Applied Language Sciences

RESEARCH Open Access

A decade of innovation in language education: Insights from eight leading CALL-related journals

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Abstract

Technological advancements—from mobile and extended reality (XR) to generative artificial intelligence (GenAI)—are central to innovation in computer-assisted language learning (CALL). This systematic review conducted a thorough analysis of 1,098 papers from eight leading CALL-related journals (2015 – 2025). With BERTopic modeling, core research topics and their evolution were identified. The study uncovered nine key topics across the eight journals, such as affect in L2 speaking, teacher development, mobile and immersive technologies, and more. Findings suggested that different topics undergo different developmental life cycles and GenAI has emerged as a unique transformer of innovation in CALL. The review concludes with practical implications for both teachers and researchers.

Keywords: innovation in CALL, topic modeling, review, generative AI, core research topics

But the good thing is, with innovation, there isn't a last nugget.
– Jeff Bezos, Founder of Amazon

1. Introduction

With the emergence and swift adoption of generative artificial intelligence (GenAI), the field of computer-assisted language learning (CALL) has entered a golden age of research. In 2018, Colpaert argued that "the CALL field remains vulnerable to absorption by other disciplines due to its feet of clay" (p. 483), yet this perspective may no longer accurately reflect the dynamics of contemporary applied linguistics (AL). Instead, we contend that other AL subfields are actively advancing CALL by sharing, integrating, and co-constructing theories, findings, pedagogical practices, and interdisciplinary insights.

A review of the latest Web of Science (WoS) report (Table 1) reveals that most of the top 10 journals in education and linguistics are technology-oriented, underscoring this shift. Interestingly, nearly all top 10 journals in educational studies are indexed in SSCI (Social Sciences Citation Index), with the exception of *Smart Learning Environments*, which is indexed in the ESCI (Emerging Sources Citation Index). With the aims and scope on the intersection of education and technology, its appearance on the list provides evidence of the growing academic value of technology in education. Among linguistics journals, in addition to CALL-specific publications such as *Computer Assisted Language Learning* and *ReCALL*, others such as *RELC Journal* in Table 1 also place a strong emphasis on the use of technology in language learning and teaching.

Moreover, an examination of the more comprehensive Scopus database and its latest CiteScore metrics for educational journals shows that certain Scopus-indexed, non-SSCI publications rank at the forefront. A prime example is *Computers and Education: Artificial Intelligence*, which holds the number 2 position among 1,957 journals with a CiteScore of 28.7 as of November 2025 (noting that these scores are updated every few months). Taken together, these trends suggest that technology has permeated nearly every facet of educational research, especially language education.

Table 1. Top 10 educational and linguistics journals in the WoS database

No.	Educational Journal	Index	2024 Impact Factor
1	*International Journal of Educational Technology in Higher Education*	SSCI	16.7
2	*Smart Learning Environments*	ESCI	12.1
3	*Educational Psychologist*	SSCI	11.4
4	*Educational Research Review*	SSCI	10.6
5	*Computers & Education*	SSCI	10.5
6	*Studies in Science Education*	SSCI	9.9
7	*British Journal of Educational Technology*	SSCI	8.1
8	*International Journal of STEM Education*	SSCI	8.0
9	*Review of Educational Research*	SSCI	7.4
10	*International Journal of Management Education*	SSCI	7.4
No.	**Linguistics Journal**	**Index**	**2024 Impact Factor**
1	*Transaction on the Association for Computational Linguistics*	SSCI	6.9
2	*Computer Assisted Language Learning*	SSCI	6.6
3	*RELC Journal*	SSCI	6.2
4	*ReCALL*	SSCI	5.7

5	*System*	SSCI	5.6
6	*Assessing Writing*	SSCI	5.5
7	*Studies in Second Language Learning and Teaching*	SSCI	5.4
8	*Computational Linguistics*	SSCI	5.3
9	*Language Teaching*	SSCI	5.1
10	*Studies in Second Language Acquisition*	SSCI	4.9

SSCI=Social Sciences Citation Index, ESCI=Emerging Sources Citation Index

Over the past three decades, technological advancements have introduced unexpected, profound innovations to language education. From early CD-ROMs and Language Massive Open Online Courses (LMOOCs) to mobile learning tools such as Padlet, and now to the integration of GenAI and extended reality (XR), language education has progressed towards more interactive, immersive, adaptive, and authentic modes of learning, compared to the traditional, decontextualized rote learning (Zhang & Zou, 2022). These innovative technologies such as GenAI and XR are innovating teaching and learning both inside and outside the classroom, influencing every aspect – from lesson preparation and in-class activities to after-class assignments (Wu et al., 2024). Recent studies have provided empirical evidence of their unique, innovative affordances, such as delivering customized, real-time feedback, boosting learning motivation, increasing language proficiencies, and improving student interactions (e.g., Kohnke et al., 2023; Wu et al., 2023; Zhang et al., 2024); however, challenges have also been documented including shortages of equipment, insufficient knowledge, and a lack of expertise for effectively planning, integrating, and implementing these technologies across diverse educational contexts (e.g., Lee & Wu, 2024; Wu & Miller, 2025).

With these technologies, innovation is now a central theme in CALL and in contemporary language education. Over the past decade, Reinders and his colleagues have collected a series of reports on innovative teaching and learning practices across various contexts such as the United Kingdom (Chong & Reinders, 2024), Korea (Reinders et al., 2025), and Vietnam and Cambodia (Phung et al., 2024). In these edited volumes, technology consistently serves as a crucial driver of innovation, empowering both learners and teachers with novel pedagogical approaches. Yet, as Carless observes, "[i]nnovation is extremely difficult to engineer successfully" (p. 1), underscoring the challenges in implementing innovative practices.

Complicating the issues is the absence of a comprehensive, systematic synthesis of innovative, technology-empowered practices in language education. Existing studies remain fragmented since they are often limited to case studies or anecdotal reports, without offering a holistic understanding of core themes, their interconnections, and temporal evolution.

To fill this gap, the present review study offers a rigorous, data-driven overview of the existing innovation-related studies in CALL. Specifically, a corpus of articles from eight leading CALL journals is selected. Furthermore, advanced natural language processing (NLP) techniques are applied to shed light on the core research topics and their relationship and developments. The following three questions guided the research:

RQ1: What are the core research topics of innovation in language education?

RQ2: What structural relationships exist among these core topics?

RQ3: How have the core research topics evolved?

2. Dataset and methods

2.1 Research Design

This study employed a systematic literature review method to map the conceptual landscape and research trends concerning innovation in CALL. The entire process of identification, screening, eligibility assessment, and inclusion of relevant studies was conducted in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Following the systematic literature retrieval and screening, the study incorporated a computational thematic analysis using the bidirectional encoder representations from transformers for the topic modeling technique (BERTopic). This integration of systematic review principles with NLP was designed to objectively identify, quantify, and interpret the latent thematic structure within the corpus of selected literature (Devlin et al., 2019), thereby providing a robust and data-driven overview of the research domain (Xian et al., 2025). The overview of the entire research method is shown in Figure 1.

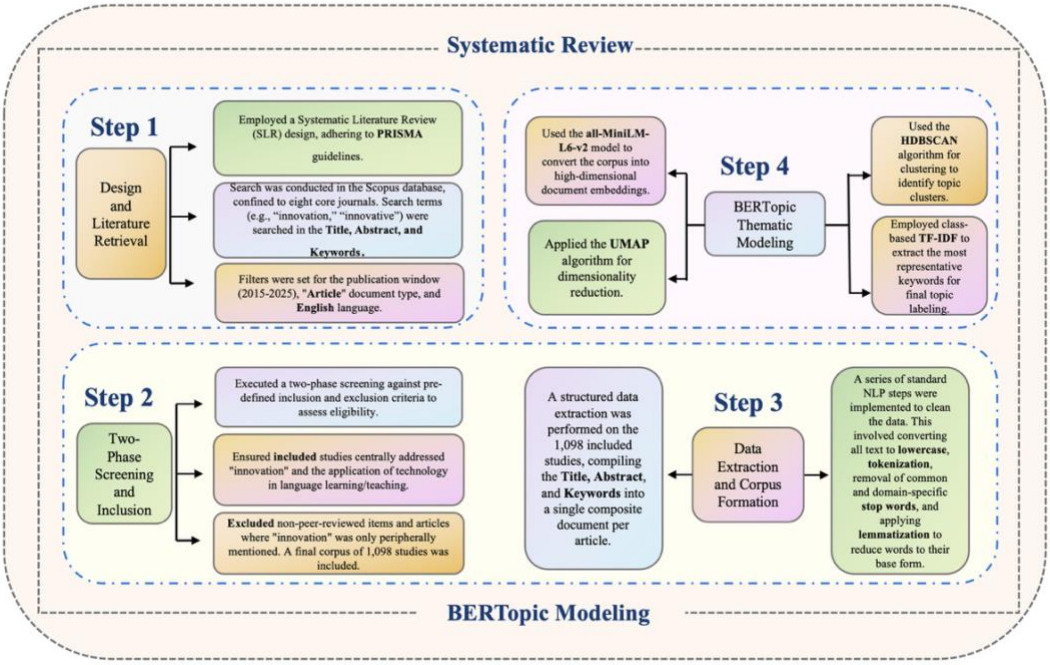

Figure 1. Overview of the research method

2.2 Data Source and Search Strategy

The literature search was performed exclusively within the Scopus database, renowned for its extensive coverage of high-quality, peer-reviewed literature. The search strategy was designed to capture a focused yet substantial body of research from the core journals in the field of CALL. The search was confined to the eight representative CALL-related journals: *Innovation in Language Learning and Teaching*, *Computer Assisted Language Learning*, *Language Learning & Technology*, *ReCALL*, *International Journal of Computer-Assisted Language Learning and Teaching*, *CALL-EJ*, *Technology in Language Teaching and Learning*, and *The JALT CALL Journal*.

The search query utilized a combination of key terms related to the core concept of

"innovation" (innovation, innovative, innovative learning, innovative teaching) searched within the article "titles, abstracts, and keywords". Several filters were applied to refine the results: Publication Window: January 1, 2015, to October 1, 2025. Document Type: "Article" to ensure the inclusion of original research. Language: "English".

2.3 Screening and Eligibility Criteria

The study selection process involved a two-phase screening against pre-defined eligibility criteria to identify the most relevant studies.

2.3.1 Inclusion Criteria

- The review includes empirical studies (qualitative, quantitative, or mixed methods) and conceptual papers that centrally address the theme of "innovation" or "innovative" practice in language education.
- Studies must focus on the application of technological tools or platforms in language learning or teaching contexts.
- Publications must fall within the specified date range, meet the language requirements, and conform to the predetermined document types.

2.3.2 Exclusion Criteria

- Publications such as editorials, book reviews, or letters are excluded.
- Articles where the terms "innovation" or "innovative" are only peripherally mentioned without constituting a substantive focus of the study are eliminated.
- Studies whose primary focus extends beyond language learning or teaching are not considered for inclusion.

2.4 Study Selection Process

The study selection process, detailed in the PRISMA flow diagram (**Figure 2**), was rigorously managed. In addition, the number of articles selected from each of these eight journals is as follows: *Innovation in Language Learning and Teaching* (n = 460), *Computer Assisted Language Learning* (n = 243), *Language Learning & Technology* (n = 67), *ReCALL* (n = 60), *International Journal of Computer-Assisted Language Learning and Teaching* (n = 59), *CALL-EJ* (n = 118), *Technology in Language Teaching and Learning* (n = 27), *The JALT CALL Journal* (n = 64).

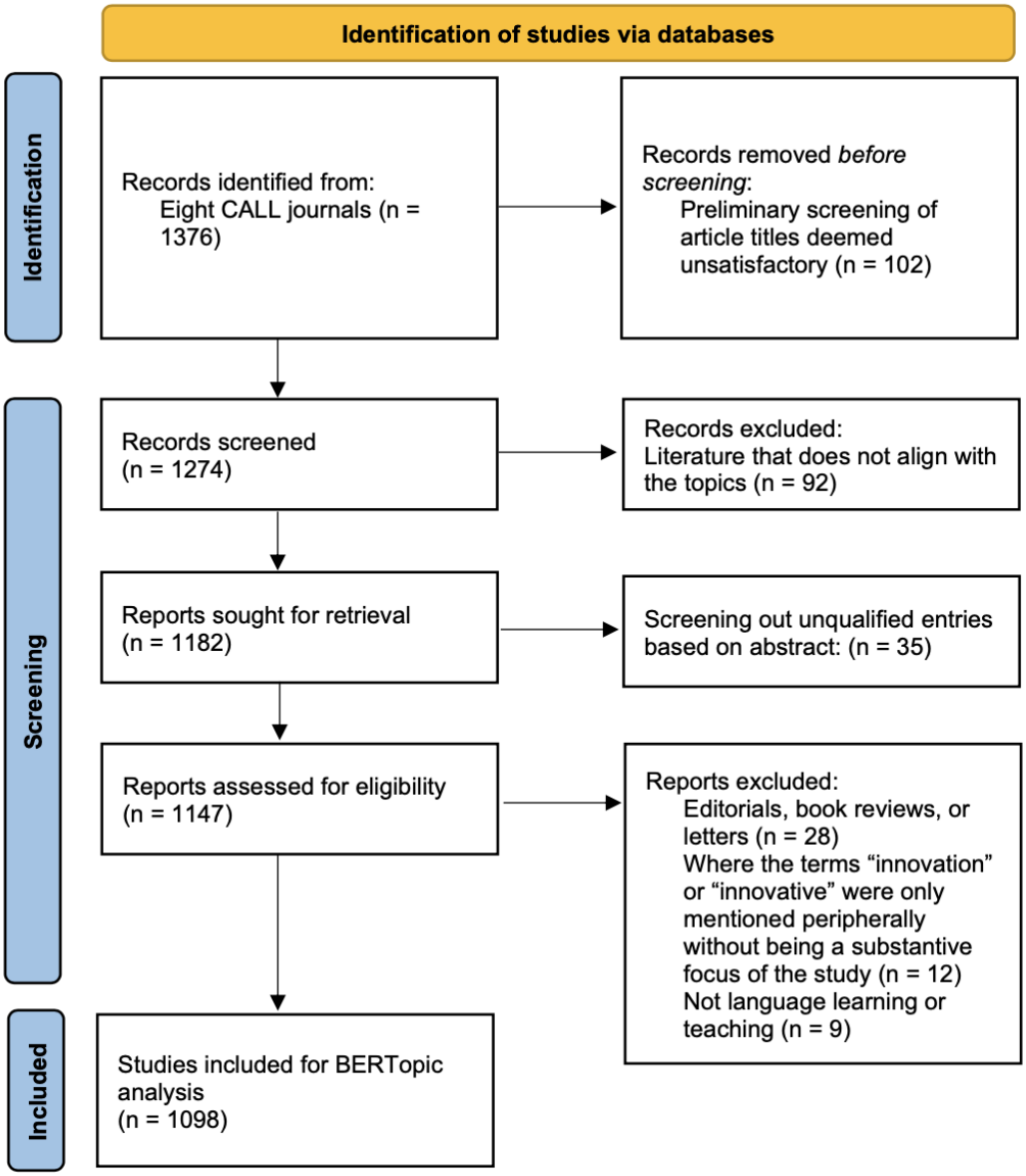

Figure 2. PRISMA flow diagram of the study selection process

2.5 Data Extraction and Analysis

2.5.1 Data Extraction and Corpus Formation

For the final set of 1,098 included studies, a structured data extraction was performed to compile the corpus for thematic modeling. The key textual components of each article were extracted and consolidated into a single composite document per article. This approach capitalizes on the fact that these elements concisely encapsulate the study's core content and themes, making them ideal for topic modeling. This collection of documents constituted the primary corpus for subsequent computational analysis. Relevant metadata, such as publication year and source journal, were also extracted to facilitate the interpretation of the resulting topics over time and across publication venues.

2.5.2 Text Pre-processing

To prepare the textual corpus for subsequent analysis, a series of standard natural language pre-processing steps was implemented to refine the data, reduce noise, and focus on meaningful semantic content (Gardazi et al., 2025). This procedure was conducted using the Python programming environment and involved several key stages. Initially, all text was converted to lowercase to ensure consistency. This was followed by tokenization, which segmented the continuous text into individual word units. Subsequently, we removed common English stop words (e.g., "the," "and") as well as frequently occurring yet semantically weak vocabulary specific to the research domain (e.g., "study," "paper," "findings") to accentuate words of substantive meaning. Finally, the words underwent lemmatization, a process that reduces them to their base or dictionary form (for instance, converting "innovative" and "innovation" to "innovate"), thereby consolidating different morphological variants at a semantic level and effectively refining conceptual expression. The clean and standardized corpus resulting from this pipeline provided a reliable foundation for the in-depth, semantic-based topic modeling that followed.

2.5.3 Topic Modeling with BERTopic

Thematic analysis was conducted using BERTopic, an advanced topic modeling technique that leverages contextual semantic understanding. Unlike traditional frequency-based models, this approach captures the deep semantic relationships between words, resulting in more coherent and interpretable topics. Our modeling process encompassed several key phases. First, we utilized the all-MiniLM-L6-v2 model from the sentence-transformers library to convert the pre-processed text corpus into high-dimensional document embeddings. This step represented the semantic content of each article as a dense numerical vector, laying the groundwork for subsequent clustering. Next, we employed the uniform manifold approximation and projection (UMAP) algorithm to reduce the dimensionality of these high-dimensional vectors (Raman et al., 2024). This process aimed to compress the data into a lower-dimensional space more suitable for clustering while preserving the most significant semantic structures between documents. Subsequently, the hierarchical density-based spatial clustering of applications with noise (HDBSCAN) algorithm, a density-based clustering method, was applied to the reduced data to identify topic clusters (Raman et al., 2024). A key advantage of this algorithm is its ability to automatically identify dense clusters of arbitrary shapes and to classify documents that do not firmly belong to any strong theme as outliers, thereby enhancing the internal purity of the final topics. Finally, for each cluster identified by HDBSCAN, a class-based term frequency-inverse document frequency (TF-IDF) technique was employed to extract the most representative keywords (Raman et al., 2024). This method evaluates the importance of words within a specific cluster relative to their frequency across the entire corpus, generating a set of highly discriminative and representative labels for each topic, which facilitates interpretation and analysis by the researchers.

3. Results

3.1 Determining Core Topics

Table 2 reveals the nine core research topics identified through BERTopic analysis, along with their basic information and characteristics. The core terms of each topic in Figure 3 and their c-TF-IDF scores reveal distinct boundaries between topics. Below is a detailed presentation of these five topics:

Topic 0 (T0) Affect in L2 speaking

Topic 0 represents the most extensively researched area within innovative CALL studies. As evidenced by the keywords in Table 2, this topic is characterized by a strong emphasis on psychological constructs, notably "self," "anxiety," and "motivation" in the context of L2 speaking development. The appearance of "teacher" among the key terms further underscores the educator's role in mediating these affective factors during speaking practice. Collectively, these lexical patterns reflect a student-centered pedagogical approach that prioritizes learners' emotional and self-regulatory experiences, aligning with a broader shift in innovative CALL approaches toward affective and psychologically informed language teaching (e.g., Fathi et al., 2024; Zhang et al., 2024).

Topic 1 (T1) Teacher development & CALL pedagogy

This research topic emphasizes teacher professional development and pedagogical innovation in CALL. Keywords such as "finding" and "data" highlight the empirical nature of this topic, and teacher education has its foundational role in the innovative learning and teaching: before technologies can be implemented into learning, teachers must first be equipped with the necessary cognitive, pedagogical, and technological competencies (Lee & Wu, 2024; Meihami, & Esfandiari, 2021). Frameworks such as TPACK (Technological Pedagogical Content Knowledge) and SAMR (Substitution, Augmentation, Modification, Redefinition) have been widely explored and revised in different technological environments, from computer technology to GenAI and XR (Lee & Wu, 2023). This strand highlights the crucial role of teachers as agents of innovation and conceptualizes innovation as a process mediated by teacher readiness. This body of work investigates how teachers should critically evaluate digital tools and adapt them to diverse learning contexts (Choi et al., 2025).

Topic 2 (T2) Mobile and immersive technologies with vocabulary learning

This topic is related to new technologies, especially virtual reality (VR) and augmented reality (AR), reflecting a tool-oriented research agenda within innovation studies. Together with "vocabulary", these keywords showcase that these tools are used to create immersive experiences for learners to develop their vocabulary knowledge and skills (Lee et al., 2024). Recognized for the capacity to simulate authentic, low-stakes scenarios in the target language, VR and AR empower learners to engage in contextualized practice (Song et al., 2023). Thus, innovation here is realized through the lens of specific digital tools and the interactive environment, positioning technological mediation as central to the learning process.

Topic 3 (T3) Intercultural communicative competence through telecollaboration

The keywords "intercultural," "telecollaboration," "Chinese,", and "English" delineate a topic that centers on cross-cultural language learning where technology plays an important role. Over the past decade, we have seen a wide array of telecollaboration research using different digital tools from the traditional computer-mediated communication to mobile-assisted interactions, and more recently VR environments (Wu et al., 2023; You et al., 2025). Within these innovative learning configurations, learners usually participate in synchronous, multimodal communication with partners from other cultural contexts. Learners develop not only linguistic skills, but also the awareness of global citizenship and other soft skills needed to thrive in the global job market.

Topic 4 (T4) Course design for online, blended, or flipped learning

This topic of CALL research addresses innovation at a curricular level. It explores the optimal design and implementation of online courses, blended learning, and flipped learning (e.g., Amiryousefi, 2019; Chu et al., 2025). In particular, LMOOCs represent an innovative approach to achieving a large-scale mode of delivery (Wright & Furneaux, 2021), contributing to the democratization of education worldwide.

Topic 5 (T5) Collaborative writing and automated writing evaluation

This topic explores the integration of human-centered ("peer" and "collaborative") and technology-driven (automated writing evaluation, AWE) methods to innovate writing practices. Previous CALL research has been characterized by different technological platforms such as Google Docs, Wiki, and online blogs (Lai, 2023; Li & Zhu, 2017), while AWE has also captured attention for its capabilities to provide feedback on low-level writing skills such as grammar (Link et al., 2022). The innovation dimension of this research lies in its focus on how learners can co-construct meaning and writing pieces with the support of technology.

Topic 6 (T6) GenAI in Language Education

This line of innovative CALL research focuses on the use of GenAI to provide personalized learning. The keyword profile for this topic is dominated by specific system names such as "ChatGPT" and "AI", so it suggests that the field is in a premature and exploratory phase of research. This emphasis on tools suggests that attention remains on understanding the capabilities and affordances of the technology (e.g., Zeevy-Solovey, 2024; Zhou & Du Preez, 2025). This is further corroborated by the semantic similarity analysis in Figure 4, which reveals the conceptual isolation of GenAI from other topics, which will be discussed in the subsequent sections.

Topic 7 (T7) Video captions for EFL input comprehension

This topic examines the use of multimodal input, particularly captioned videos, to enhance receptive skills, including listening and reading. Scholars such as Teng (2025) and Lin (2022) have conducted studies to compare how different types of captions provide audiovisual scaffolding for language learning. Key words like "test" and "comprehension" further point to an outcome-oriented approach to innovation that focuses on the

measurement of learner gains in the technology environments.

Topic 8 (T8) Digital game-based learning and creative project-based language learning

The keywords under this topic in Table 2 signal the creation of experiential and expressive language learning experiences in CALL studies. Words such as "creative," "game," "enjoyment," "story," and "narrative" reflect pedagogical approaches such as digital game-based learning, project-based learning, and digital storytelling learning, which emphasize agency, motivation, and multimodal literacy (Li et al., 2022; Lee, 2019; Tour et al., 2021).

Innovation here is manifested as the design of personally interesting and emotionally engaging learning experiences, where technology functions as a canvas for creation. Also, gaming elements such as reward systems, real-time interactions, and scaffolded challenges have played a role in fostering authentic learning opportunities for learners to develop language and creativity skills (Foroutan Far & Taghizadeh, 2024).

Table 2. Nine core topics of innovation in eight CALL journals

Topics	Document Distribution	Topic Name	Key Terms
0	193	Affect in L2 speaking	L2, speaking, efl, English, self, teacher, anxiety, motivation, foreign, participant
1	163	Teacher development & CALL pedagogy	Teacher, English, teaching, call, practice, classroom, development, finding, data, approach
2	161	Mobile and immersive technologies with vocabulary learning	Technology, vocabulary, mobile, VR, digital, teacher, AR, based, English, game
3	105	Intercultural communicative competence through telecollaboration	Chinese, intercultural, English, teacher, telecollaboration, data, CLIL, analysis, dynamic, participant
4	92	Course design for online, blended, or flipped learning	Online, teacher, lmooc, course, teaching, flipped, blended, English, design, EFL
5	78	Collaborative writing and automated writing evaluation	Writing, feedback, peer, EFL, collaborative, dmc, awe, text, performance, analysis
6	64	GenAI in Language Education	AI, chatgpt, genai, tool, artificial, writing, intelligence, teacher, generative, education
7	43	Video captions for EFL input comprehension	Reading, listening, comprehension, EFL, caption, video, strategy, vocabulary, test, participant
8	21	Digital game-based learning and creative project-based language learning	Creativity, creative, project, digital, game, enjoyment, approach, story, narrative

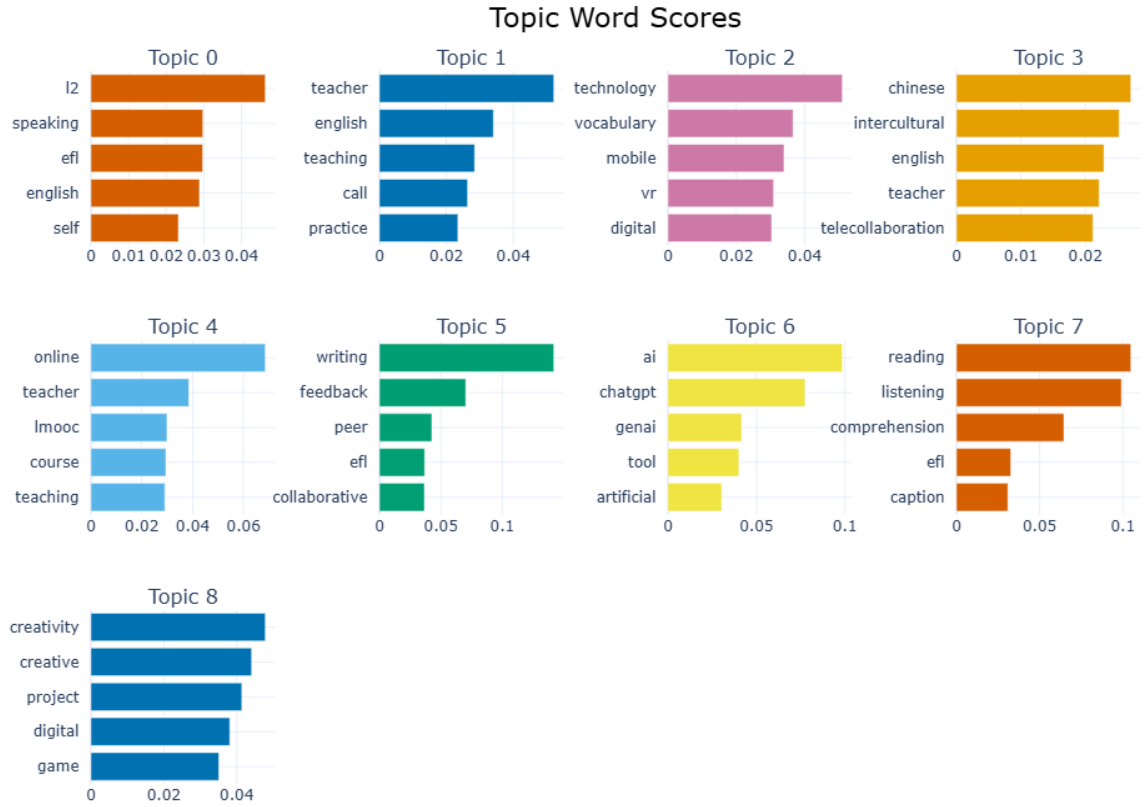

Figure 3. The core keywords for each topic and their c-TF-IDF scores

3.2 Topic Similarity Analysis

The similarity matrix heatmap (Figure 4) reveals a clear hierarchical structure among the nine topics, featured by clusters of strong associations alongside more isolated topics. The overall matrix exhibits a block-like distribution pattern, suggesting the presence of several conceptually cohesive subsets with varying degrees of inter-cluster relatedness. The main diagonal, representing each node's self-correlation, maintains theoretical perfect correlation as expected. The nodes T0 and T1, and T1 and T3, demonstrate the highest degree of similarity (score of 1.00), with a correlation coefficient exceeding 0.92, forming the most strongly correlated pair. Closely following are pairs such as T1 and T4, T2 and T3, T0 and T7, T0 and T3, and T3 and T4 with similarity values ranging between 0.90 and 0.92, suggesting a tightly knit core cluster. At the moderate association level, connections such as T0 and T2, T4 and T5, and T3 and T8 show a correlation of approximately 0.85, while others such as T1 and T5, T2 and T7, and T3 and T6 fall within the 0.8 to 0.85 range, reflecting looser but still notable linkages. In contrast, T6 (GenAI in Language Education) displays generally weaker connections to the other nodes, with similarity coefficients mostly below 0.8, appearing as a distinctly lighter-shaded region in the color gradient and highlighting its relative conceptual independence.

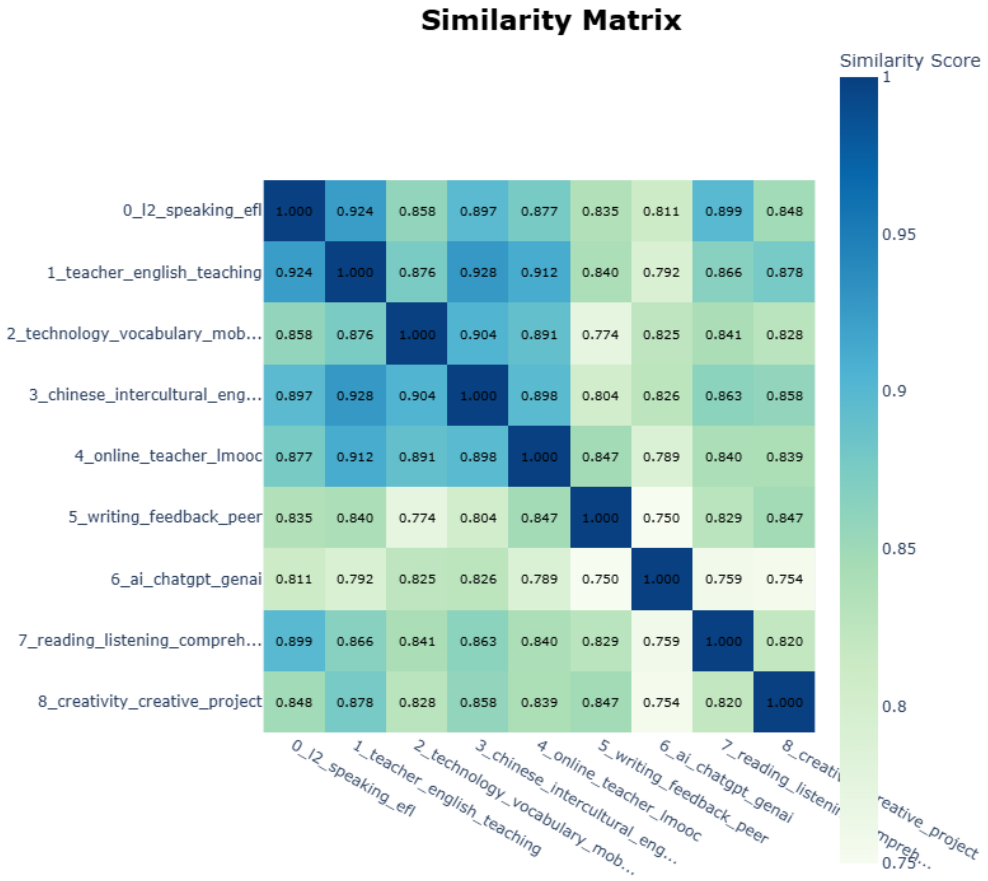

Figure 4. Heatmaps of semantic similarity between topics

3.3 Topic Evolution Over Time

Figure 5 showcases a clear technology-driven development of innovations in language education from 2015 to 2025. Specifically, T6 demonstrates an explosive growth pattern, with minimal scholarly attention prior to 2023, followed by a rapid rise as a dominant research theme, a trajectory that closely aligns with the widespread adoption of GenAI technologies. By comparison, T0 and T2 maintain consistently high research interest throughout the period, indicating their transition into a relatively mature phase of development. Notably, T1 and T4 exhibit synchronous growth between 2020-2022, driven by the shift to remote learning during the pandemic.

In contrast, T8 shows a steady, linear growth trajectory, suggesting sustained and stable development in this research area. Furthermore, T3 displays a gradual upward curve, reflecting its progressive accumulation of academic attention as an emerging research direction. However, T5 and T7 maintain relatively stable fluctuations, indicating these traditional research fields have entered a developmental plateau. In summary, the data clearly reveal a dynamic balance between emerging and established themes: while technology-intensive topics accelerate rapidly, foundational pedagogical themes continue to evolve steadily, together shaping the advancing frontier of language education.

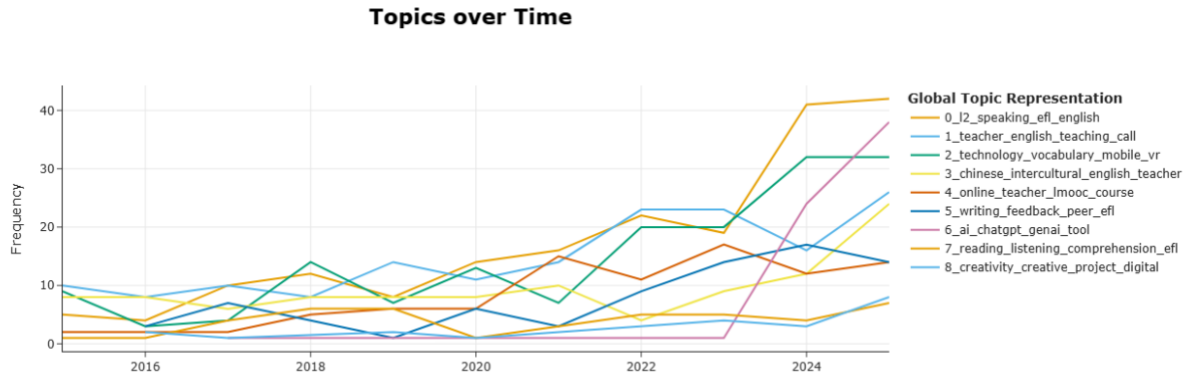

Figure 5. Topic evolution over time

4. Discussion

4.1 Thematic Structure and Trajectories of Innovation in CALL

Evidenced in Figure 4, the review discovers that T1 (Teacher development & CALL pedagogy) is a central hub in the landscape of innovation within the eight CALL-related journals. Together with T0 (Affect in L2 speaking), T3 (Intercultural communicative competence through telecollaboration), and T4 (Course design for online, blended, or flipped learning), these topics form a tight conceptual cluster. This clustering suggests that over the past decade, the CALL journals prioritized the augmentation of L2 pedagogical practices, instead of centering on the technological tools *per se*. Several trends within this cluster should be highlighted. First, teacher education and learner psychology have remained prominent and seem that they will continue to receive attention in innovative CALL studies (Figure 5). Second, telecollaboration has sustained its popularity for language learners to practice intercultural and intracultural communicative competence (e.g., Priego & Liaw, 2017; Wu et al., 2022). It is worth noting that Figure 5 shows an increasing trend from 2022. One possible reason is the growing availability of AR and VR that overcome the limitations of traditional video-based chatting by extending learning opportunities to enable learners to perform actions, experience virtual scenes, and interact with virtual elements or characters (Wu, 2021; Wu & Lee, 2025). Third, MOOCs, flipped learning, and blended learning were widely explored due to the normalization of computer and mobile technologies. However, as Figure 5 shows, this line of research has plateaued compared to other topics. Perhaps this is related to the fact that many existing studies, not just language research, have demonstrated that these three pedagogical methods are not as innovative nor effective as recent emerging methods (Hew & Cheung, 2014).

The keywords in Table 2 and Figure 3 further suggest a spectrum of research maturity for the nine topics. T2 and T6 with emerging technologies are marked by tool-oriented terms such as VR, AR, and AI. In contrast, T5 (Collaborative writing and automated writing evaluation), T7 (Video captions for EFL input comprehension), and T8 (Digital game-based learning and creative project-based language learning) from Figure 4 represent more established streams. They also have weaker links with emerging technologies. For T5, automatic writing tools such as Grammarly emphasize the correction of errors while

overlooking the importance of ideas and content co-construction (Dizon & Gayed, 2021). Similarly, video captions and digital game-based learning are largely limited to computers (Dashtestani, 2022). Only recent researchers have begun discussing the potential of aligning these conventional research areas with innovative technologies (e.g., Wu et al., 2025).

In terms of T2 and T6, there are two distinctive modes of innovation. T2 exemplified dependent innovation, which has strong associations with various topics in Figure 4. This highlights that mobile and immersive technologies are being used to enrich existing learning contexts for learning practices (Hwang & Lee, 2024; Wu & Miller, 2021). On the contrary, T6 demonstrates independent innovation, pronounced by its weak semantic connections with other topics. This isolation points out that GenAI is not being treated merely as an extension of existing CALL technologies. Rather, it functions as a unique and potentially disruptive force to innovating language learning paradigms (Huang et al., 2023).

A few factors have contributed to this independence. First, differing from traditional automated writing tools that provide corrections on linguistic errors, GenAI has the great potential to engage learners by generating and interacting with the learner in a dialogic and natural manner. This offers brand new opportunities for moving away from tool-based learning towards learner-technology collaboration (Chen et al., 2022). Second, as mentioned, the established domains are so far largely refined to computer and mobile technologies, but GenAI is only starting to be integrated into language education. Third, current discourse around GenAI centers on its technical affordances and limitations since this technology is relatively new to language teachers and learners (Huang et al., 2023). Deeper theoretical discussions are to be expected in the coming years (Pérez-Paredes et al., 2025; Yang et al., 2025).

Yet, this isolation of the GenAI topic should not be deemed as a shortcoming. Not aligning with existing topics can also mean a potential innovation in the future learning paradigm. This is indeed happening in language education as we have seen GenAI is positioned not only as a tool but as a game-changer for teachers and learners across lesson planning, learning activities design, assessment reform, and more. In order to better leverage GenAI in innovative language education, effort is required to maximize its transformative potential from theoretical, pedagogical, technical, and methodological perspectives.

4.2 An Integrated Model of Innovation in CALL

This review depicts the current landscape of innovative CALL based on a bibliometric analysis of 1,098 articles published in eight CALL-related journals. Overall, the analysis reveals nine core research topics over the past decade. Some of these topics form tightly interconnected clusters that constitute the foundations of this field, while others represent emerging topics with potential to innovate and transform the CALL paradigm.

The framework in Figure 6 showcases the structure and core mediating factors of innovative CALL. Existing research shows a three-layer hierarchical model of innovation:

a. Tool Layer (Foundational): This layer focuses on the affordances and constraints of new technologies such as VR and AI since these technologies are relatively novel for language teachers and learners. Gaining an in-depth understanding of the

technology can help teachers and learners make informed pedagogical decisions in their teaching and learning.

b. Design Layer (Predominant): The majority of current studies fall into this category which centers on pedagogical design and curriculum development informed by innovative CALL technologies. This is of prime importance for language teachers and learners as this layer translates the potential of new technologies into specific instructional practices.
c. Psychology Layer (Emerging): Building upon the previous layers, this layer explores the affective, motivational, and social mechanisms that modify students' learning behavior and efficacy.

At the heart of this model are two mediating constructs: Teacher Agency and Learner Agency. Teacher agency, as the most central construct from the analysis, drives the design, adaptation, and guidance of technological integration. Learner agency, on the other hand, embodies engagement, self-regulation, interest, and ownership of the learning process, serving as the internal engine through which innovative technological experiences are processed and converted into meaningful learning gains.

Collectively, the three core layers and two mediating factors are oriented toward the ultimate goal of fostering language competence and broader global competencies. The value of innovation in CALL does not reside in the technology itself but is achieved by the dynamic interplay between agentic teachers and learners within and across each layer. This integrative model provides a coherent conceptual map for situating diverse research strands and for guiding future inquiry into the multifaceted nature of innovation in CALL.

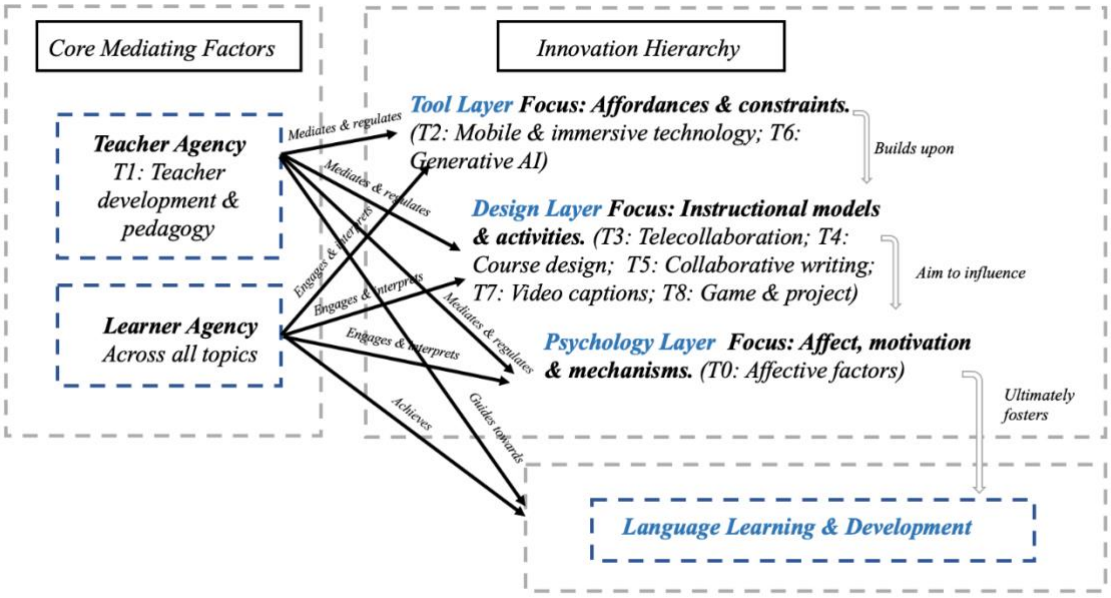

Figure 6. Multidimensional innovation ecosystem in CALL

5. Implications and Limitations

Based on the findings of this review, a few important implications emerge for practice and research. First, basic educational topics such as teacher education and course design remain stable in the CALL field; however, there is a clear need for teachers and educators to innovate both the language learning experiences and outcomes with emerging technologies. For example, VR offers innovative ways to immerse learners in authentic and interactive situations, but little is known due to its technical and resource constraints (Lee et al., 2024). Second, Figure 5 illuminates that topics of innovation in CALL research appear to evolve through different stages from emergence, rapid development, to maturity, and stabilization. This cycle reminds us that scholarly attention should be tailored to a topic's developmental phase. For example, for high-growth topics such as T2 and T6, more empirical research is in need to establish foundational evidence and pedagogical frameworks. In contrast, for well-established topics such as T7, systematic reviews and meta-analyses may provide greater value by synthesizing existing knowledge and suggesting future trends to further innovate the line of inquiry. Third, the eight research topics generated from BERTopic modeling outline a roadmap for future inquiry. These topics hold potential for synergistic integration. For instance, future studies should explore how VR (T2) can enhance affections in L2 speaking (T0), particularly in intercultural communicative scenarios (T3). Such cross-topic explorations can be of great value to more forward innovative language education.

Akin to other review studies, this review has its own limitations. First, this review was limited to eight leading CALL-related journals. Yet, given its interdisciplinary nature, a large quantity of research on innovation and technology is now published in non-CALL journals such as *RELC Journal*. Second, as the search strategy relied on the term "innovation," the review may have excluded studies that embody innovative practices or technologies, but without using this specific term. Despite these limitations, this review offers up-to-date, data-driven insights into the current landscape of innovation within CALL publications. This paper provides a valuable reference for future inquiry into technology-enhanced innovation in language education.

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