A Bibliometric Study of Mobile-Assisted Language Learning from 2013 to 2023: Research Themes and Trends

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Abstract

The widespread use of mobile-assisted language learning (MALL) in learning and teaching foreign languages has attracted significant interest. Following the substantial impact of COVID-19 on language education, the focus on MALL among researchers has increased to a new level. This paper reviewed the MALL-related Social Science Citation Index (SSCI) articles from 2013 to 2023, sourced from the Web of Science (WOS). Out of 535 identified articles, 241 were analyzed systematically to generate knowledge maps using CiteSpace. Based on the bibliometric study, this research identified and discussed the popular themes and research trends in MALL. Three major themes emerged through keyword co-occurrence analysis: 1) a primary focus on the English language; 2) technology integration in language learning; and 3) a learner-centered focus. The results also revealed four research trends: 1) development and application of mobile learning technologies; 2) in-depth study of language acquisition and skills development; 3) innovative research on learner characteristics and teaching methods; and 4) a shift in research methods. This research contributes to the existing literature by consolidating current knowledge and offering guidance for future investigations or developments in MALL.

Keywords: mobile-assisted language learning, CiteSpace, bibliometric study, research trends

1. Introduction

Alongside the rapid development of mobile technologies, adopting them within the education field is becoming increasingly common. Mobile devices are now considered indispensable instruments in language acquisition, and more attention has been given to applying mobile devices to support foreign or second language learning (EFL/ESL) (Pan et al., 2024). This increasing adoption of portable mobile devices has created a more accessible, flexible, and personalized learning environment among higher education institutions (Karakaya & Bozkurt, 2022), and has contributed to the emergence of mobile-assisted language learning (MALL). MALL enables learners to engage with language learning at any time and from any location through multiple learning platforms and mobile applications (Li et al., 2023). It brings great convenience to language learners by integrating mobile technologies into language education, providing benefits for language skills development. The rapid growth in using mobile applications for individual, professional, or educational purposes during the last few decades (Mihaylova et al., 2022) has made mobile language learning a pervasive aspect of modern education.

In recent decades, there has been a significant increase in conducting systematic reviews on MALL (Li et al., 2022). For example, Mihaylova et al. (2022) used meta-analysis to systematically review grey literature and journal articles published from 2007 to 2017. This review study found that using mobile language learning applications can cause a moderate-to-strong overall effect, proving that mobile language learning applications could effectively improve language achievement. In another review study, Karakaya & Bozkurt (2022) examined MALL research between 2008 and 2020, using text mining techniques and social network analysis (SNA). Their research was aimed at understanding and revealing research and thematic patterns in MALL. The results identified five broad research themes, including MALL to support higher education, MALL for learning in the wild, etc. The researchers also highlighted that nonlinguistic factors related to learners' interactions with mobile devices or mobile applications have been insufficiently studied (Karakaya & Bozkurt, 2022). From a perspective of situated learning theory (SLT), Li and coworkers (2022) systematically reviewed MALL in China. Under the guidance of two original elements of SLT,

four derived elements (e.g., apprenticeship learning) and five major studied elements (e.g., adopted applications or software) were identified from the retrieved dataset (Li et al., 2022). The research findings indicated a need to develop effective MALL teaching methods in relevant contexts that are linked to sociocultural aspects of language learning. Additionally, Wei (2022) reviewed the role of technology-based EFL academic motivation to understand the effect of MALL and computer-assisted language learning (CALL) on learners' motivation. It was found that learners' motivation could be positively affected by the usefulness of digital instruments, effectiveness, and purposeful attractiveness (Wei, 2022).

However, most of these review studies have heavily focused on specific contexts like gamification (Su et al., 2021), skills like pronunciation (Tseng et al., 2022), or perspectives like self-regulated learning (Viberg et al., 2020), lacking a visual perspective using knowledge maps. With rapid technological changes, especially after the pandemic, some newly applied technologies might have emerged and been adopted in the MALL field. Thus, this study explored the landscape of MALL research through the visualization of CiteSpace to discern what major themes researchers have been trying to explain and reveal the research trends between 2013 and 2023. The purposes of this review study can be three-fold: 1) to identify the popular research themes and frontiers in MALL; 2) to find key authors and institutions in the MALL field and their collaborations; and 3) to reveal the research trends in MALL over the past decade.

2. Methodology

2.1 Research Tools and Data Collection

Data from this research was visualized using CiteSpace 6.3.R1 Advanced, a software designed to respond to inquiries concerning the dynamics and organization of a knowledge area (Chen, 2016). It is a Java-based tool designed for visualization and network analysis. CiteSpace focuses on identifying critical points during the advancement of a specific field, especially pivotal points and turning points (Ye, 2018). When applied to bibliometric studies, it offers various functions while supporting different types of analysis, such as keyword co-occurrences, journal co-citation analysis, and co-authorship analysis (Rawat & Sood, 2021).

The reviewed literature of this study was indexed from the WOS Core Collection from 2013-2023. First, the search strategy involved a thematic query with specific keywords to ensure a broader inclusion of literature, including "mobile assisted language learning," "mobile support language learning," "mobile language learning," "mobile assisted language," and "mobile device language learning." This process aimed to capture a broader spectrum of studies in the MALL field, from empirical research to theoretical reviews. Second, the search was refined to include articles, review articles, and editorial materials indexed by the Social Sciences Citation Index (SSCI) and published in English only.

The initial search yielded a total of 535 relevant literature. Subsequently, a manual review of the abstracts was conducted to ensure the high relevance and quality of the data by excluding the following types of irrelevant literature: 1) literature that does not involve MALL, for example, robot-assisted language learning (RALL), CALL, and others; 2) mobile-assisted learning that does not target languages, such as mobile learning in the business field, medical field, and others; 3) relevant literature focused on mobile-assisted language courses design or implementation. In the end, 241 highly relevant literature were obtained for further analysis. The final collection serves as the foundation of this review study, providing a concentrated resource for exploring trends, frontiers, and themes in the MALL context over the past decade.

2.2 Data Analysis

This paper focused on keyword co-occurrence and document co-citation analysis, analyzing cooperations among authors, institutions, and countries, and the evolution of MALL during the past decades. The first step is identifying critical researchers, revealing the academic collaboration networks, and highlighting research trends through co-authorship and co-authors' country and institution analyses. Second, document co-citation was conducted to gain a brief understanding of contributing journals and articles in the field of MALL. Next, keyword co-occurrence analysis was used to recognize key themes in MALL adopting the log-likelihood-ration (LLR) test method to generate cluster labels. Keywords that belong to the same cluster indicate a close connection (Jia & Harji, 2023). Fourth, to explore the knowledge evolution of MALL, this review also adopted timeline analysis to develop a comprehensive network of relevant literature. Last, burst detection of keywords was adopted to identify trends involved in MALL-related research.

3. Results

3.1 Articles Counts and Trends

Figure 1 presents the annual totals of MALL-related studies published in WOS core collections from 2013 to 2023. Overall, research in MALL has shown a growing trend over the past decade. The number of publications grew slowly with highs and lows. Although a decline was observed from 2014 to 2016, it reached a new high in 2017. It can also be observed that research on MALL has continued to grow since 2019, and climbed to the highest point in 2022. This research peak is a reflection of current social conditions and the growing urgency for adopting MALL in the education field.

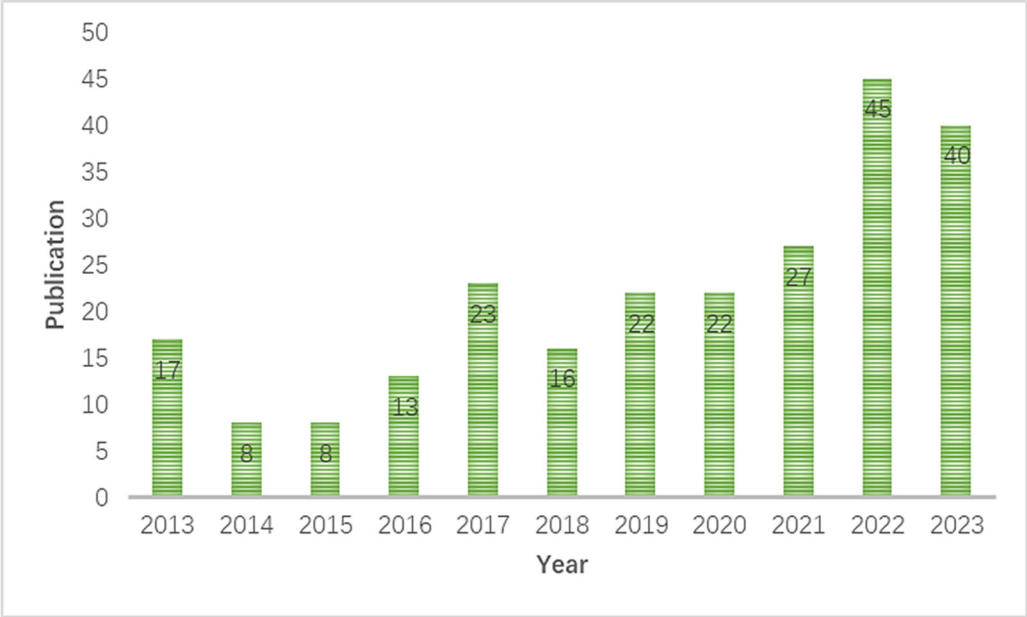

Figure 1. Number of Publications from 2013 to 2023

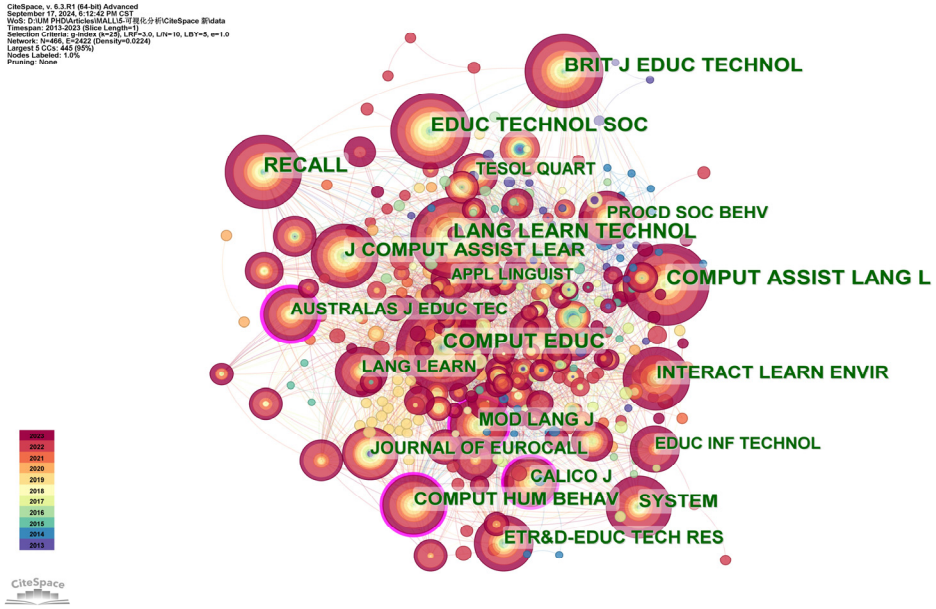

Figure 2. Journal Co-Citation Analysis

The trend presented in Figure 1 reflects a rapid and deep penetration of mobile technologies within the education field and reveals researchers' growing attention to the effect of adopting MALL. This might be attributed to many reasons. Since 2019, the COVID-19 pandemic has significantly changed the approach to teaching and learning, as teachers and students were forced to teach and learn remotely. The increase in MALL research from 2019 to 2023 could be attributed to this. Additionally, the wide adoption of mobile technologies to enhance language learning (Hsu & Lin, 2022a), advanced in virtual learning environments and mobile applications (Khlaisang & Sukavatee, 2023), and the shift towards remote and online language learning (Faozi & Handayani, 2023) may also be influencing factors behind this.

3.2 High-Productive Journals

This section identifies the journals frequently cited in the MALL field to assist researchers in literature retrieval and article publication (Figure 2). Table 1 presents the top 20 frequently cited journals. It was found that *Computer Education* (161) is the most frequently cited journal, followed by *Computer Assisted Language Learning* (136), *Language Learning and Technology* (133), etc. This indicates that these journals play a critical role in academic discussions and communications of MALL, serving as important platforms for researchers to obtain the latest research findings.

In addition, the co-occurrence of the cited journals reveals the concentration of research topics. The frequent co-occurrence of "computer" and "technology" shows that MALL is often studied as a sub-area of CALL and is viewed as an education technology. Observing from the scope of the frequently cited journals, research on MALL is not limited to the field of language learning and educational technology. Researchers have extended it into interdisciplinary fields, such as human behaviors and psychology. This indicates that today, MALL has been developed into a multidisciplinary research field, attracting attention from researchers with different disciplinary backgrounds.

Table 1. Top 20 Frequently Cited Journals

Total Citations	Year	Journal
161	2013	Computer Education
136	2013	Computer Assisted Language Learning
133	2013	Language Learning and Technology
123	2013	British Journal of Education Technology
117	2013	Education Technology & Society
114	2013	ReCALL
101	2013	Journal of Computer Assisted Learning
85	2015	Interactive Learning Environments
81	2013	System
77	2013	Computers in Human Behavior
66	2013	The Morden Language Journal
64	2014	Educational Technology Research and Development
57	2015	Procedia – Social and Behavioral Sciences
56	2013	Journal of EUROCALL
55	2015	The Language Learning Journal
55	2013	Australasian Journal of Educational Technology
54	2013	CALICO Journal
43	2019	Education and Information Technologies
43	2013	TESOL Quarterly
40	2013	Applied Linguistics

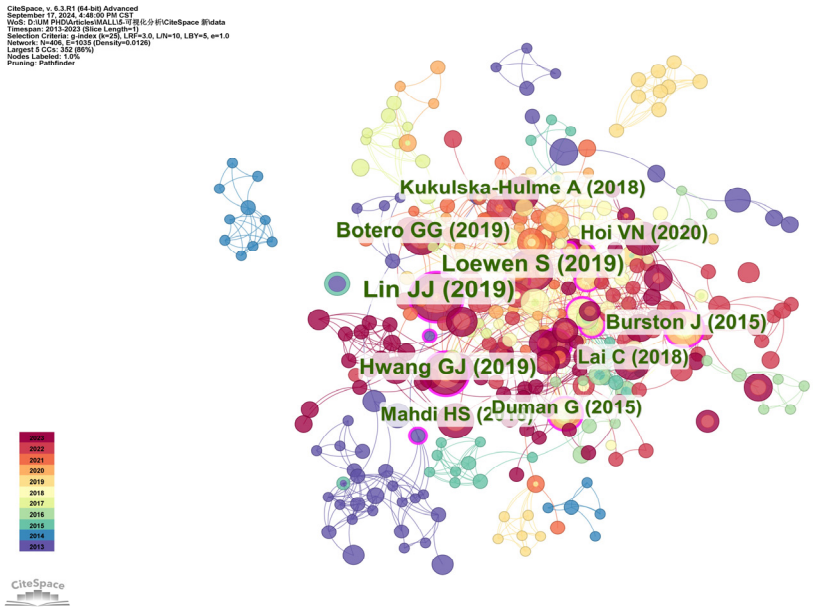

Figure 3. Document Co-Citation Analysis

3.3 Document Co-Citation Analysis

Table 2. Top 10 Frequently Cited Articles

Total citation	Year	Article title	Authors	Journal
25	2019	Mobile-assisted ESL/EFL vocabulary learning: A systematic review and meta-analysis	Lin & Lin	Computer Assisted Language Learning
19	2019	Mobile-assisted language learning: A Duolingo case study	Loewen et al.	ReCALL
16	2019	Trends in the research design and application of mobile language learning: A review of 2007-2016 publications in selected SSCI journals	Hwang & Fu	Interactive Learning Environments
14	2019	Self-directed language learning in a mobile-assisted, out-of-class context: Do students walk the talk?	Botero et al.	Computer Assisted Language Learning
13	2018	Mobile collaborative language learning: State of the art	Kukulska-Hulme & Viberg	British Journal of Educational Technology
13	2015	Twenty years of MALL project implementation: A meta-analysis of learning outcomes	Burston J.	ReCALL
12	2018	Effectiveness of Mobile Devices on Vocabulary Learning: A Meta-Analysis	Mahdi H. S.	Journal of Educational Computing Research
12	2018	Self-directed use of mobile devices for language learning beyond the classroom	Lai & Zheng	ReCALL
11	2015	Research trends in mobile assisted language learning from 2000 to 2012	Duman et al.	ReCALL
11	2020	Understanding higher education learners' acceptance and use of mobile devices for language learning: A Rasch-based path modeling approach	Hoi V. N.	Computers & Education

By constructing networks of cited references, document co-citation analysis of CiteSpace can help researchers create an overview network of relevant literature (Chen, 2017). Figure 3 lists some frequently cited articles in the MALL field, which hold a crucial position. Table 2 shows the top ten frequently cited articles. The top-ranked one was *Mobile-assisted ESL/EFL vocabulary learning: a systematic review and meta-analysis* (Lin & Lin, 2019) (25), followed by *Mobile-assisted language learning: A Duolingo case study* (Loewen et al., 2019) (19) and *Trends in the research design and application of mobile language learning: a review of 2007-2016 publications in selected SSCI journals* (Hwang & Fu, 2019) (16).

These highly cited articles can be seen as representative of the MALL research. Articles published in 2019 are cited more frequently, indicating that multiple influential research emerged in the MALL field during this year. This may be attributed to the COVID-19 pandemic when people started to teach and learn online and remotely. Additionally, research focused on mobile-assisted vocabulary learning, mobile devices, and review studies of MALL have received widespread attention from researchers. These articles were published in several influential academic journals, such as *Computer Assisted Language Learning* and the *British Journal of Educational Technology*, which aligned with the previous results of journal co-citation analysis.

3.4 Co-Authorship Analysis

Table 3. Authors with More than Two Publications from 2013 to 2023

Author	Total publication number	First author	Year
Wong, Lung-Hsiang	5	4	2013-2016
Xodabande, Ismail	5	3	2022-2023
Chen, Yan	4	4	2017-2023
Hwang, Wu-Yuin	4	1	2014-2018
Chai, Ching Sing	3	1	2015-2016
Huang, Yueh-Min	3	1	2014-2018
Wu, Wen-Chi Vivian	3	1	2016-2021

Figure 4. Co-authorship of MALL Research from 2013 to 2023

Based on the dataset, this review study analyzed the co-authorship to form an academic cooperation network and identified critical researchers in the field. Table 3 presents authors with more than two publications from 2013 to 2023. It can be observed that Wong Lung-Hsiang has published five articles from 2013 to 2016, with four of them as

the first author, contributing a lot at this stage. His articles were all related to mobile-assisted seamless Chinese language learning, which may extend the MALL field to a new context. Additionally, Xodabande Ismail has published five articles within a short period (2022-2023), with three of them as the first authors. This indicates that he plays a vital role in recent academic research on MALL. Other researchers, for example, Chen Yan and Hwang Wu-Yin, have also consistently contributed to MALL. Their publications covered a long period from 2017 to 2023, showing a long-term involvement and significant impact. Figure 4 reveals the cooperation and academic connections among researchers in the MALL field. The knowledge map has more than 260 nodes, indicating an extensive collaboration among researchers. Moreover, the modularity quality (Q=0.3706) and weighted mean silhouette coefficient (S=0.7243) of the network show a clear community structure, meaning researchers in the MALL field tend to cooperate with scholars who share a similar research interest.

3.5 International Collaborations

Table 4 and Table 5 present the number of publications in different countries (n≥10) and institutions (n≥5). The top-ranked country by publications counts was the People's Republic of China, with 105 publications (including Taiwan, China), followed by the USA, with 43 publications, and Iran, with 16 publications. The top-ranked institution within the MALL field is National Taiwan Normal University, with ten publications. Among the eleven highly productive institutions, four belong to Taiwan, China. This indicates that Taiwan contributes significantly to the development of MALL. Looking at the geography distribution, it can be found that research on MALL is not restricted to one specific area. Countries such as China, the USA, and Saudi Arabia frequently collaborate with other countries, suggesting that MALL is a highly promising research field for international collaboration (Figure 5).

Table 4. Highly Productive Countries (publications≥10)

Countries	Total publication number	Year
People's Republic of China	57	2013
Taiwan, China	48	2013
USA	43	2013
Iran	16	2013
Spain	15	2014
Turkey	14	2015
Saudi Arabia	10	2016

Table 5. Highly Productive Institutions (publications≥5)

Institutions	Total publication number	Year
National Taiwan Normal University	10	2013
Education University of Hong Kong (EdUHK)	7	2016
National Cheng Kung University	7	2014
National Institute of Education (NIE) Singapore	6	2013
National Central University	6	2014
Nanyang Technological University	6	2013
National Taiwan University of Science & Technology	6	2018
Islamic Azad University	5	2016
Kharazmi University	5	2022
Nanjing Normal University	5	2018
Near East University	5	2017

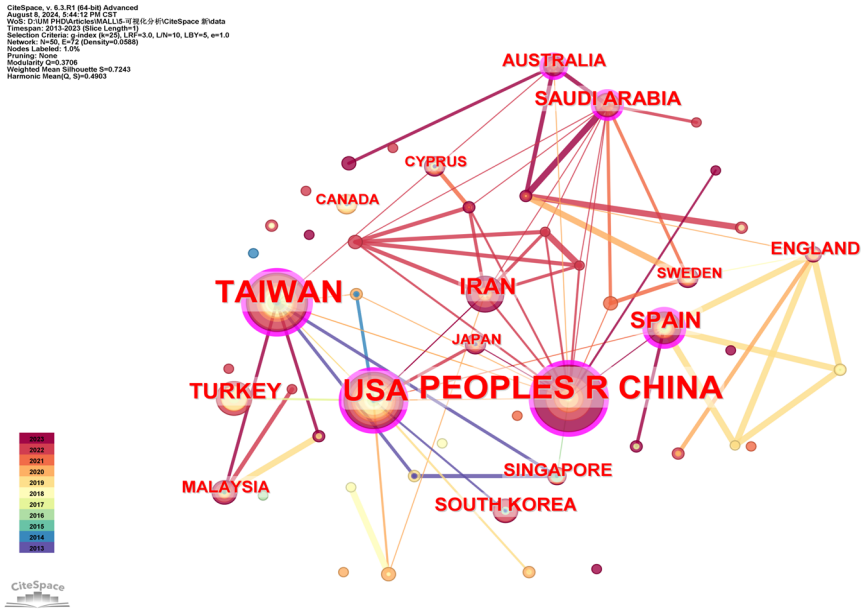

Figure 5. Distribution of Co-Authors' Countries

Moreover, institutions from Asia, especially Southeast Asia and East Asia cooperate more frequently, playing an important role in the field (Figure 6). This also indicates a frequent collaboration between high-resource countries (e.g., the USA and Australia) and emerging economies (e.g., China and Turkey). These collaborations might offer opportunities to bridge gaps between technologically advanced regions and resource-constrained regions, playing a critical role in MALL developments and innovations. On the other side, this cross-country collaboration may also promote mutual learning. While emerging economies may benefit from knowledge sharing, high-resource countries can gain insights into the specific and unique educational challenges in resource-constrained countries. This kind of mutual learning among countries will contribute to the global spread of MALL, expanding it to suit different cultural and educational contexts.

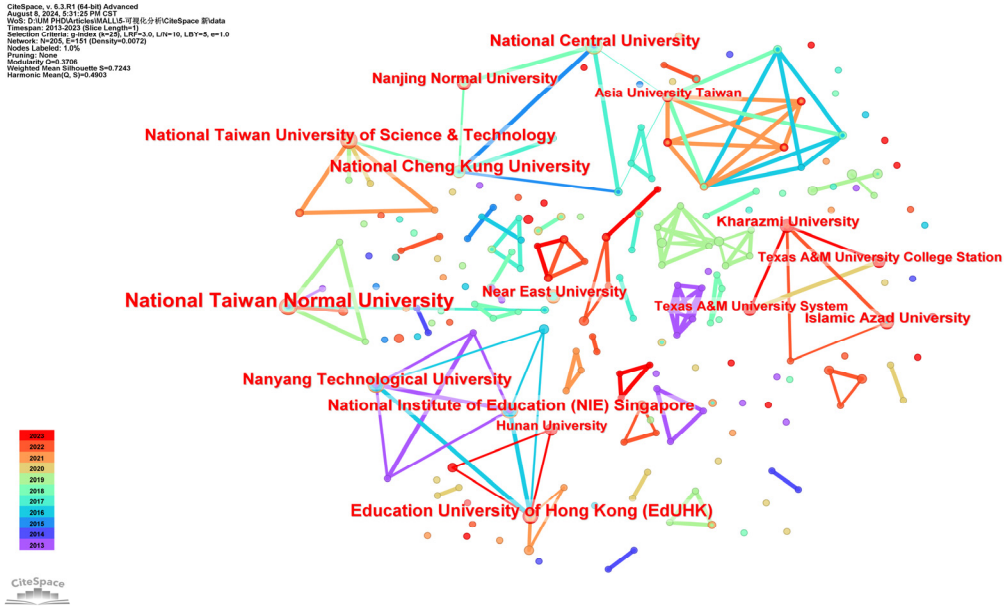

Figure 6. Distribution of Co-Authors' Institutions

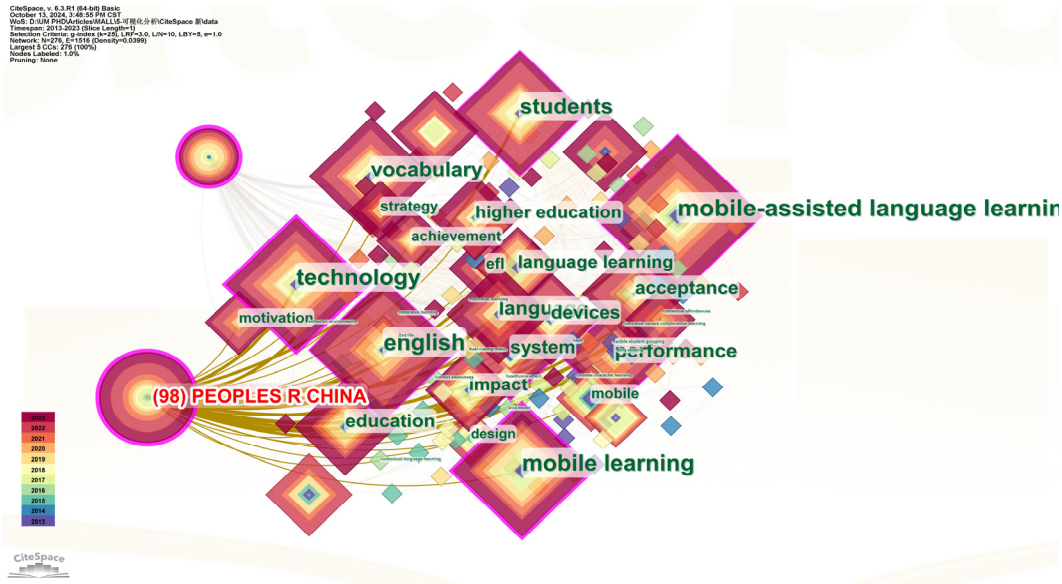

Figure 7. Frequently Cited Keywords in China

China stands out as a prominent research hub, presenting its contribution to the global development of MALL. This might be attributed to the supportive policies of the Chinese government. In 2015, the Chinese government issued a policy named "Internet +", which promoted the integration of real-time and interactive learning into English teaching in colleges and universities. Furthermore, in 2020, the Ministry of Education of China issued an official document *Guidance for College English Teaching (2020)*, proposing that colleges and universities should use information technologies such as blended courses and virtual simulation experimental courses, to create a diverse educational environment. As shown in Figure 7 and Figure 8, the research focus of China and the USA share many similarities. They both emphasized a lot on higher education contexts (Hu et al., 2023; Matsumoto, 2021), the role of technology and learners (Baron, 2013; Hsu & Lin, 2022b), device usage (Ducate & Lomicka, 2013; Hwang et al., 2014), and vocabulary (Dore et al., 2019; Hao et al., 2019). However, there also exist some differences. MALL-related studies in China address students' learning motivations (Yang & Kuo, 2022; Yu et al., 2023), students acceptance of MALL or mobile applications (Hsu & Lin, 2022a; Yang et al., 2023), and the role of mobile phones (Huang, 2021; Yang, 2017), while researchers from the USA (Cho & Castañeda, 2019; Ko & Lim, 2022; Loewen et al., 2020) focus on mobile applications.

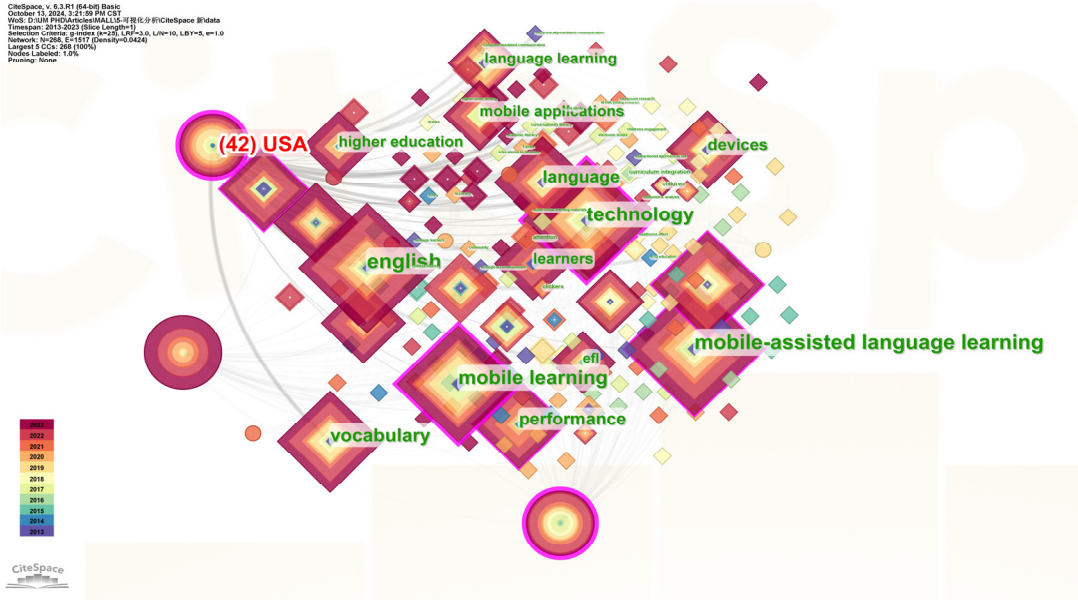

Figure 8. Frequently Cited Keywords in the USA

3.6 Keyword Co-Occurrence Analysis

3.6.1 Keyword Co-Occurrence and Clusters

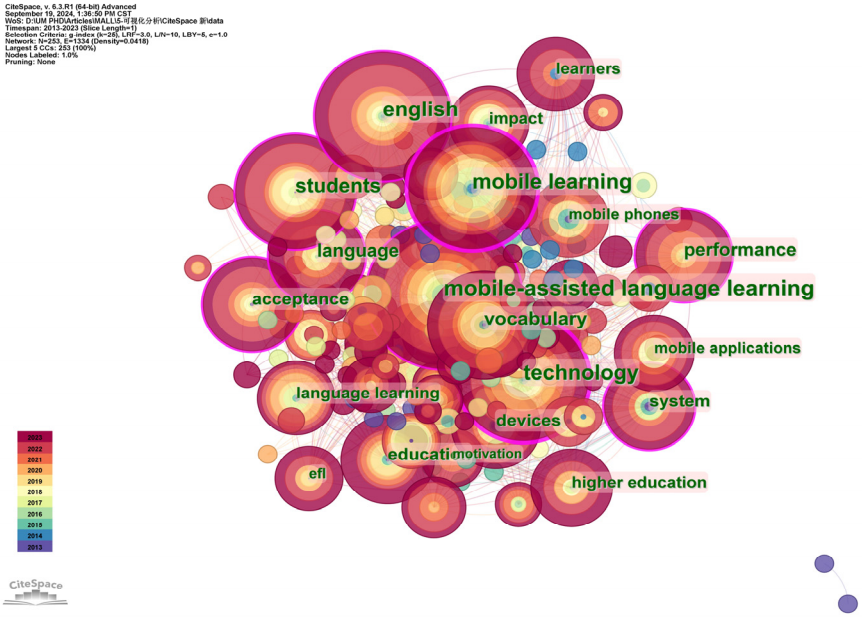

Figure 9. Keyword Co-Occurrence Network

Table 6. Frequently Used Keywords (frequency>10)

Keywords	Frequency	Centrality	Year
mobile-assisted language learning	69	0.17	2013
English	57	0.14	2013
technology	51	0.2	2013
mobile learning	50	0.27	2013
students	41	0.16	2013
vocabulary	36	0.09	2013
performance	30	0.13	2014
language	28	0.12	2013
acceptance	25	0.11	2013
education	24	0.05	2013
system	23	0.12	2013
devices	23	0.07	2013
higher education	20	0.08	2014
impact	20	0.1	2013
learners	19	0.09	2013
language learning	19	0.06	2013
mobile applications	18	0.05	2017
mobile phones	18	0.04	2013
EFL	14	0.03	2015
motivation	12	0.03	2019
mobile	11	0.04	2013
achievement	11	0.07	2018
meta analysis	11	0.01	2020

The keyword co-occurrence analysis plays a significant role in the scientometric analysis (Rawat & Sood, 2021). It is commonly used to identify research hotspots and emerging frontiers within a specific field (Wang & Lu, 2020). This review study conducted the keyword co-occurrence analysis based on the following steps: 1) time slicing from January 2013 to December 2023, years per slice: 1; 2) node types: keyword; 3) pruning: none. This review presented the co-occurring author keywords with a frequency greater than ten and depicted the keyword co-occurrence network for studies in the MALL field. As shown in Table 6, apart from "mobile-assisted language learning," the keyword "English" has drawn the most attention from researchers, followed by "technology" and "mobile learning." Additionally, seven of these frequently used keywords can be related to mobile technology, including "technology," "mobile learning," "acceptance," "devices," "mobile applications," "mobile phones," and "mobile." This indicateds that technology-related content has been a significant research topic in the MALL field from 2013 to 2023.

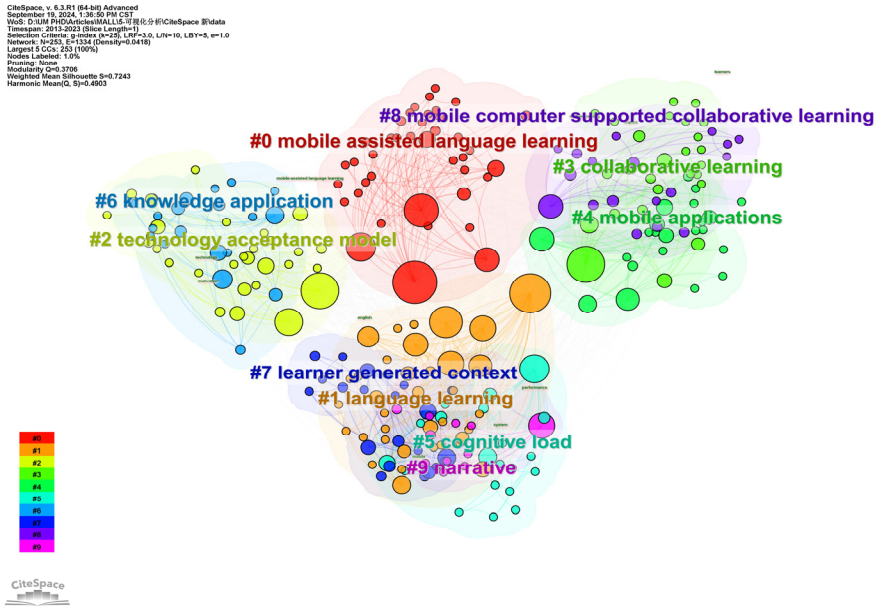

Figure 10. Keyword Co-Occurrence Clusters

Next, keyword clusters were operated and graphically presented in Figure 10. Ten major clusters (with a size larger than 10) were identified from the select literature, including #0 mobile-assisted language learning, #1 language learning, #2 technology acceptance model, #3 collaborative learning, #4 mobile applications, #5 cognitive load, #6 knowledge application, #7 learner-generated context, #8 mobile computer supported collaborative learning and #9 narrative. The results presented in Figure 10 are consistent with the previous findings from the keyword co-occurrence analysis. Clusters #2 technology acceptance model and #4 mobile applications highlight a growing trend of integrating technologies into language education. Furthermore, clusters #3 collaborative learning, #7 learner-generated context, and #8 mobile computer-supported collaborative learning suggest that research on MALL has increasingly focused on learner-centered content.

In CiteSpace, *burstness* refers to an exponential increase in the frequency of occurrence of a specific keyword, indicating that a potential topic has gained or is gaining a high level of interest over a particular period. Therefore, analysis of the burstness of keywords is considered a pointer to highly active research areas. Based on the citation bursts and timing of keyword emergence, emerging trends in the research field can be explored to some extent. The top 20 keywords with the strongest citation bursts from 2013 to 2023 are displayed in Figure 11, sorted by the strength of bursts. Among these frequently cited keywords, acquisition ranked first with a burst strength of 2.78, followed by skills (2.51) and mobile applications (2.36). The higher the burst strength, the more pronounced cutting-edge trends are. As a result, research related to the acquisition of languages, development of language skills, and adoption of mobile applications might be current research trends in the field of MALL.

Top 20 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2013 - 2023
acquisition	2013	**2.78**	2017	2018	
skills	2021	**2.51**	2021	2023	
mobile applications	2017	**2.36**	2017	2018	
mobile	2013	**2.18**	2013	2017	
instruction	2015	**2.17**	2021	2023	
knowledge	2017	**1.84**	2017	2019	
students	2013	**1.65**	2018	2019	
game-based learning	2014	**1.61**	2018	2019	
metaanalysis	2020	**1.55**	2020	2023	
comprehension	2017	**1.52**	2017	2018	
motivation	2019	**1.52**	2021	2023	
behavior	2019	**1.49**	2019	2020	
young children	2017	**1.48**	2017	2020	
environment	2015	**1.47**	2015	2020	
context	2015	**1.42**	2015	2016	
cognitive psychology	2015	**1.37**	2015	2019	
computer-assisted language learning	2013	**1.33**	2013	2019	
design	2015	**1.31**	2015	2018	
mobile devices	2014	**1.31**	2014	2018	
learners	2013	**1.25**	2013	2014	

Figure 11. Top 20 Keywords with the Strongest Citation Bursts

3.6.2 Knowledge Evolution of MALL

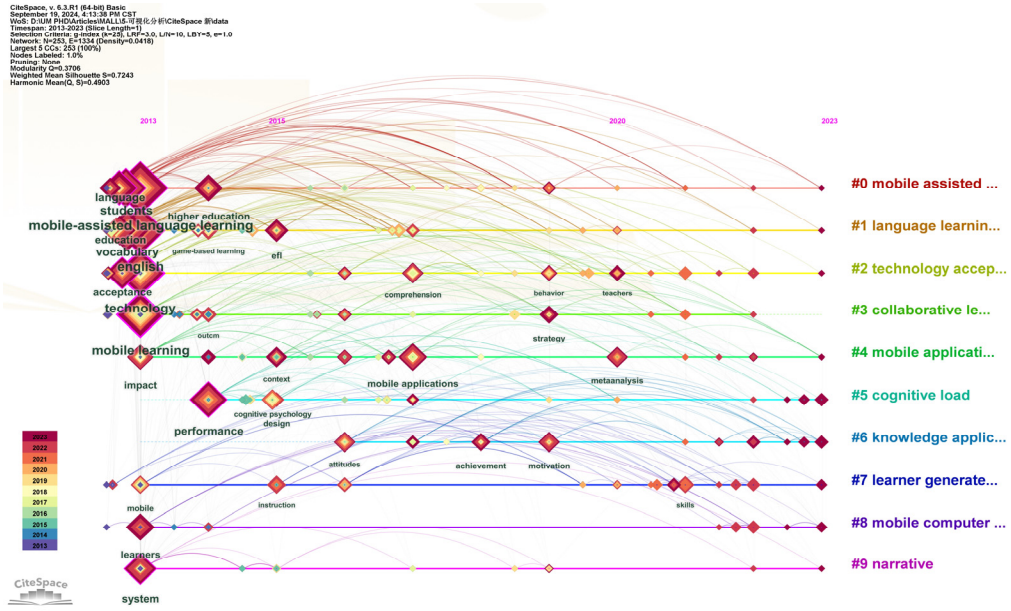

Figure 12. Timeline Visualization of Keyword Co-Occurrence Clusters

The timeline visualization (Figure 12) of the selected literature was analyzed on CiteSpace to observe the research trends and key turning points in the field of MALL. The results revealed a notable shift in the research focus over the decade. In the early phase (2013-2015), researchers focused more on the infrastructure development of MALL primarily and explored the initial application of technology in language education. Keywords such as “mobile” and “mobile learning” emerged as research hotspots at this stage, suggesting that researchers were gradually realizing the potential of mobile technologies and devices in language learning. Later, from 2016 to 2019, the focus shifted toward mobile applications with the further development of mobile technologies, and the keyword “mobile applications”

emerged as a hotspot. Students' "attitudes," "behaviors," "achievement" and "motivation" of MALL started to attract researchers' wide attention, indicating that research interest has been shifted to individual differences among learners. In the latest stage (2020-2023), the appearance of the keyword "meta-analysis" reveals that research in MALL has begun to emphasize review studies. Researchers tend to summarize existing studies and reflect on the issues identified, marketing a shift toward more analytical and reflective approaches in MALL research.

4. Discussion

4.1 Themes Involved in MALL

4.1.1 Primary Focus on English Language

"English" (frequency=57) ranked as the second most frequently used keyword, indicating that most of the selected literature was focused on mobile-assisted English learning, especially English as a foreign language (EFL) (frequency=14). This might be attributed to several reasons. First, English has long been regarded as a primary language for work and study worldwide. People are often required to prove their English proficiency levels by passing international exams such as IELTS and TOEFL, especially for those from non-English-speaking countries. Second, as students' interest in using mobile devices to learn the English language has been growing (Metruk, 2024), there has been a growing trend in integrating technologies into EFL/ESL (Pan et al., 2024). As a result, the popularity of MALL among EFL learners is likely to secure its place in future educational developments.

4.1.2 Technology Integration in Language Learning

As observed in Table 6, the high-frequency co-occurrence of keywords such as "technology," "acceptance," "mobile applications," and "mobile phones" reflects the importance of technology in language learning. This finding is supported by keyword cluster #2 technology acceptance model and cluster #4 mobile applications. With the rapid advancement in mobile technologies, MALL, with its convenient and enjoyable characteristics, is prevalent among learners and educators in the language field (Pan et al., 2024). The ubiquitous availability of mobile devices such as tablets and phones has made MALL evolve into a fast-progressing approach (Karakaya & Bozkurt, 2022). In a meta-analysis of MALL implementation studies across twenty years, it has been found that a significant number of these studies were centered around technology (Burston, 2015). Students' self-initiated use of mobile devices has been explored in the emerging studies in the MALL field, and these devices were proven to have successfully facilitated students' performance in foreign language learning (Li et al., 2022).

4.1.3 A Learner-Centered Focus

The frequent occurrence of keywords such as "students" and "learners" and cluster #7 learner-generated context reveals that language learners are often selected as research subjects. In contemporary education, students prefer to learn independently and are more likely to adopt new technologies to enhance learning (Ghobadi & Taki, 2018). However, adopting these technologies might challenge them, as students with different proficiency levels may achieve different learning outcomes (Shadiev & Yang, 2020). This might be one of the reasons that researchers in the MALL field have paid much attention to the individual differences among learners. Additionally, the personalized process of language learning via mobile makes it necessary to investigate the role of learner-related variables (Mohammadi & Masoumi, 2021).

4.2 Research Trends and Frontiers in MALL

4.2.1 Development and Application of Mobile Learning Technologies

The definition of MALL and its fundamental attributes focus on the impact of mobile devices and mobile learning on language learners. After the pandemic, more than 80% of teachers intended to implement blended learning or online learning (Yang et al., 2023). As presented in Figure 9, the burst in the keywords "computer-assisted language learning" (2013-2019) and "mobile" (2013-2017) lasted for six and four years, respectively. When combined with the burst of "mobile applications" (2017-2018) and "mobile devices" (2014-2018), it becomes clear that mobile technologies in the education field were highly valued by researchers from 2013 to 2019. Although the keyword "mobile applications" has a short period of increased activity, its high burst strength (2.36) indicates that research on mobile applications within the MALL field exerts a significant and extensive influence within this short period. This trend reflects the critical role of mobile technologies and their growing prevalence in language learning, as numerous language applications available on the market show that mobile devices could be ideal tools for language learning (Botero et al., 2018). Research focusing on exploring and assessing mobile applications or tools to promote language learning could be research frontiers in MALL.

4.2.2 In-Depth Study of Language Acquisition and Skills Development

A significant increase in citations of "acquisition" from 2017 to 2018, with a strength of bursts of 2.78 can be observed from the research results. It reflects that during this period, research on MALL was significantly influenced by language acquisition. Additionally, from 2021 to 2023, the keywords "skills" and "instructions" have presented strong citation bursts and robust persistence. This might be attributed to the advantages of MALL applications, which assist learners in improving their language skills and forming language systems (Helwa, 2017). It also implies a research concern with skills development and confirms the importance of teaching instructions in language learning. For example, researchers might dedicate themselves to understanding how to promote learners' language skills through instructional interventions or technology integrations. This indicates that research on improving learners' skills effectively and optimizing teaching instructions is a research focus.

4.2.3 Innovative Research on Learner Characteristics and Teaching Methods

Scholars are exploring innovative teaching methods and learning strategies to tailor learners' different needs and personal characteristics. This finding aligns with Kim & Lee's (2016), which found that research trends in the MALL field have shifted to student-centered learning activities (Kim & Lee, 2016). This can be reflected in the bursts of the keywords "cognitive psychology" in 2015 and "game-based learning" in 2018. Moreover, the strong bursts of the keywords "behavior" (2019-2020) and "motivation" (2021-2023) suggest that researchers are not only paying attention to understanding learners' characteristics but also exploring ways to stimulate their learning motivations and improve learning behaviors. This finding indicates that the research frontiers of MALL have gradually shifted from understanding the role of technology to exploring learning modes. Meanwhile, it points out that current implementations of MALL tend to address how to pave the way from learners' perspective (Karakaya & Bozkurt, 2022). The deep and practical integration of game-based learning, learning motivation, and mobile technology might be a future research topic.

4.2.4 A Shift in Research Methods

With the emergence of the keyword "meta-analysis" (2020-2023), the shift in research methods has become an evident research trend in the MALL field. The number of review studies in MALL has indeed increased in recent decades (Daly, 2022), as more and more researchers are adopting a meta-analysis approach to examine and assess the existing research in MALL (Mihaylova et al., 2022; Sung et al., 2015). This might be due to the nature of meta-analysis as a statistical technique, which allows researchers to integrate and review research findings from previous research. This shift in research methods suggests a growing focus on understanding MALL through more rigorous and scientific approaches, showing that evaluating its role in language acquisition might be a future research direction.

5. Conclusion

This review study used CiteSpace to analyze 241 MALL-related literature published on WOS Core Collections and indexed by SSCI from 2013 to 2023. By generating and analyzing the knowledge maps of keyword co-occurrence and keyword citation bursts, this paper identified three major research themes and four research trends in the field of MALL. These themes and trends reflect current research hotspots involved in MALL while providing valuable guidance for future research. Meanwhile, these trends could help improve learners' language learning effectiveness and satisfy diverse learning needs. With the rapid advancements in mobile technologies and the deepening of educational theories, it is anticipated that more breakthroughs and innovations could be achieved in the MALL field.

5.1 Significance and Implications of Research

According to the literature retrieval in WOS, MALL-related research has gained remarkable progress and has been growing since 2019. This review study contributes to the development of MALL by systematically analyzing and identifying major research themes and global trends. The text addresses the increasing significance of incorporating mobile technologies into language learning to address post-pandemic challenges. The research findings imply that MALL as a flexible and cost-effective solution, can be adopted to enhance language learners' learning outcomes and language educators' teaching efficiency.

This study provides a few implications for language educators and policymakers. First, language educators can integrate MALL with traditional teaching to boost learners' language learning motivations. They are encouraged to use personalized learning tools to meet individual needs. For instance, teachers can add gamified elements and integrate reward systems in class to enhance students' engagement. Using adaptive mobile platforms to track students' learning progress would also be helpful by allowing teachers to make timely adjustments. Second, they can learn

how to use newly emerged technologies like virtual reality (VR), artificial intelligence (AI), and augmented reality (AR) to create a more immersive learning experience for language learners. Educators can adopt MALL in a flipped or blended classroom model as well. They can incorporate mobile-assisted tools like multifunctional mobile language applications to deliver pre-class content. For example, language teachers can use applications that support personalized learning like Duolingo to assign language tasks before class. This will allow them to put more time into engaging in deeper discussions and exploring various topics during class.

Policymakers can facilitate the integration of MALL in language education through economic policies. For example, they can invest in mobile technology infrastructure, particularly in under-resourced regions. These investments can include establishing funding programs, donating mobile devices for schools, and offering grants for developing mobile educational applications. These financial supports to some extent, can bridge the imbalance of mobile technology development among different regions. Other than that, policymakers can focus on improving infrastructure such as internet connectivity to ensure the effective use of mobile devices in under-developed areas. It would be helpful if policymakers could provide professional training programs for language teachers to train their mobile technology abilities and increase their mobile self-efficacy level. These programs should be targeted at enhancing language educators' digital literacy and improving their ability to design mobile-related curriculums.

5.2 Limitations of Research

Although this review study provides a relatively comprehensive view of MALL-related research from 2013 to 2023, it does have some limitations. First, this study selected literature published in WOS Core Collections and indexed by SSCI, meaning it only covers part of the MALL-related research. SSCI-indexed journals provide researchers with high-quality literature in MALL, however, analyzing research trends by focusing on these journals only may unintentionally exclude some grey literature and non-English publications. Thus, the scope and diversity of the dataset are limited in this research. Future research is recommended to capture a more diverse range of research by expanding the scope of datasets to include other databases such as Scopus and Google Scholar. Second, as keyword co-occurrence analysis mainly depends on the keywords set by authors, this study might fail to capture the implicit research trends and bring deeper research discussions. Furthermore, this review study did not dive further to analyze the research topics and research questions of the selected literature in detail. Future research is suggested to further investigate how these trends influence the development of MALL worldwide.

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