to generate bibliometric network visualizations, including co-authorship analysis, keyword co-occurrence mapping, density visualization, and thematic trend analysis.

Through these analyses, the study identified dominant research themes, emerging topics, collaboration patterns, and the evolution of TPACK research in language education, particularly the transition from ICT-based instructional approaches toward Artificial Intelligence-supported pedagogy.

4. Results and Discussion

4.1.TPACK Research in Language Education 2018–2026

The analysis of publication output from 2018 to 2026 reveals a significant increase in research related to Technological Pedagogical and Content Knowledge (TPACK) in language education. The data were retrieved from Google Scholar through Publish or Perish using keywords related to TPACK, Artificial Intelligence, and language education. From the initial search of 1000 documents, a final dataset of 720 relevant publications

was obtained after screening and data cleaning processes based on publication relevance, duplication, keywords, and research focus.

As presented in Table 2 and visualized in Figure 1, the annual publication trend demonstrates a gradual increase between 2018 and 2022, followed by a substantial rise starting in 2023. The number of publications increased from 34 documents in 2023 to 141 documents in 2024 and reached its peak with 364 publications in 2025. Although publications in 2026 appear lower, this is likely due to the ongoing indexing process for the current year. Overall, these findings indicate that TPACK research in language education has expanded rapidly alongside the growing integration of digital pedagogy and Artificial Intelligence in educational practices.

The increasing trend also reflects a shift in research focus from conventional ICT integration toward AI-supported language learning environments. Earlier publications between 2018 and 2021 were predominantly associated with ICT integration, online learning platforms, digital pedagogy, and technology acceptance in language education contexts. However, recent publications increasingly address AI literacy, ChatGPT, intelligent learning systems, generative AI, and AI-supported pedagogy in language education. Similar trends were identified in previous studies highlighting the rapid growth of AI-related research in language teaching and learning (Karataş & Ataç, 2025; Ma et al., 2024).

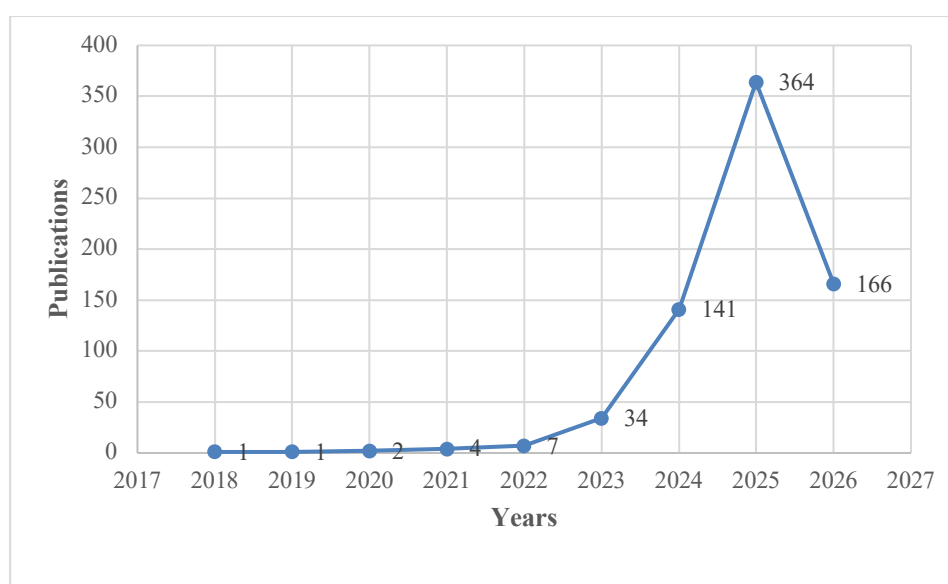


Figure 1. Annual report of publications.

Table 2. Annual report research on “TPACK in language education”.

Years	Publications	(%) of Publications
2018	1	0,14%
2019	1	0,14%
2020	2	0,28%
2021	4	0,56%
2022	7	0,97%
2023	34	4,72%
2024	141	19,58%
2025	364	50,56%
2026	166	23,06%
Total	720	100%

4.2. Most Influential and Highly Cited Publications

The citation analysis identifies the most influential publications contributing to the development of TPACK, Artificial Intelligence, and language education research. As presented in Table 3, the most highly cited studies are dominated by publications discussing generative Artificial Intelligence, AI-supported writing instruction, automated feedback systems, and teachers' perceptions toward AI integration in language learning environments. The study entitled AI-generated feedback on writing: Insights into efficacy and ENL student preference published in 2023 became the most cited publication with 750 citations, followed by studies examining generative AI in the writing process and AI-supported assessment in higher education contexts.

The findings indicate that recent research trends in language education are increasingly influenced by the rapid emergence of Artificial Intelligence technologies, particularly generative AI applications such as ChatGPT and automated feedback systems. Earlier studies within technology-enhanced language learning primarily emphasized ICT integration, computer-assisted language learning, and online pedagogy. However, highly cited publications from 2023 to 2025 demonstrate a substantial shift toward AI literacy, AI acceptance, intelligent learning environments, and AI-mediated language instruction. This transition suggests that educational technology research is entering a new phase in which Artificial Intelligence becomes a central component of digital pedagogy in language and literacy learning.

In addition, several highly cited publications focus on teachers' and students' perceptions of AI integration, indicating that pedagogical readiness and technological acceptance remain important issues in contemporary educational research. Studies related to AI-generated feedback, AI-assisted writing, and automated assessment also dominate recent citation trends, reflecting the growing interest in personalized and adaptive learning systems within English language education. These findings support the argument that TPACK research is evolving from conventional ICT-oriented approaches toward more intelligent and AI-supported pedagogical frameworks, including AI-TPACK and Intelligent-TPACK models discussed in recent studies (Chiu, 2026; Karataş & Ataç, 2025). Similar findings were also reported by Ma et al. (2024), who identified a rapid expansion of Artificial Intelligence research in language teaching and learning, particularly in areas related to digital literacy, adaptive learning, and AI-supported instructional practices.

Table 3. Most cited articles on TPACK, artificial intelligence, and language education.

No	Cites	Title	Year	Cites Per Year	Ref.
1	750	AI-generated feedback on writing: Insights into efficacy and ENL student preference	2023	250.00.00	Escalante et al. (2023)
2	619	Not quite eye to AI: Student and teacher perspectives on the use of generative artificial intelligence in the writing process	2023	206.33.00	Barrett & Pack (2023)
3	500	A scoping review on how generative artificial intelligence transforms assessment in higher education	2024	250.00.00	Xia et al. (2024)
4	437	Influence of pedagogical beliefs and perceived trust on teachers' acceptance of educational artificial intelligence tools	2023	145.67	Choi et al. (2023)
5	405	Artificial intelligence in English language teaching: The good, the bad and the ugly	2023	135.00.00	Hockly (2023)

No	Cites	Title	Year	Cites Per Year	Ref.
6	361	Artificial intelligence technologies and applications for language learning and teaching	2025	361.00.00	Son et al. (2025)
7	270	Toward an understanding of preservice English as a foreign language teachers' acceptance of computer-assisted language learning 2.0 in the People's Republic of China	2018	33.75	Mei et al. (2018)
8	251	Modelling generative AI acceptance, perceived teachers' enthusiasm and self-efficacy to English as a foreign language learners' well-being in the digital era	2024	125.50.00	Huang et al. (2024)
9	251	Is ChatGPT an evil or an angel for second language education and research? A phenomenographic study of research-active EFL teachers' perceptions	2024	125.50.00	Derakhshan & Ghiasvand (2024)
10	239	Computer-assisted pronunciation training (CAPT): Current issues and future directions	2021	47.80	Rogerson-Revell (2021)
11	211	Exploring EFL university teachers' beliefs in integrating ChatGPT and other large language models in language education: A study in China	2024	105.50.00	Gao et al. (2024)
12	207	Teaching pronunciation: The state of the art 2021	2021	41.40.00	Pennington (2021)
13	162	Ready for online? Exploring EFL teachers' ICT acceptance and ICT literacy during COVID-19 in mainland China	2022	40.50.00	Li (2022)
14	150	Enhancing English as a Foreign Language (EFL) Learners' Writing with ChatGPT: A University-Level Course Design.	2024	75.00.00	Tseng & Lin (2024)
15	142	Does generative artificial intelligence improve the academic achievement of college students? A meta-analysis	2024	71.00.00	Sun & Zhou (2024)
16	131	Design and assessment of AI-based learning tools in higher education: A systematic review	2025	131.00.00	Luo et al. (2025)
17	130	Fostering engagement in AI-mediate Chinese EFL classrooms: The role of classroom climate, AI literacy, and resilience	2025	130.00.00	Wang et al. (2025)
18	125	A systematic literature review of attitudes, intentions and behaviours of teaching academics pertaining to AI and generative AI (GenAI) in higher education: An analysis of GenAI adoption using the UTAUT framework.	2024	62.50.00	Nikolic et al. (2024)
19	116	The affordances of artificial intelligence-based tools for supporting 21st-century skills: A systematic review of empirical research in higher education	2024	58.00.00	Celik et al. (2024)
20	105	Combining chatbot and social media: Enhancing personal learning environment	2020	17.50	Haristiani & Rifa'i (2020)

No	Cites	Title	Year	Cites Per Year	Ref.
		(PLE) in language learning			
21	102	The effects of generative AI on collaborative problem-solving and team creativity performance in digital story creation: An experimental study	2025	102.00.00	Wei et al. (2025)
22	100	ChatGPT and ELT: Exploring Teachers' Voices.	2024	50.00.00	Mabuan (2024)
23	100	Assessment and learning outcomes for generative AI in higher education: A scoping review on current research status and trends	2024	50.00.00	Weng et al. (2024)
24	92	Automated feedback and automated scoring in the elementary grades: Usage, attitudes, and associations with writing outcomes in a districtwide implementation of MI Write	2021	18.40	Wilson et al. (2021)
25	82	Challenges and opportunities for foreign language teachers in the era of artificial intelligence	2024	41.00.00	Yang (2024)

4.3. Visualization of Research Data Mapping of TPACK in Language Education

The co-occurrence analysis was conducted using VOSviewer to identify the conceptual structure and thematic relationships within TPACK research in language education. The minimum number of occurrences of a term was set at 10. Of the 3063 identified terms, 98 terms met the threshold requirement. Based on the relevance score calculated by the software, 59 of the most relevant terms were selected for network visualization analysis.

As illustrated in Figure 2, the co-occurrence network demonstrates a structured relationship among research themes and resulted in five major clusters consisting of 59 interconnected items. The visualization indicates that TPACK research in language education is closely associated with Artificial Intelligence, AI literacy, digital pedagogy, English language learning, and technology integration. The network also reveals that recent studies increasingly connect TPACK with AI-supported learning environments and generative AI technologies.

The first cluster (red), consisting of 20 items, includes ai literacy, ai tool, assessment, educational technology, effect, efl classroom, efl context, efl learner, feedback, field, genai, generative ai, generative artificial intelligence, instructional context, language instruction, learner, pack, proficiency, strategy, and systematic literature review. This cluster mainly focuses on AI-supported instructional practices, language learning strategies, and generative AI integration in English language education.

The second cluster (green), comprising 13 items, includes academic writing, ai integration, artificial intelligence technology, attitude, efl student, empirical study, English language, experience, gap, knowledge, technological pedagogical content knowledge, technology integration, and tpack. This cluster reflects the relationship between TPACK, AI integration, and teachers' or students' experiences in technology-enhanced language learning environments.

The third cluster (blue), with 11 items, includes ai tpack, china, content knowledge, factor, framework, pedagogical content knowledge, pedagogy, readiness, technological pedagogy, technological pedagogical content, and technological pedagogical knowledge.

This cluster emphasizes theoretical frameworks, pedagogical readiness, and the emerging development of AI-TPACK models in educational research.

The fourth cluster (yellow), consisting of 9 items, includes ai technology, challenge, challenges, content, efl teaching, elt, foreign language education, journal, and opportunity. This cluster mainly discusses challenges and opportunities related to AI technology implementation in English language teaching and foreign language education contexts.

The fifth cluster (purple), with 6 items, includes efl, English language education, English language learning, foreign language, and review. This cluster represents broader discussions regarding English language learning and review-based studies within technology-supported educational environments.

Overall, the cluster distribution indicates that contemporary TPACK research in language education is increasingly interdisciplinary and strongly connected with Artificial Intelligence integration, digital pedagogy, and language learning innovation. The dominance of terms related to AI literacy, generative AI, AI tools, and AI-TPACK suggests that recent studies are shifting beyond conventional ICT integration toward more intelligent and adaptive educational environments. These findings are consistent with recent studies emphasizing the growing influence of Artificial Intelligence in language education and the emergence of AI-oriented TPACK frameworks in contemporary pedagogical research (Chiu, 2026; Karatas & Ataç, 2025; Ma et al., 2024).

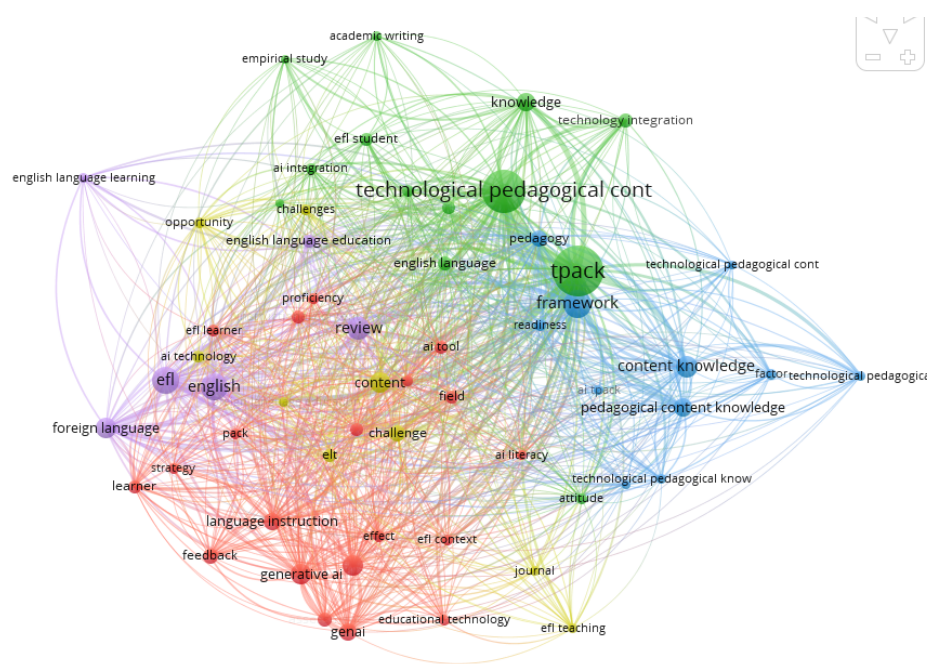


Figure 2. Network visualization based on co-occurrence of terms.

The overlay visualization presented in Figure 3 demonstrates the temporal development of research themes in TPACK and language education. Earlier studies were primarily associated with ICT integration, technology acceptance, and online learning environments. However, more recent publications increasingly focus on generative AI, AI literacy, AI tools, and AI-TPACK, indicating a significant shift toward Artificial Intelligence-supported pedagogy. This finding suggests that TPACK research has evolved from conventional technology integration toward more intelligent and adaptive digital learning systems. Similar trends were also identified in recent studies emphasizing the emergence of AI-supported pedagogy and Intelligent-TPACK frameworks in educational research (Chiu, 2026; Karatas & Ataç, 2025).

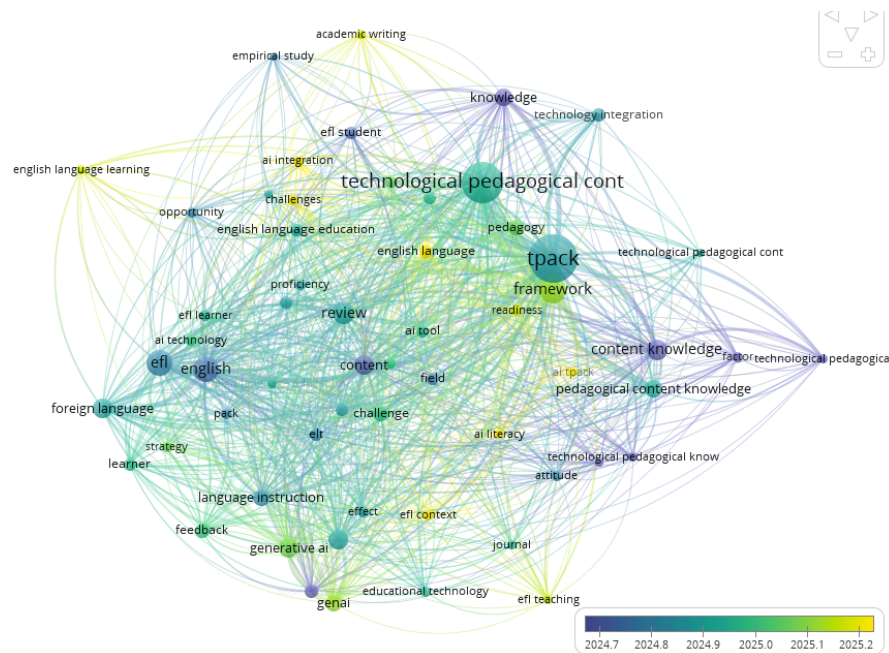


Figure 3. Overlay visualization based on co-occurrence of terms.

Furthermore, the density visualization shown in Figure 4 highlights the most dominant and frequently discussed themes within the research field. The terms *tpack*, technological pedagogical content knowledge, framework, English language, and content knowledge appear as the most densely connected areas, indicating their central role in language education research. At the same time, newer themes such as generative AI, genAI, AI literacy, and AI integration have started to emerge as important research directions, reflecting the growing influence of Artificial Intelligence in language and literacy learning contexts. These findings reinforce the argument that TPACK research is currently undergoing a paradigm shift from ICT-oriented pedagogy toward AI-integrated language education.

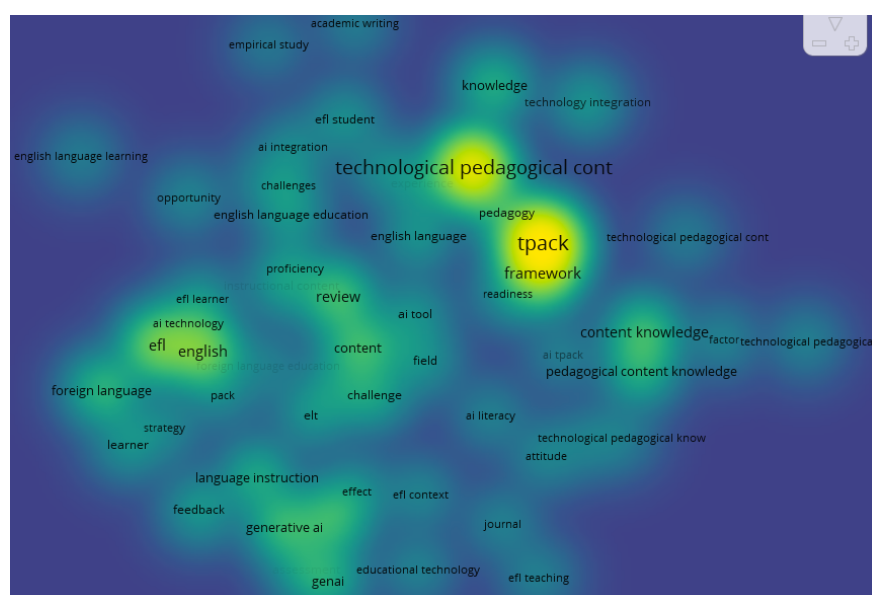


Figure 4. Density visualization based on the co-occurrence of terms.

The network visualization based on TPACK presented in Figure 5 demonstrates that *tpack* and technological pedagogical content knowledge function as the central nodes connecting various themes within language education research. The visualization reveals

strong relationships between TPACK and concepts such as framework, pedagogy, content knowledge, technology integration, and readiness, indicating that TPACK remains the primary framework guiding technology-enhanced language learning. In addition, emerging connections between TPACK and Artificial Intelligence-related concepts such as AI literacy, AI tools, and AI-TPACK suggest that recent studies increasingly position TPACK as a flexible framework capable of adapting to AI-supported pedagogical environments (Chiu, 2026; Karataş & Ataç, 2025).

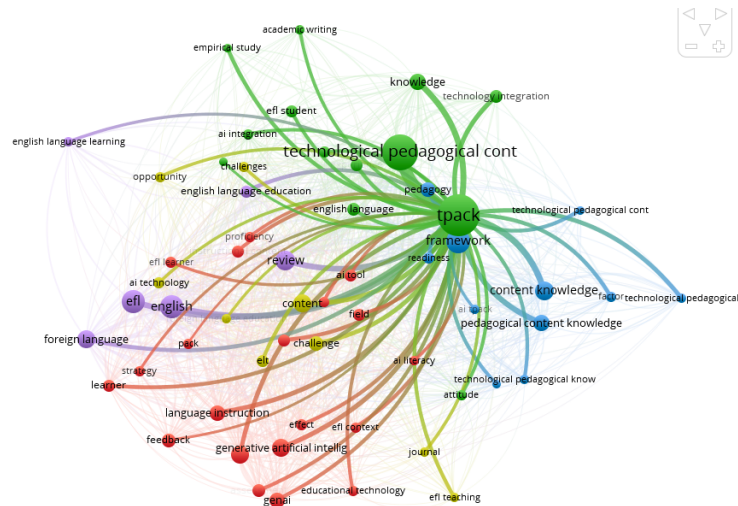


Figure 5. Network visualization based on TPACK.

The network visualization based on AI integration shown in Figure 6 highlights the growing influence of Artificial Intelligence in language education research. Dominant terms such as generative AI, AI literacy, AI tool, feedback, and assessment appear strongly interconnected, indicating that AI integration research is increasingly associated with adaptive learning systems, automated feedback, and personalized language learning environments. The close relationship between AI-related concepts and pedagogical terms also suggests that Artificial Intelligence has become an important component of contemporary language teaching and literacy learning practices (Ma et al., 2024; Yang, 2024).

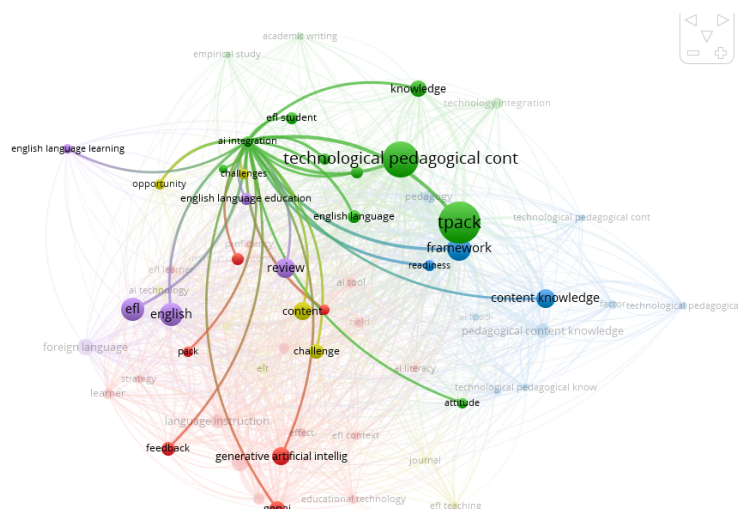


Figure 6. Network visualization based on AI integration.

The network visualization based on EFL presented in Figure 7 demonstrates that English as a Foreign Language (EFL) research is strongly connected with technology

integration, digital pedagogy, and Artificial Intelligence-supported learning environments. Terms such as EFL learner, English language education, language instruction, proficiency, and feedback appear closely linked within the network, indicating the important role of technology-enhanced learning in English language teaching. Furthermore, the emergence of AI-related concepts such as generative AI and AI-assisted feedback reflects the growing transformation of EFL research toward more adaptive and intelligent language learning environments.

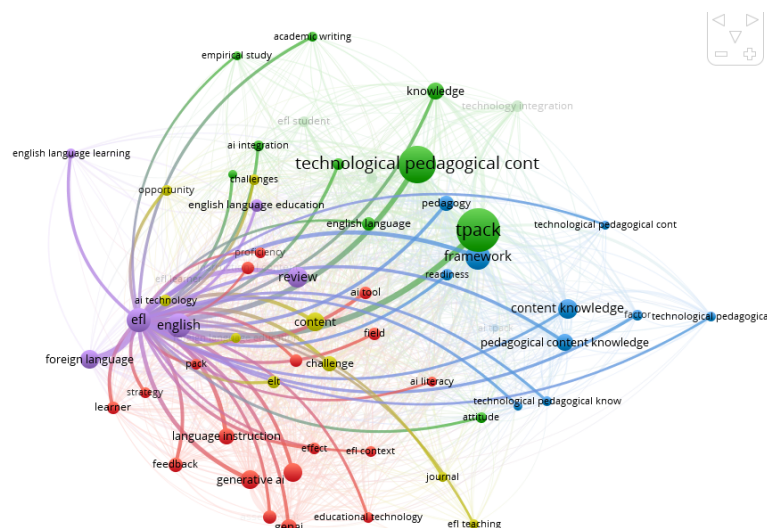


Figure 7. Network visualization based on EFL.

4.4.Synthesis and Implications

The findings of this bibliometric analysis demonstrate that TPACK research in language education has experienced substantial development between 2018 and 2026, particularly following the rapid expansion of Artificial Intelligence in educational contexts. The increasing number of publications, dominant citation trends, and co-occurrence mapping collectively indicate a significant transformation from conventional ICT-oriented pedagogy toward AI-supported language learning environments. Earlier studies mainly focused on technology integration, online learning, and digital pedagogy, whereas recent research increasingly emphasizes AI literacy, generative AI, AI-assisted feedback, AI integration, and AI-TPACK within English language education contexts. The visualization analysis further confirms that Artificial Intelligence has become one of the central themes shaping current and emerging research directions in language and literacy learning. Similar trends were also identified in recent studies highlighting the growing integration of AI into language education and the evolution of AI-oriented TPACK frameworks (Chiu, 2026; Karatas & Ataç, 2025; Ma et al., 2024).

These findings imply that language educators and researchers need to reconsider the role of TPACK in contemporary educational environments increasingly influenced by Artificial Intelligence technologies. The emergence of AI-supported pedagogy suggests that teachers are not only required to integrate technology into instructional practices but also to develop competencies related to AI literacy, ethical AI use, and intelligent digital pedagogy. In addition, the findings indicate that future studies should move beyond conventional ICT integration and explore more empirical investigations related to AI-TPACK implementation, generative AI in language learning, adaptive learning systems, and AI-supported reading and writing instruction. Consequently, this study contributes to the growing discussion regarding the transformation of language education toward more adaptive, intelligent, and technology-enhanced learning environments.

5. Conclusion

This bibliometric study demonstrates that TPACK research in language education has evolved significantly from ICT-oriented pedagogy toward Artificial Intelligence-supported learning environments between 2018 and 2026. The increasing publication trends, citation patterns, and visualization mapping indicate that recent studies increasingly emphasize themes such as AI literacy, generative AI, AI-assisted feedback, and AI-TPACK within English language education contexts. These findings suggest that Artificial Intelligence has become an emerging direction in contemporary language and literacy learning research, while the TPACK framework continues to adapt to the transformation of digital pedagogy and intelligent learning environments. Therefore, future studies are encouraged to explore more empirical investigations related to AI-integrated pedagogy, particularly in English reading and writing instruction and adaptive language learning contexts.

Conflict of Interest Statement

There is no conflict of interest regarding the publication of this article.

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Oya: All stages and process of article.

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