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Mapping Research Trends and Future Directions in Computer-Assisted Language Learning: A Bibliometric Analysis (2009–2023)

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Abstract

Computer-Assisted Language Learning (CALL), an interdisciplinary field integrating information technology and linguistics, has emerged as a prominent focus in second-language acquisition research. The primary problem addressed in this study is the lack of a comprehensive mapping of research trends, thematic focuses, and developmental trajectories of CALL over the past fifteen years, particularly in the context of rapid advancements in artificial intelligence. Therefore, the objective of this study is to identify research hotspots, explore developmental patterns, and examine future trends in CALL research at both international and domestic levels. This study adopts a bibliometric approach, utilizing CiteSpace to analyze relevant literature retrieved from the Web of Science Core Collection and the China National Knowledge Infrastructure (CNKI) databases, covering the period from 2009 to 2023. The analysis focuses on keyword co-occurrence, citation networks, and cluster mapping to reveal the structural and thematic evolution of CALL research. The findings indicate that integrating emerging technologies—such as artificial intelligence, virtual reality, ubiquitous learning, flipped classrooms, and automated assessment—has significantly transformed the learning environment, pedagogical strategies, and instructional methods in foreign language education. Furthermore, the research focus has gradually shifted from technology adoption to deeper pedagogical integration. However, a notable gap remains in effectively bridging theoretical frameworks with practical implementation in language teaching contexts. The implications of this study highlight the need to develop more contextually grounded, adaptive, and theory-driven CALL models, as well as to foster interdisciplinary collaboration to enhance language learning effectiveness in the digital era. Additionally, this study provides strategic insights for guiding future CALL research, particularly within domestic academic contexts.

Keywords: *Artificial Intelligence, Citespace, Computer-Assisted Language Learning, Learning Environment*

A. Introduction

Computer-Assisted Language Learning (CALL) originated in the United States and refers to “the exploration and research of computer applications in language teaching”. In recent years, driven by big data and deep learning, the widespread application of artificial intelligence has sparked significant changes in language education (Mirani et al., 2019). With the parallel development of computer science and pedagogical theory, CALL, as an interdisciplinary field of information technology and linguistics, has made significant progress, yielding a wealth of research results and fundamentally changing traditional foreign language teaching methods (Butler-Pascoe, 2011). Through the use of intelligent technology, foreign language teaching can

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achieve “personalised teaching”, “virtualised environment”, and “automated management”. After 2012, international research on intelligent language teaching entered a period of rapid development (Chen et al., 2020).

From theoretical research to practical application, CALL is changing learners' cognitive processes and teaching practices. At the theoretical level, Mike Levy has reviewed and summarised research methods in the field of CALL, including the scope, objectives, and methods of CALL research (Levy, 2000), as well as technological innovations (Levy, 2007), research challenges (Levy et al., 2015), and the role of qualitative research in the CALL context (Levy, 2015). In the learning environment, learners are no longer confined to traditional classrooms relying on teacher-led lectures and blackboard notes, but can utilise a large number of intelligent and information devices for learning and summarising, expanding the learning space and scope. In terms of learning content, learners' study materials have become more diverse, personalised, and authentic. Students are no longer limited to reading and reciting single-sentence patterns from textbooks; they are now more engaged in learning foreign languages in virtual scenarios and in reinforcing input and output through technological means. In terms of interactive modes, CALL has expanded the scope of interaction, allowing it to move beyond verbal interaction between teachers and students or among students, to include human-computer interaction and cross-temporal and spatial interactions, which help learners gain more diverse, exhaustive, and professional feedback. Researchers continue to enrich the connotations of CALL from various perspectives, including language interaction feedback, learner output evaluation, and big data analysis of student language-learning behaviours (Divekar et al., 2022).

Looking at CALL research both domestically and internationally, research in China began relatively late, and both theoretical and empirical research still need further development. As research on CALL advances, it is necessary to systematically review and summarise relevant research at home and abroad. On one hand, this will provide a clearer understanding of the current status and research hotspots of domestic and international research. On the other hand, by reviewing domestic and international research, it will reveal the shortcomings of current domestic research and draw on international research to improve domestic studies. Therefore, this article adopts a bibliometric approach to analyse the SSCI and CSSCI literature on CALL from 2009 to 2023, collected from the Web of Science and CNKI databases. The study aimed to comprehensively reflect the research hotspots and development trends of CALL at home and abroad over the past fifteen years, and to provide valuable references for future related teaching research and practice.

B. Methods

Research Design

This study adopts a bibliometric research design with a descriptive-quantitative approach to map the development of research in Computer-Assisted Language Learning (CALL). This approach is considered appropriate because it enables the systematic, measurable identification of patterns, trends, and relationships among concepts in scientific literature. Furthermore, the study employs CiteSpace for visualization analysis to illustrate the knowledge domain and the evolutionary dynamics of CALL research over time. Through this design, the study aims to explore research hotspots, the evolution of themes, and future development directions of CALL at both global and domestic levels.

Research Procedure

The research procedure began with a systematic literature retrieval using the advanced search mode in two major databases: the Web of Science Core Collection for international publications and the China National Knowledge Infrastructure (CNKI) for domestic publications. The search employed keywords such as "computer-assisted language learning," "artificial intelligence," as well as related terms including "digitization + language learning" and "intelligence + second language." The time span was limited to publications from 2009 to 2023. A manual screening process was then conducted to exclude irrelevant articles and those not aligned with the research theme. As a result, 2,532 initial records were obtained from Web of Science and 543 from CNKI. The downloaded data were subsequently processed using CiteSpace, including conversion, denoising, and standardization, resulting in 297 valid international records and 208 valid domestic records.

Data Collection Techniques

Data collection in this study was conducted through document analysis of scientific publications indexed in reputable databases. International data were sourced from the Web of Science Core Collection, restricted to English-language publications, while domestic data were obtained from CNKI, specifically from journals categorized under CSSCI. The inclusion criteria comprised articles relevant to CALL, focusing on technology-enhanced language learning, and falling within the specified time frame. Articles that were irrelevant, duplicated, or not aligned with the thematic scope were excluded. All selected data were downloaded in compatible formats to facilitate further analysis using bibliometric tools.

Data Analysis Techniques

Data analysis was performed using CiteSpace version 6.2.R6, developed by Chaomei Chen of Drexel University. The analysis included knowledge domain mapping via co-occurrence, cluster, and timeline analyses to identify relationships among keywords and track the evolution of research themes over time. In addition, Microsoft Excel was utilized to analyze publication trends and keyword frequencies. The results were visualized through network maps, enabling a comprehensive interpretation of research trends, hotspots, and developmental trajectories in CALL over the past fifteen years. This analytical approach provides a systematic and in-depth understanding of CALL research dynamics at both global and domestic levels.

C. Results and Discussion

Trends in Publication Years

The changing number of publications can serve as an indicator of the current status and trends in this research field. Figures 1 and 2 show the changes in the number of publications on CALL at home and abroad over the years. An overall fluctuating growth trend in the quantity of related publications can be observed over the past 15 years, with a rapid increase in recent years. This indicates that this research field remains an important influence on language learning, attracting widespread attention from domestic and international scholars.

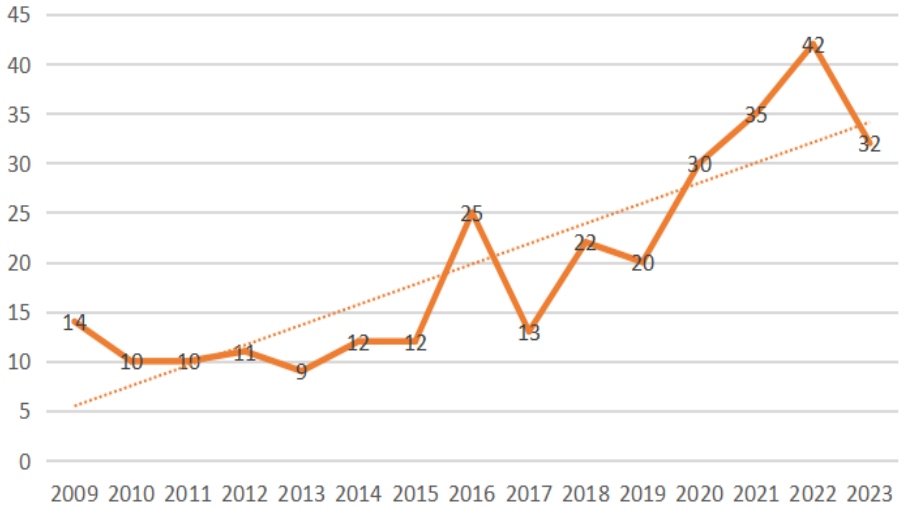

Figure 1. Number of publications on SSCI from 2009 to 2023

Figure 1 shows that between 2009 and 2016, the number of publications in international SSCI journals on CALL research remained around 10 per year. The growth trend after 2016 was particularly noticeable, with the number of publications steadily increasing and peaking in 2022 at 42 articles. This trend reflects the positive development of international research on CALL over the past two decades, indicating that related research has attracted significant attention in the international academic community and is currently a hot topic. The reason 2016 was a turning point may be primarily due to AlphaGo's victory over the world Go champion, which greatly piqued researchers' interest in intelligent technology.

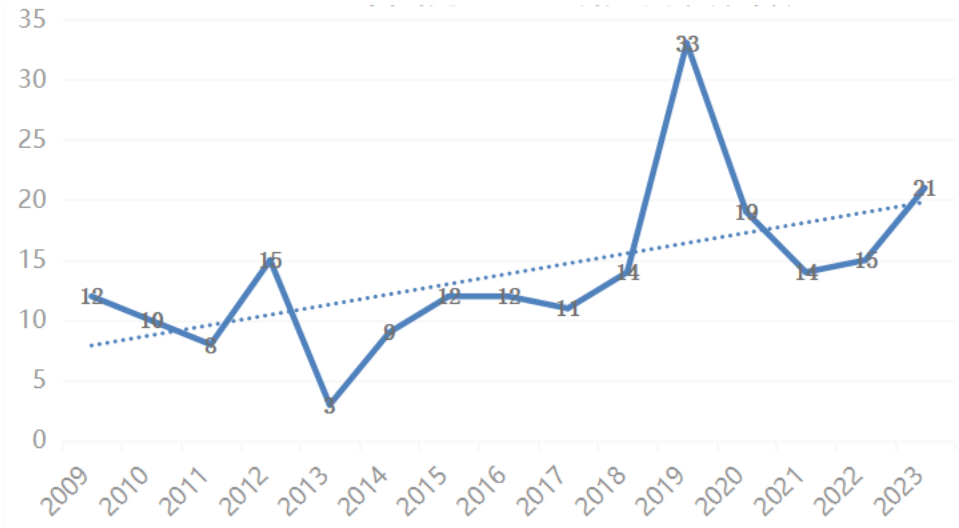

Figure 2. Number of publications on CSSCI from 2009 to 2023

Figure 2 displays the changes in the number of publications on CALL research in domestic CSSCI journals over the years. From the figure, it can be observed that the total number of publications in domestic CSSCI journals is significantly less than that in international journals, with the annual publication volume remaining around 15 articles, except in 2019. After 2018, there was a noticeable increase in the number of publications, possibly influenced by a series of documents issued by the Ministry of Education of the People's Republic of China to promote the development of artificial intelligence, such as the "New Generation Artificial Intelligence Development Plan" (2017) and the "Higher Education Artificial Intelligence Innovation Action

Plan" (2018). These policies have played an important role in promoting research on intelligent language teaching.

Distribution of Publications in Journals

Tables 1 and 2 present the top 5 journals, both domestically and internationally, by the number of publications. From the tables, it can be seen that the journals in which CALL research is published, both domestically and internationally, are top-tier in linguistics and psychology.

Table 1. Distribution of Research Journals on CALL Abroad

Journal Title	Number of publications
Computer-Assisted Language Learning	94
Recall	24
System	20
Language Learning & Technology	18
Computers & Education	9

The journal with the highest number of publications in international CALL research is "Computer Assisted Language Learning", which spans linguistics and computer science and is a Q1 journal in linguistics. The table indicates that CALL has received significant attention in linguistics and cognitive science, with a high volume of high-quality research.

Table 2. Distribution of domestic journals on CALL

Journal Title	Number of publications
Technology-Enhanced Foreign Language Education （外语电化教学）	55
Modern Educational Technology （现代教育技术）	15
Foreign Language World （外语界）	11
China Educational Technology （中国电化教育）	9
Journal of The Chinese Society of Education （中国教育学刊）	9

The journal with the highest number of publications in domestic CALL is "Technology Enhanced Foreign Language Education", which is a Q1 journal in linguistics. From the table, it can be seen that research on domestic CALL is deeply influenced by the field of foreign language teaching, with the published journals mostly belonging to foreign language teaching or technological education journals, such as "Modern Educational Technology" and "Foreign Language World". The top 5 domestic journals account for 48% of all journal publications. Additionally, a large number of articles on CALL are also published in "Foreign Language Education" and "Foreign Languages and Their Teaching". Currently, CALL research has a high output of high-quality research results and is a hot topic in China.

Hotspots in CALL Research

Keywords, as the core and essence of an article, to some extent reflect the research direction and content of the field. Keywords with high frequency can be seen as the research hotspots in this field. By running CiteSpace and selecting "keywords" as the analysis content, setting "Time Slicing" to "2009-2023", with 1 year as a time slice, and choosing "Top 50 levels" in the "Selection Criteria", a co-occurrence knowledge map of keywords in CALL from 2009 to 2023 is generated, as shown in Figures 3 and 4.

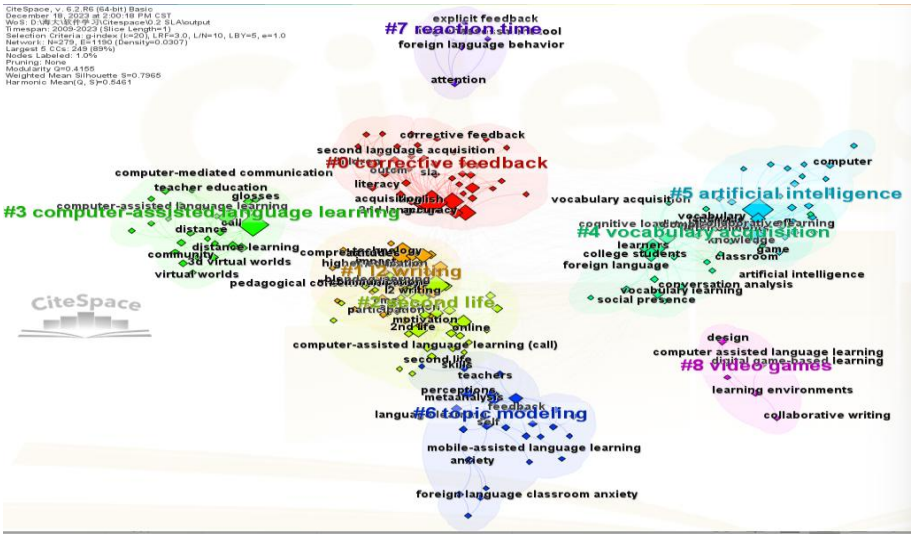

Figure 3. Keyword co-occurrence mapping knowledge domain of SSCI

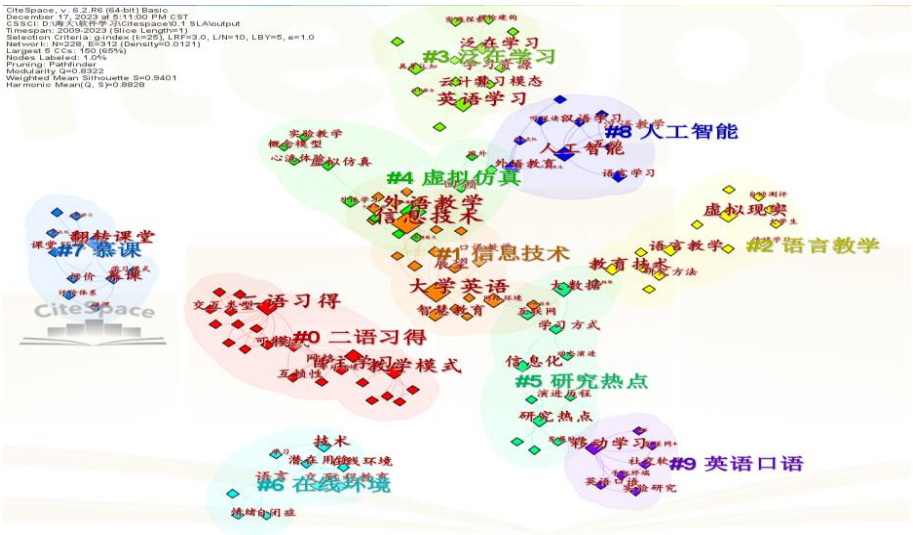

Figure 4. Keyword co-occurrence mapping in the knowledge domain of CSSCI

According to Figures 3 and 4, the co-occurrence mapping of keywords in SSCI and CSSCI yields 24 and 14 high-frequency keywords, respectively. The first 8 keywords, as shown in Tables 3 and 4, represent the hotspots and key areas of research in CALL from 2009 to 2023 and are an important resource for CALL research.

Table 3. High-frequency keywords in SSCI from 2009 to 2023

High-frequency Keywords	Frequency
Students/Learners	68
English	48
Call	42
Language	42
Technology	39
Acquisition	23

High-frequency Keywords	Frequency
Classroom	19
Second Language	18
Education	17
Second Life	15

Table 4. High-frequency keywords in CSSCI from 2009 to 2023

High-frequency Keywords	Frequency
Information Technology (信息技术)	14
College English (大学英语)	12
Foreign Language Teaching (外语教学)	11
Second Language Acquisition (二语习得)	7
Virtual Reality (虚拟现实)	6
Flipped Classroom (翻转课堂)	6
Network Environment (网络环境)	6
Teaching Model (教学模式)	6
Big Data (大数据)	6
Teaching Model (教学模式)	6

In order to intuitively understand the research hotspots and development trends in this field, we uses Citespace software to analyse the timeline graph. In the graph, the larger the font and node, the higher the weight, and the thickness of the lines between nodes represents the frequency of co-occurrence. From the graphs, it can be seen that the node “information technology” has a long duration in the graph, with many connections, indicating its intricate relationships with other nodes, especially with “second language acquisition” and “language teaching”. This also demonstrates the deep integration of artificial intelligence technology and language teaching. In addition, from Figure 6, it can be seen that, apart from “artificial intelligence”, “online environment”, “ubiquitous learning”, “flipped classroom”, “classroom environment”, and “virtual reality” are also research hotspots.

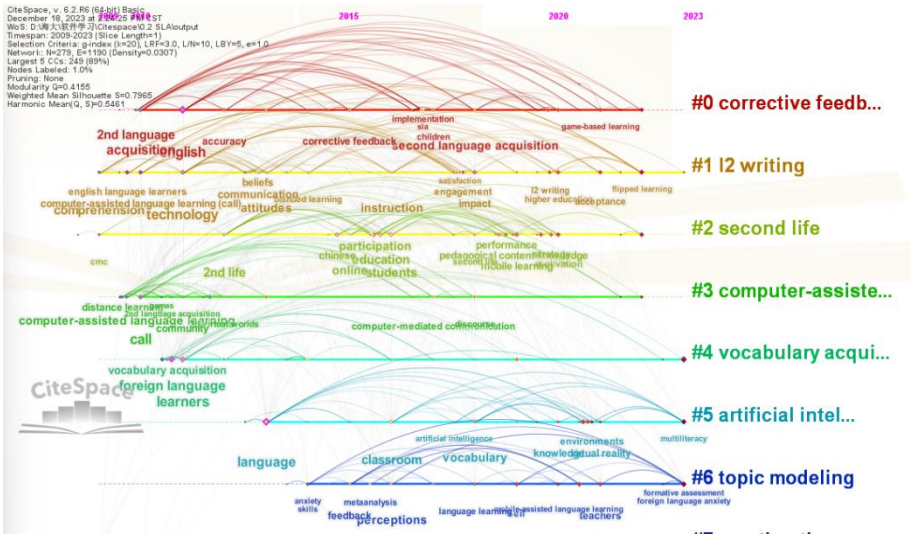

Figure 5. Keyword Timeline Graph of SSCI from 2009 to 2023

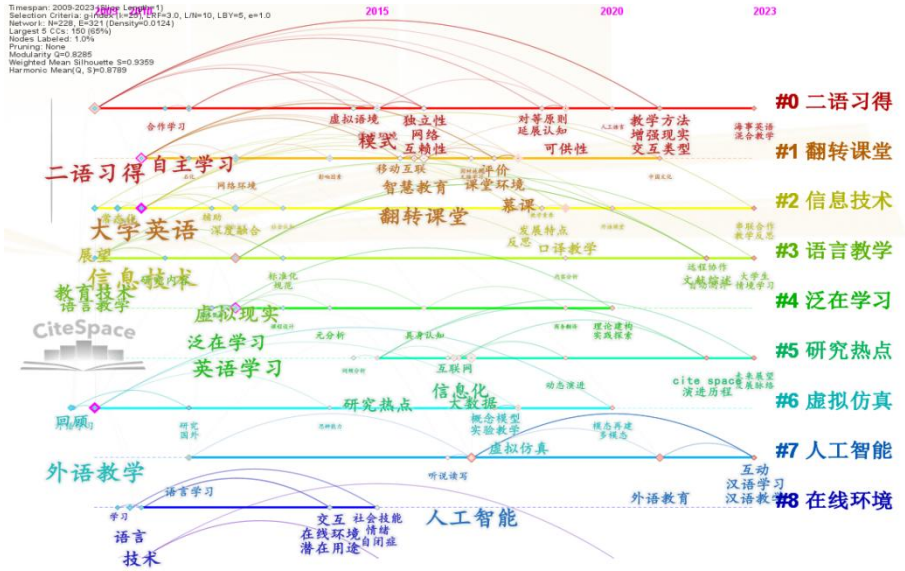

Figure 6. Keyword Timeline Graph of CSSCI from 2009 to 2023

Emerging Trends in CALL

Artificial Intelligence Changing the Learning Environment

CALL has positively impacted the learning environment by providing learning resources, promoting personalised learning, improving teaching effectiveness, and expanding learning spaces. This enables learners and teachers to no longer rely on traditional learning environments such as classroom instruction and textbook-based learning, providing language learners with a richer, more convenient, and more efficient learning experience.

Artificial intelligence has enriched the language-using environment, expanding the time and space for learning. Augmented and virtual reality, and language learning through digital games, have created more relaxed and authentic language-learning environments. For example, in recent years, there has been a surge in language-teaching research based on the virtual community "Second Life", with specific studies covering teaching effectiveness, participant collaboration, comparisons of text and speech input, task design, and learning motivation (Chen, 2018). Furthermore, artificial intelligence has made the learning environment mobile, no longer confined to the classroom. In 2020, Liu et al. used a combination of subjective and objective measures to evaluate the effectiveness and usability of mobile learning chatbots (Liu et al., 2020).

Artificial intelligence promotes personalised learning, improves teaching effectiveness, and helps to create a student-centred classroom atmosphere. According to Dörnyei (2006), individual differences in language learners are reflected in factors such as cognition and emotion. Among them, there is ample research on learning anxiety, learning motivation, and self-efficacy. Hong et al. (2017) found that self-efficacy in online learning can be predicted by intrinsic motivation for learning Chinese, whereas flow experience is related to learning progress. Yin et al. discussed the impact of a micro-learning system based on chatbots on students' learning motivation and academic performance (Yin et al., 2021). It is worth noting that digital games also have a significant impact on language learning among young children and teenagers. Analysing game data can track learners' second-language development in games and evaluate language-learning effects, such as learners' willingness to communicate, speaking fluency, and vocabulary size (Sundqvist, 2019).

Flipped Classroom Assisting Deep Learning

The flipped classroom is a student-centred teaching model that moves traditional classroom content out of the classroom, allowing students to master knowledge through self-study and pre-learning at home, while the classroom is used more for discussion, practice, and problem-solving. The promotion of language learning through the flipped classroom is reflected primarily in personalised and autonomous learning, practical communication, and intercultural communication. These innovative teaching methods help students become the main focus of the classroom, thereby improving teaching efficiency.

The flipped classroom provides more opportunities for practice and communication. Students can engage in more written expression, oral practice, and practical activities in the classroom, as well as have more in-depth discussions and exchanges with classmates and teachers, thereby improving their language expression and communication skills. Chen et al. (2017) designed an oral training course using the flipped classroom model to examine its impact on second-language learning. Empirical research found that flipped classroom teaching not only enhances students' positive expression but also significantly improves their idiomatic knowledge, successfully achieving the teaching objectives. Fathi and Ebadi (2020) discussed the impact of the flipped classroom on global writing performance and the English language proficiency of English as a Foreign Language (EFL) students, focusing on complexity, accuracy, and fluency. The experiment showed that the flipped classroom significantly and effectively improved the overall writing performance and writing fluency of English students compared to a non-flipped classroom.

The flipped classroom can promote students' active, autonomous learning and critical thinking abilities. In traditional language-learning models, students mainly passively receive knowledge from teachers, whereas in the flipped classroom, students prepare classroom content through autonomous learning and pre-learning, then participate in activities such as discussions and problem-solving. In the flipped classroom, students can use multimedia resources and online platforms to learn about the languages and cultures of different countries and regions, thereby enhancing their intercultural communication and understanding. Xue et al. (2015) also demonstrated, through empirical research, that structured and semi-structured flipped classroom teaching designs are more effective than non-flipped classroom designs. They can help students achieve better learning outcomes to varying degrees, shaping a more positive attitude towards learning and investing more energy in the learning process. Wang et al. (2021) explored students' views on the creation of learning resources called China Island (CI) at a city university in Australia. The result indicates that students prefer the experiential learning opportunities provided by CI for exploring Chinese culture and language outside the classroom, and that they have gained a deeper understanding of complex pragmatic issues in real-life communication.

Ubiquitous Learning Enhancing Multiple Skills

Ubiquitous learning refers to learning activities that can take place anytime, anywhere, without being limited by time and location. In the field of foreign language learning, ubiquitous learning can enhance students' listening, speaking, reading, writing, and translation skills through online resources, mobile applications, and other means. This learning method provides students with a more flexible and convenient way to learn, helping them improve their foreign language skills more comprehensively.

Ubiquitous learning can enhance students' listening, speaking, reading, writing, and translation abilities through online resources. Students can utilise various online learning platforms, mobile applications, remote teaching, etc., to improve their language skills, such as Coursera, edX, Duolingo, and Rosetta Stone. Ubiquitous learning helps tailor language input to

different learners, thereby enhancing its effectiveness. Zou et al. (2018) discussed a self-developed vocabulary learning system that can analyse scores across different tasks and user model features and recommend personalised vocabulary learning tasks. Ubiquitous learning can provide a more authentic and effective environment for language output, promoting learners' practice after language learning. Wen (2020) developed an intelligent English recognition system that accurately identifies syllables and word pronunciation, providing learners with a speaking practice environment and effectively improving their speaking proficiency.

Ubiquitous learning provides a richer way and platform for human-computer interaction and feedback. Speech recognition, speech assessment, speech synthesis, speech dialogue, and other technologies play a crucial role in speaking practice software, human-computer dialogue systems, and automated speaking assessment systems. In 2004, Li et al. proposed the concept of intelligent speech agents, developed a functional model, and outlined the functions a speech agent system should possess, thereby promoting the development of speech recognition technology. Since then, numerous scholars have improved the effectiveness of language feedback by developing a range of models and algorithms. In addition, the development and application of automatic evaluation systems have improved the machine scoring of writing outcomes, thereby enhancing learners' writing ability (Elgort, 2017). In 2018, Peng et al. developed an Automatic Language Tutor (ALT) computer-assisted speech training system that integrates three presentation conditions. In 2020, Wang established a multi-parameter evaluation model for university students' oral English speech that combines the advantages of subjective and objective evaluation and assesses speech across four aspects: pitch, speech rate, rhythm, and intonation.

Intelligent teaching provides a real online language context

Through language environment simulation, interactive dialogue, cultural background presentation, and real-time language application, intelligent teaching can provide a genuine online language-learning context. With intelligent teaching, students can experience real language learning in a virtual environment, better understand the practical application of language, and improve their actual language use.

Intelligent teaching provides real communication scenarios, which help improve overall language proficiency. By applying new technologies, teachers can guide learners to immerse themselves in the authentic social and cultural context of the target language using intelligent devices. The use of intelligent teaching devices in remote collaboration can create authentic communication scenarios for language learning, effectively enhancing learners' oral expression abilities (Lio et al., 2019). Research indicates that understanding the language features reflected when discussing different topics in the target language is beneficial for improving learners' cross-cultural communication skills and linguistic appropriateness (Oskoz & Gimeno-Sanz, 2020). Integrating social networks into language classrooms provides students with opportunities for language practice, aiding the development of cross-cultural communication skills, improving oral fluency, fostering cooperative awareness, and enhancing knowledge construction abilities (Sun et al., 2017). Furthermore, future language learner data will further drive research into language usage characteristics and personalised development. At present, data mining techniques can reveal learners' hidden behavioural patterns (Godwin Jones, 2021), and by creating practical communication scenarios, they can help students develop effective learning strategies and expand personalised learning pathways.

Intelligent teaching provides real-time language context, enabling students to receive instant feedback and guidance as they use language. In virtual language environments, the system can promptly provide students with guidance and feedback on grammar, pronunciation, and more, helping them correct errors in a timely manner and improve their language application abilities.

Research shows that pronunciation training and corrective feedback software not only enhance learners' perception of target pronunciation features and substantially improve their pronunciation (Fouz-Gonzalez, 2020), but also strengthen learners' pragmatic awareness, thereby improving the appropriateness of their oral output. Additionally, computer-generated corrective feedback can improve learners' second language writing quality (Bakla, 2020). Moreover, feedback and assessment provided by machines are gradually becoming more personalised based on individual differences (Ai, 2017). With the help of intelligent teaching systems, students' self-error recognition and correction abilities are also expected to improve (Slavui et al., 2017).

Frontier analysis

Based on the co-occurrence network of keywords, highlighting keyword detection can provide insights into changes in research development in this field. Figure 5 shows 15 burst words in the SSCI foreign research on CALL, while Figure 6 shows 15 burst words in the CSSCI domestic journal research on CALL, representing the frontier changes in domestic and foreign research. Burst words refer to specific keywords that suddenly increase in quantity within a certain period of time. Keyword burstiness can reveal research hotspots and their evolution over a given period. Both figures show that the research hotspots in the CALL field are rich and focus on three aspects: technological methods, teaching subjects, and teaching content. In terms of technological means, “educational technology”, “virtual reality”, “network environment”, “flipped classroom”, “big data”, and “MOOCs” have become hot topics. Regarding teaching subjects, before 2021, researchers paid more attention to learners as the main subjects, focusing on their cognitive processes and communicative skills. However, from 2021 to 2023, teachers, as a teaching subject, received greater attention, with teaching methods, strategies, and forms becoming a hot topic. In terms of teaching content, early research hotspots focused on learners’ communicative and comprehension abilities, while later research hotspots shifted to learners’ oral, translation, and information literacy abilities.

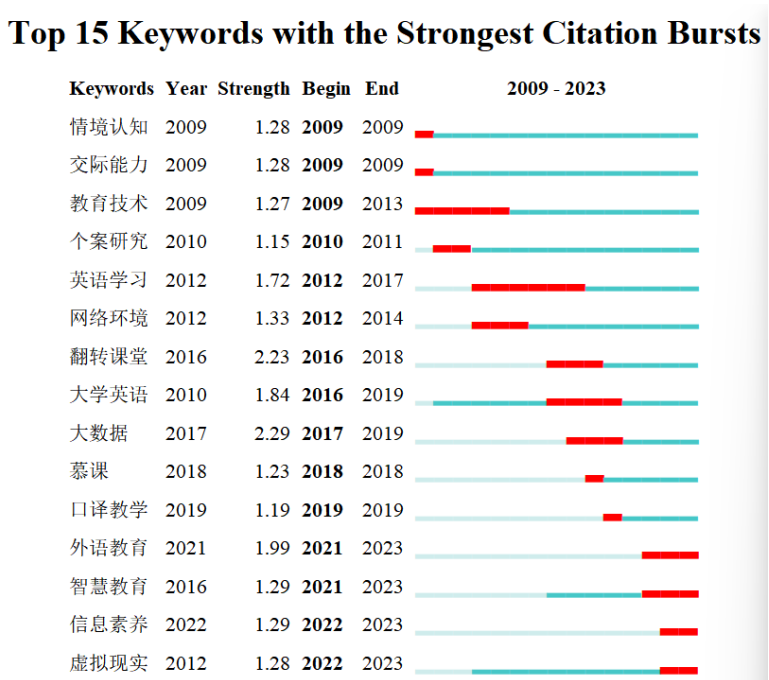

Figure 7. Top 15 keywords with the strongest citation bursts for CSSCI

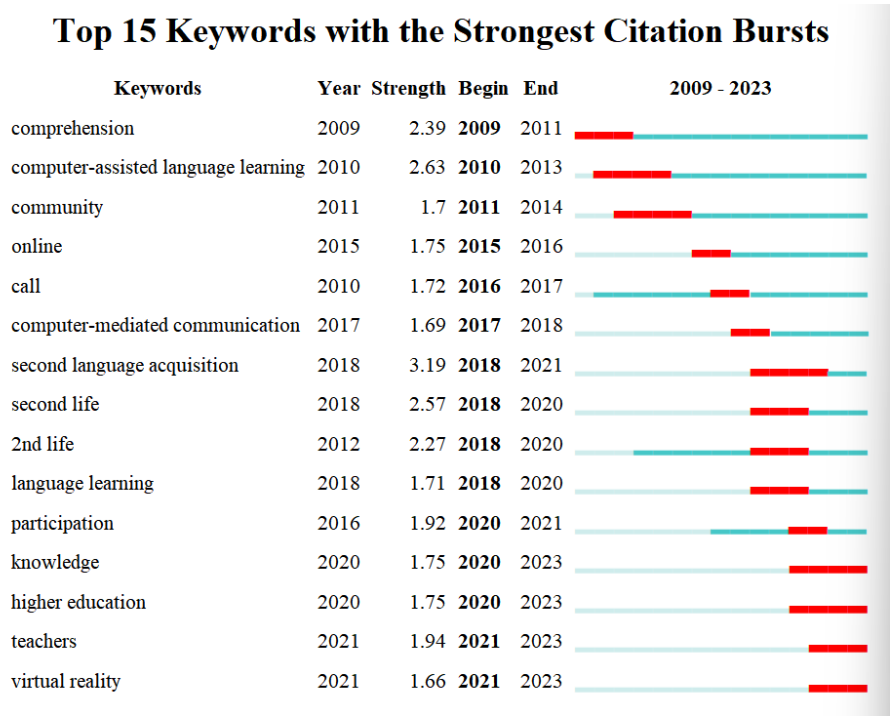

Figure 8. Top 15 keywords with the strongest citation bursts for SSCI

Virtual technology has become a hot topic since 2021. 2021 was referred to as the "metaverse" year, and after years of development, virtual reality technology has entered a new stage, which will have a significant impact on intelligent language teaching. In fact, research on virtual reality technology has a long history. For example, in 2016, Xia (2016) designed and implemented a virtual teacher that can provide learners with operational guidance. Through controlled group experiments, the effectiveness of the virtual teacher was verified.

Teacher education has become a hot topic from 2021 to 2023, focusing on the design of research on teacher cognition and development. Digital technology has a crucial impact on foreign language learning, and integrating it into foreign language classrooms poses additional challenges for teachers. As the leader of CALL, teachers' attitudes towards digital technology, teaching experience, technical assessment abilities, and role positioning in teaching are highly valued. The academic community has also begun to focus on teachers' learning in educational technology and to analyze the role of educational technology in teachers' growth. Multiple studies have examined how to develop language teacher education programmes and CALL professional development plans tailored to national conditions (Crosthwaite et al., 2021).

The topics of information literacy and information knowledge have seen a significant increase in attention from 2020 to 2023. The application of artificial intelligence technology has expanded the range of communication scenarios and communication targets for learners, while also placing higher demands on their information literacy. The willingness and attitude of learners to participate greatly influence the expressive effect of their second language, thus affecting their acquisition of cross-cultural knowledge and skills (Oskoz & Gimeno-Sanz, 2020). The ability of learners to use smart devices and their willingness to engage in intelligent learning greatly influence learning outcomes. Existing research indicates that educational technology enhances students' initiative and independence and visualizes students' collaborative learning processes, with a focus on the design of technology-supported collaborative tasks (Su & Zou, 2022).

Research Gaps and Future Prospects

Currently, there are some shortcomings in the research on CALL

Ethical issues related to the application of technology still exist. Different experts hold varying opinions about ChatGPT. On the one hand, ChatGPT can quickly generate a paper on a topic, which may undermine students' independent thinking, writing, and critical thinking. Some even believe that ChatGPT will affect a form of writing practiced for generations, with retired MIT professor Noam Chomsky stating that "ChatGPT is essentially high-tech plagiarism" and "a way to avoid learning" (Marshall, 2023). On the other hand, if designed and used reasonably, ChatGPT can play an important role in education and teaching.

The integration between CALL and educational theory is insufficient. Currently, research on intelligent language teaching mainly focuses on the development of intelligent technologies, with limited empirical research grounded in language teaching practice, making it difficult to be widely applied in teaching. Although intelligent technology has brought significant changes to foreign language teaching, teachers remain indispensable in education, providing moral guidance to students and serving as mentors in shaping professional and social development. Deeply integrating intelligent technology with educational theory and helping teachers adapt to an intelligent class that is technology-supported remains a long and arduous task. Furthermore, research on CALL often focuses on specific languages or language-learning stages, lacking universal studies across languages and learners of different age groups.

The level of accuracy, safety, and refinement of intelligent technology is not high. For example, English writing automatic correction systems cannot fully evaluate subjective content such as topic relevance, discourse structure, and logic, nor can they identify complex sentence structures or some serious grammatical errors. Even if errors are identified, correct examples cannot be provided. Big data technology is currently in its infancy, with risks such as inaccurate statistical data and student privacy data leakage. Machine translation models are constrained by limited corpora, overly reliant on language data, and struggle to convey the original author's personal emotions. Speech recognition technology struggles to accurately identify fuzzy and variant speech in high-noise, far-field, non-routine-language, and mass-gathering scenarios, leaving significant room for improvement in accuracy.

In terms of future prospects, CALL research can develop in the following directions.

Firstly, it should emphasise the cultivation of teacher guidance and student information literacy. The deep integration of artificial intelligence technology continuously expands the range and scope of language-learning scenarios, driving ongoing reforms in language education. New technologies also bring new challenges (Tan et al., 2016), and how teachers provide learning materials, demonstrate language, guide and encourage learners to express themselves, and provide appropriate feedback in various new teaching scenarios still needs exploration (Baralt & Gomez, 2017). Secondly, CALL should provide more personalised, data-driven support to guide learners' language development. Currently, big data acquisition enables tracking learners' performance, and data mining technology can reveal learners' hidden behavioural patterns (Godwin-Jones, 2021), helping students develop effective learning strategies and expand personalised learning approaches. Additionally, CALL should strengthen interdisciplinary integration to promote language learning from multiple perspectives and change the learning environment. Language learning should be seen as a socio-cultural experience, with greater attention to learners' cross-cultural communication abilities and the social strategies they use in language communication. Furthermore, future research in CALL can focus more on the development and sharing of teaching resources. With the development of

open educational resources, a broader platform for sharing teaching resources can be established to provide more high-quality resources for teachers and promote their sharing and reuse.

The future development of CALL will be more intelligent, diverse, intuitive, and convenient, providing better language learning opportunities and experiences for more people. With the ongoing advances and applications of technology, CALL is expected to become an important direction in language learning and to make greater contributions to global language education.

D. Conclusion

Since 2010, CALL research has entered a phase of deep application. In the past decade, CALL research can be divided into two stages based on its development: a stage of stable growth (2009-2015) and a stage of rapid development (2016-2023). The research on CALL starts with technology, such as AR, VR, etc., which use the latest technologies to optimize the learning environment of students, or improve their learning efficiency through human-computer interaction; On the other hand, it takes learning methods and subjects as a breakthrough point to explore how language teachers and researchers incorporate technology into teaching practice or research agendas, and to explore the emotions and motivations of students themselves. Both domestic and international perspectives on CALL research primarily involve language acquisition theory, language teaching methods, language skills training, foreign language teaching and learning environments, the development of teaching resources, and the evaluation of teaching effectiveness. Through interdisciplinary research and practice, CALL has created new development opportunities for language learning and teaching, offering new pathways and methods to improve the efficiency of language learning and the quality of teaching.

Based on 297 SSCI literature and 208 CSSCI literature on CALL over the past 15 years, this study conducted a visual analysis using CiteSpace. By using content analysis and quantitative statistical methods, this article identifies the research objects, research questions, and experimental paradigms in the key literature, examines the research progress and development trends over the past 15 years at home and abroad, and provides a reference for scholars in related fields to understand frontier trends. By comparing domestic and international research, the article identifies shortcomings in domestic CALL research and outlines future research directions. Research has found that domestic CALL research began relatively late. Although the number of domestic CALL research publications has continued to increase in recent years, the field has not yet developed a scale and system, and research content and experimental paradigms remain relatively limited. In the future, research on CALL should draw on the perspectives and methods of relevant foreign studies, enrich experimental paradigms, and technical means. At the same time, domestic scholars should strengthen the development of relevant theories, enhance academic communication and interdisciplinary cooperation, and establish a systematic framework for CALL research, thereby promoting in-depth exploration from multiple perspectives and levels.

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