

Bibliometric Analysis of Computer- and Mobile-Assisted Language Learning: A Comprehensive Review

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ABSTRACT

Keywords:

Computer-Assisted Language Learning, Mobile-Assisted Language Learning, Bibliometric Data, Citation Network, Bibliometric Analysis

Computer- and Mobile-Assisted Language Learning (CMALL) has transformed language education dramatically in that it has improved the way of learning. In this paper, the bibliometric analysis is used to search the articles related to CMALL, covering 2004-2024 in the Scopus database containing 5,287 articles (4,542 in CALL, and 745 in MALL). It is intended to chart the trend in publication, determine the active authors and organizations, discuss the patterns of collaboration, and examine the thematic trends of the discipline. Using Boolean search techniques and filters to ensure relevance and quality, the analysis employs VOS viewer software to visualise co-authorship, citation, and keyword co-occurrence networks. The research findings are organised into three essential domains: publication trends, co-author collaboration, and citation networks. According to the analysis findings, the growing international research interest in CMALL has led to the USA and China emerging as primary contributors. Some of the main themes are AI integration, teaching through mobile apps, cognitive techniques, and digital sustainability. The study of CMALL progression is a data-based analysis of its overall academic organization and international significance. It also points out gaps in the research and how future studies can explore the relationship between educational technology and language acquisition.

Introduction

The research time frame of this study ranges between 2004 and 2024, which is 20 years of significant technological developments in the language teaching field, such as the development and changes of Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL). Some of the most notable developments in the world of language training are also found in the timeline, such as the extensive use of mobile learning, the use of artificial

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intelligence, and the development of virtual learning environments. Scopus is utilized because researchers consider it to have a broad coverage, is adequately indexed, and provides an abundance of citation information (Mongeon and Paul-Hus, 2016; Martino-Martin, 2018). Compared to other scientific databases, such as Web of Science and Google Scholar, Scopus provides the sponsor and scope of information necessary to conduct a study in the field of Computer- and Mobile-Assisted Language Learning successfully. This conclusion was reached by the researchers when they examined the indexing coverage and metadata quality and disciplinary relevance of Scopus, Web of Science, and Google Scholar. The rationale for using Scopus is owing to its high accuracy in citation, frequency of the records, as well as a very extensive indexing of the peer-reviewed journals on language education, which is pertinent to CMALL.

Computer-Assisted Language Learning (CALL) is an interdisciplinary practice that combines applied linguistics, educational technology, and computer science, and it is also being more and more acknowledged by scholars as a way of improving language pedagogy. Since the introduction of the first computer-based language programmes in the early sixties, CALL (century slang: computer-assisted language learning) has considerably evolved as it was created to utilise computers and digital devices to support the process of language acquisition (Woo & Choi, 2021). These were programmes centred on drills and practice (Yang et al., 2020). These applications have been enhanced with multimedia and interactive features over the years, which allow students to interact with the instructional content in a more active manner (Drigas & Charami, 2014). CALL is currently composed of a great number of different platforms. They are standalone applications, web-based applications, and learning management systems (LMS) (Woo & Choi, 2021). The basic purpose of language learning is the establishment of efficient, interactive, and individualised learning conditions (Woo & Choi, 2021). A good number of CALL programmes utilise adaptive technology that includes the use of feedback, voice recognition, and learning algorithms that adapt to the needs of each student (Woo & Choi, 2021). Technology is an essential factor in grid planning and constructing CALL curriculum since it helps to supplement the teaching strategies to enhance the learning gains (Tamilmani & Nagalakshmi, 2019).

The language acquisition process can be modified with the use of blended learning approaches that integrate online & face-to-face training using technology (Hinkelman, 2018). The degree of freedom given to students in CALL makes it an excellent opportunity to exploit the unique attributes of each student (Li, 2023). The learner agency is shaped through self-regulated learning & self-directed learning and the facilitation of the transformation of undergraduate students into autonomous professionals and the promotion of a lifelong learning practice (Gupta et al., 2024).

It is also worth mentioning that artificial intelligence usage is a new area of study because more attention towards Computer-Assisted Language Learning (CALL) in language teaching is growing (Woo and Choi, 2021). A subfield of CALL is Intelligent Computer-Assisted Language Learning (ICALL), which uses artificial intelligence technologies, such as Natural Language Processing (NLP), User Modelling (UM), Expert Systems (ES), and Intelligent Tutoring Systems (ITS) to enhance language learning and teaching (Woo and Choi, 2021). This progress proves the way language acquisition has been transformed beyond the conventional drills and practice to newer and more creative and imaginative ways of acquiring language. Language education is being transformed with the assistance of Artificial Intelligence (AI) and Machine Learning (ML), which provide more personalised classes and automate the administrative process, as well as making it more accessible (Intellectsoft, 2025). Moreover,

the current research directions, like green human resource management, also indicate the increasing popularity of sustainability integration in language learning technology and practices (Hariharasudan and Kot, 2021). This gives CALL an impressive list of benefits. It allows the students to be free and independent since they are also free to learn at their own pace and time. Another benefit of the use of CALL is the greater convenience of using real language material and communicating in real-life contexts, which is also valuable to second language learning (Yang et al., 2020; Al Hebshi and Gamlo, 2022).

This offers CALL a significant number of benefits. It gives the students the freedom and autonomy since they are at liberty to learn whenever and how they wish. Callback is also useful to make it easier to work with real-life sources and interact with real-life persons, which are also critical in the process of second language acquisition (Yang et al., 2020; Al Hebshi and Gamlo, 2022). Mobile-Assisted Language Learning (MALL) is a form of CALL that has come about due to the spread of mobile phones and smartphones. MALL involves the use of mobile gadgets like smartphones and tablets to help individuals learn languages in the shape of formal and informal schooling. The mobility aspect of these devices and the fact that they are accessible by students at any given place and time implies that students can get the language-learning material at all times and places, hence, they have a chance to practice and study outside the classroom.

MALL has emerged as a powerful tool to assist individuals to learn and teaching English, particularly in locations where English is used as a second or foreign language (Al Hebshi & Gamlo, 2022). Another important means of influence is vocabulary development, which is often regarded as the keystone of language learning. Research on the effectiveness of mobile game-based learning in improving vocabulary acquisition by language learners has produced favourable and inconclusive findings. Although there is a body of research that reports positive outcomes, such as improvements in speaking, writing, and vocabulary learning, many studies also report limited functionality of current mobile language learning applications, including poor contextual relevance, insufficient flexibility to the individual learner's needs, and limited corrective feedback (Dizon & Gayed, 2021; Qian & Tang, 2018).

The research period for this study spans from 2004 to 2024, encompassing two decades of significant technological advancements in language education, including the development and progression of Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL). This timeframe is complete with the key advances in global language training, including the proliferation of mobile education, the application of artificial intelligence, and the emergence of virtual learning platforms. Bibliometrics researchers use Scopus because it covers a wide range, has good indexing, and is rich in citation data (Mongeon and Paul-Hus, 2016; Mart Martin et al., 2018). Scopus provides the depth and breadth required to render research in the area of Computer- and Mobile-Assisted Language Learning efficiently compared to the other databases (e.g., Web of Science and Google Scholar). The researchers discovered this result by analysing the coverage of the indexing, the quality of metadata, and the disciplinary relevance of Scopus, Web of Science, and Google Scholar. Scopus will be selected because it has great citation accuracy, regularities, and searching of major journals in language education associated with CMALL that are peer-reviewed.

Computer-Assisted Language Learning (CALL) is an interdisciplinary field of research that involves the integration of applied linguistics, educational technology, and Computer science, and researchers are finding it to be an instrument for enhancing language teaching practices. The first computer-based language programmes appeared in the early sixties, and CALL, which was originally meant to be used as a way to learn and teach languages with the assistance of

computers and other digital solutions, has been significantly improved over the years (Woo and Choi, 2021). These were programmes centered on drill-and-practice techniques (Yang et al., 2020). Over the years, these apps have incorporated multimedia and interactive capabilities, which allow students to actively interact with instructional content (Drigas and Charami, 2014). CALL currently consists of a large number of different platforms. They are independent applications, web applications, and learning management systems (Woo and Choi, 2021). The ultimate purpose of language learning is to develop effective, interesting, and individualised learning conditions (Woo and Choi, 2021). Adaptive technology (including feedback systems, voice recognition, and learning algorithms that adapt to the needs of each student) is part of many of the CALL programs (Woo and Choi, 2021). Technology is an important aspect of the design and development of CALL curricula, as it is used to complement the teaching strategies and optimize learning results (Tamilmani and Nagalakshmi, 2019).

Blended learning approaches that presuppose both online and face-to-face training are a means to implement technology into the language acquisition process (Hinkelman, 2018). CALL offers a high degree of freedom; hence it can be a good-better place to exploit the individual attributes of the students (Li, 2023). Self-directed learning and self-regulated learning play a critical role in developing learner agency as well as helping undergraduate students become autonomous professionals and participate in lifelong learning (Gupta et al., 2024). With the increased popularity of computer-assisted language learning (CALL) in language teaching, artificial intelligence applications have become an important field of inquiry (Woo and Choi, 2021). Intelligent Computer-Assisted Language Learning (ICALL) is one of the CALL branches that applies the methods of artificial intelligence (Natural Language Processing (NLP), User Modelling (UM), Expert Systems (ES), and Intelligent Tutoring Systems (ITS)) to the process of teaching and learning a language (Woo and Choi, 2021). This development demonstrates how language learning has transformed into more complex drills and practice, to creative and innovative means of learning. The advancements of technologies, such as Artificial Intelligence and Machine Learning are changing language education by making classes more personalised, automation of administrative processes and making those more accessible (Intellectsoft, 2025). Moreover, emerging issues, such as the topic of green human resource management, also highlight the growing popularity of implementing sustainability in language learning technology and methods (Hariharasudan and Kot, 2021). CALL has numerous benefits. It offers more freedom and independence to students so that they can study at their will and pleasure. With CALL, there is an increased possibility of using the original language sources and speaking in real life, which turns out to be relevant in learning the second language (Yang et al., 2020; al-Hebshi and Gamlo, 2022).

As a result, CALL has many benefits. It is free and independent because students are free to choose the time and method of study. Real language resources and real-life situation discussion are also easier to utilize with the help of CALL, which is important to second language learning (Yang et al., 2020; Al Hebshi and Gamlo, 2022). Mobile-Assisted Language Learning (MALL) is a variant of CALL, which has developed with the development of mobile devices and smartphones. MALL utilizes the use of mobile devices like smartphones and tablets to help people learn languages in formal and informal settings. Being lightweight and portable, the students will have access to language-learning materials at any time and location, as well as a chance to practice and learning outside the classroom.

MALL has proved to be an effective instrument that can help people learn and teach English, especially in those places where English is learned as a second or a foreign language (Al Hebshi and Gamlo, 2022). The other significant source of influence is in the field of vocabulary

development, which is widely touted as the basis of language acquisition. Studies of the efficiency of mobile game-based learning as a tool for fostering vocabulary acquisition among language students have yielded both positive and negative results. Contrary to the positive results of numerous studies, such as the enhanced speaking, writing, and vocabulary learning, other authors highlight the weakness of the existing mobile language learning platforms, including the lack of contextual relevance, the inability to adapt to the needs of learners, and minimal corrective feedback (Dizon and Gayed, 2021; Qian and Tang, 2018).

The contribution of Computer-Assisted Language Learning (CALL) and Mobile-Assisted language learning (MALL) to language learning programs and the role of teachers in supporting extracurricular activities, especially MALL, is a relatively untapped field requiring further studies (Qian and Tang, 2018). As technology continues to improve, CALL and MALL, too, will improve to offer more dynamic and efficient solutions to both language learners and language teachers. Due to the development of CALL, the perspectives on the manner of teaching and learning language have been shifted. CALL has grown to include multimedia, AI, and technology, which enables people to communicate with each other. Educational, technical, and social forces have brought about these revolutions. Research indicates that CALL is adaptable as the students are able to study under varying circumstances, as they practice the target language as well as their mother languages in reality. Intelligent Computer-Assisted Language Learning (ICALL) is one of such specialized subdomains. It employs machine learning and AI to maximise user experience.

Another instrument that has been popularised and utilises the functionality and accessibility of mobile devices is Mobile-Assisted Language Learning (MALL). It has been demonstrated that it is possible to learn vocabulary and enhance overall language proficiency with the help of MALL. Nevertheless, they still have problems, including the use of extraneous content, inadequate relevance in the real world, and the absence of tools to deliver individualised feedback and follow-ups (Dizon and Gayed, 2021). The world of CALL and MALL will keep developing, and especially, they will become more entangled in virtual reality and AI-based applications (Kannan & Munday, 2018). The concept of green human resource management included in CALL and MALL is a new research methodology that underpins the practices of sustainable technology in education (Hariharasudan and Kot, 2021). Both CALL and MALL have demonstrated their effectiveness in the teaching of a language, and to this day, certain long-standing problems, including the digital divide and the potential worry about the quality of educational software, remain uninvestigated and need further exploration (Han, 2020).

Motivation of the Study

This study was prompted by the developing research on computer- and mobile-assisted language learning (CMALL), and the developing influence it has on academic publication. Although this area has expanded, not many comprehensive, recent bibliometric studies give a basic overview of the CMALL research landscape. Recent research is mainly focused on limited periods of time, a given technology, or a particular geographical region, therefore limiting the emergence of a holistic picture of global research activities.

Despite numerous studies on CALL and MALL, a thorough and up-to-date bibliometric survey of the tendencies of publications, networks of collaboration, and patterns of citation in this area is needed. Bibliometric mapping allows researchers to trace the development of the scholarship, determine which issues are insufficiently studied, and evaluate significant technical advances, e.g., the integration of AI and mobile devices, but also identify prominent authors and scholarly communities. An understanding of how networks of researchers, co-authorship networks, and

co-citation networks work will provide an intellectual map of the CMALL research environment.

The purpose of the study is to examine the temporal distribution of the research and identify areas of future research, specifically the utilisation of AI technology and the execution of sustainable learning paradigms. The study uses bibliometric data on the Scopus database to review the research on Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL) published in the period between 2004 and 2024. It conducts extensive investigations on current trends in publishing, critical institutions, scholars, and collaborative and bibliographic associations. Therefore, the current bibliometric research provides an interesting way of locating the new fields of research and informing the academic priorities in the directions of the future, thereby contributing to the knowledge base development in filling the gaps identified. To aid this endeavour, this paper requires VOSviewer software to render cluster maps, which may display the interrelationship and thematic linkages in the development of CALL and MALL.

Methodology

Bibliometric approach

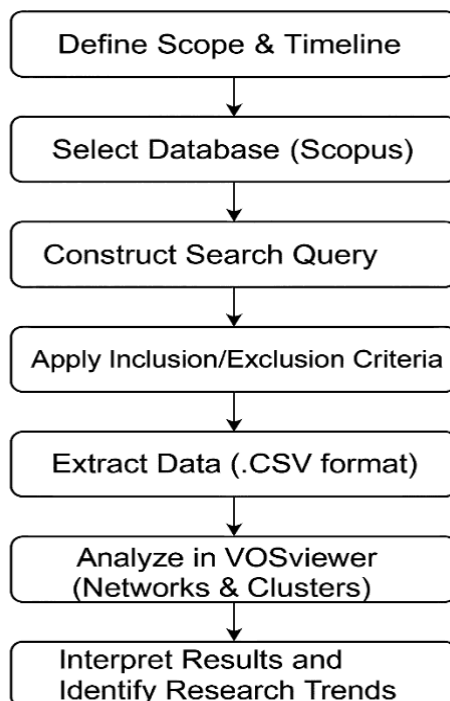
This research has become a potent historical and theoretical contribution to bibliometric studies because of the systematic approach of collecting and analysing data. The width and length of the analysis are certain. It observed the bibliometric trend of the CALL and MALL studies, 2004-24. This period in history was selected based on the observation that mobile technology and AI-integrated tools were finding more applications in the teaching of languages during this period of human history. The main source of information was the Scopus database, which has broad coverage, methodological accuracy, and quality information required in a rigorous bibliometric analysis. In order to get a unified and representative corpus of literature, a search query with Boolean operators and filters of interest was applied systematically. The search string used was: TITLE-ABS-KEY (computer AND assisted AND language AND learning) AND PUBYEAR > 2003 AND PUBYEAR < 2025 AND (LIMIT-TO (PUBSTAGE , “final”)) AND (LIMIT-TO (LANGUAGE , “English”)) AND (LIMIT-TO (DOCTYPE , “ar”) OR LIMIT-TO (DOCTYPE , “cp”) OR LIMIT-TO (DOCTYPE , “re”) OR LIMIT-TO (DOCTYPE , “ch”)) AND TITLE-ABS-KEY (mobile AND assisted AND language AND learning).

To ensure that the dataset was efficient and reliable, the evaluation process used particular criteria of inclusion and exclusion of items. The review included peer-reviewed journal articles, conference papers, and book chapters published in English and labelled as final-stage publications. Editorials, notes, and duplicate items were eliminated to make sure that the information was correct. The bibliographic records were transformed into CSV format after a search and filtering process to enable them to be analysed. The data set that was made consisted of the necessary pieces of information, such as the year of publication, names of authors, type of document, name of institution they worked for, citation number, and keywords. We demonstrated with the help of VOSviewer software patterns of co-authorship, citation network, and groups of conceptual keywords visually. The VOSviewer data analysis has identified famous authors, dominant research themes, and emerging topics in the CMALL field. These findings were placed in a wider context of technology-enhanced language learning, and

important patterns were identified, as well as providing future research goals. Figure 1 shows how this project was researched.

Figure 1.

Research Flow of the Study



Guiding Research Questions

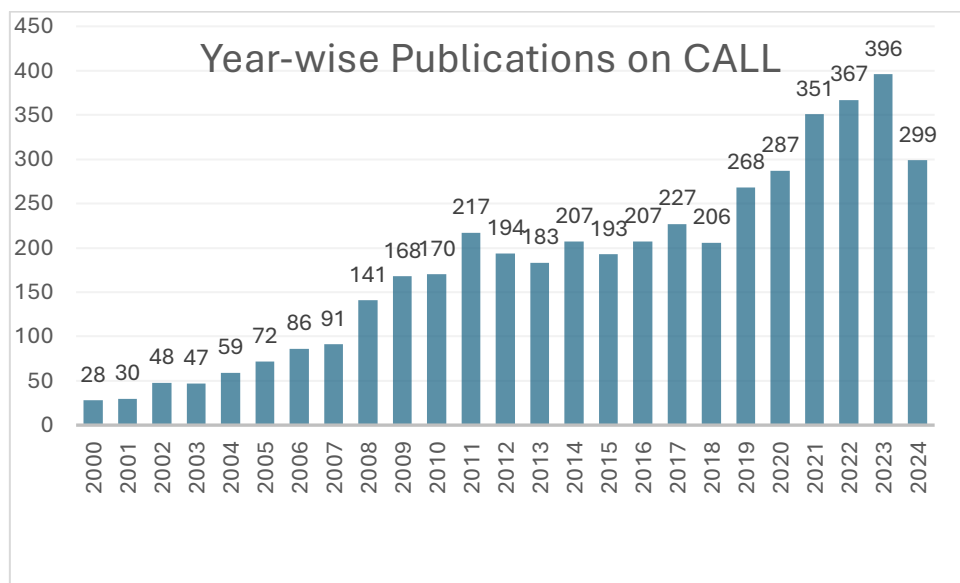
The questions below will enable us to use bibliometric analysis to assess the level of knowledge on CMALL that exists at the moment. By responding to these questions, the research aims to discover important trends, significant contributors, collaborative networks, and conceptual developments in the topic between 2004 and 2024.

What are the trends in CMALL publication from 2004 to 2024?

To learn more about the development of the CMALL study area, it is necessary to compare the alterations in publications. The research problem is to determine the number and rate of increase of scholarly production annually and to identify the periods during which the activity of research increased significantly (Ahsan et al., 2023; Chen et al., 2024; Mulyani, 2021). The examination of these data can reveal the times of increased academic attention and investment towards CMALL, which provides valuable information about the dynamics of the development of the research over time (Bakan and Han, 2019; Xue et al., 2021). This research could also uncover the first presentation of certain technologies or practices, as well as how the changes in the educational laws, technological advances, and other situational conditions influenced research directions (Ifthikar et al., 2022).

Figure 2.

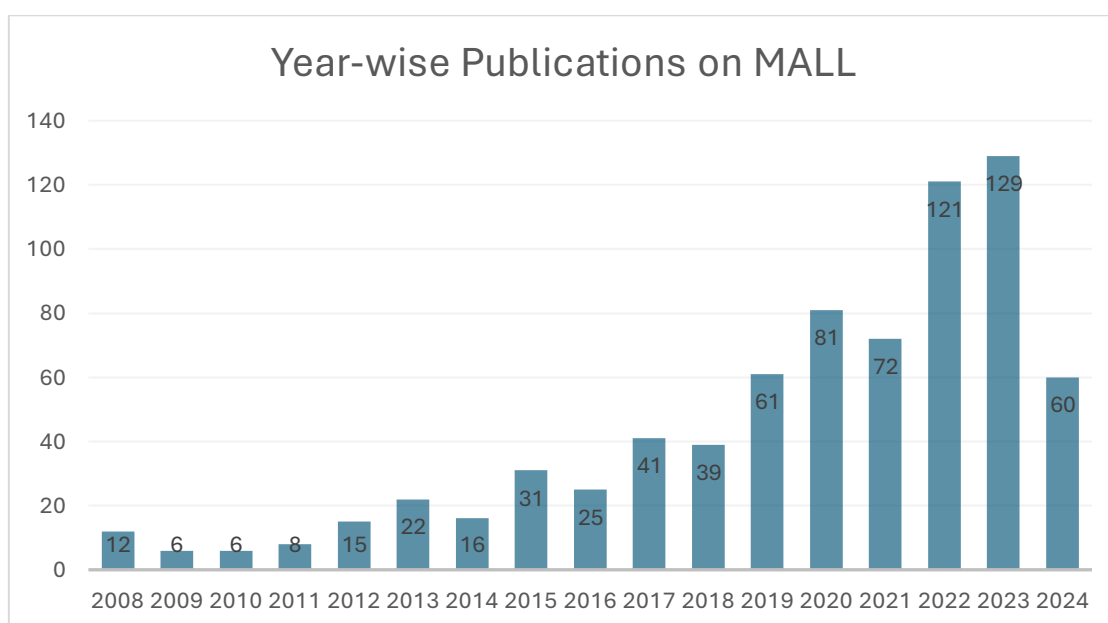
Year-wise Publication on CALL



Although there are fewer publications on MALL than on CALL, the number of MALL publications has increased significantly in the past few years. There has been a significant increase in MALL articles, similar to the rise in CALL research. This suggests that more academics are interested in mobile-assisted approaches for learning a language. Figure 3 shows this tendency quite well; it shows how MALL's publishing has grown throughout the course of the research period.

Figure 3.

Year-wise Publications on MALL



Who are the most prominent writers and institutions in this area?

To identify the major contributions to CMALL research is not only the recognition of those individuals who have revolutionised the issue over the years, but also the scholarly influence and contribution of a particular writer or organisation. In this research topic, the researcher aims to identify the most prolific and frequently referred-to authors with the intention of highlighting individuals and institutions that have made a significant contribution to the topic. The goal is to identify the seminal contributions of innovative scholars and institutions through a comparison of citation analysis and publishing metrics, and also to recognise emerging researchers and centres of excellence.

This would make it easier to have a complete understanding of the CMALL intellectual milieu, both in terms of existing authorities and emerging contributions. The report also admits the shortcomings of citation and publication conventions, which can potentially marginalise scientists in underfunded institutions or non-English-speaking countries. To ensure this, the analysis willingly encompasses new contributions by the underrepresented countries, which encourages inclusivity and acknowledges that the world is diverse in its research work in the field. The present research outlines the existing structure of influence in CMALL studies and defines possible options for future collaborators and funders, sharing resources, or engaging in co-authorship projects (Yazdi et al., 2024; Podsakoff et al., 2008).

How do the co-authorship networks in CMALL show how research is done together?

These findings show how important collaboration is to the progress of science. The paper researches the co-authorship networks to improve the understanding of the collaborative processes of the CMALL research community. The paper aims to explain the nature of these networks by determining the most collaborative scholars and institutions, as well as the requirements that determine high degrees of academic connectivity.

Mapping these ties, the study can successfully determine centres of cooperation in different regions of the world and trace the development of cooperative networks over the course of time. These results clarify the sharing of information both across academia and geographical borders to improve understanding of cooperation trends, formation of alliances, and to determine the possible gaps or bottlenecks in collaborative efforts. These kinds of studies present useful information about the patterns of scholarly interaction, along with the potential and possibilities of sustaining and developing collaborative research projects in CMALL (Boța-Avram, 2022; Biscaro & Giupponi, 2014).

Which are the key categories of thought in CMALL studies, and how have they changed?

In the CMALL sphere, the definition of the core topic areas and the core research objectives presuppose knowledge of the patterns in the themes and how they change across years. Although this paper does not provide a comprehensive content analysis of specific articles, the recognition of keywords and thematic clusters that occur most often shows the main areas of research in CMALL. The aim is to outline the main research questions and trace the shift of the focus of the field over the past twenty years of research.

Through mapping theme clusters, we get to know the various kinds of research methods and activities undertaken in CMALL. This thematic review will also allow us to discover novel ways of researching, detect the literature gaps, and think about future research. The arrangement of these clusters would result in a more systematic understanding of the intellectual progress of CMALL, and its conceptual and methodological improvements can be recorded (Herring, 2013; Xi, 2018).

Primary Data

This research was based on the Scopus database as its main source of information. Scopus database was selected as it has been extensively indexed with scholarly and professional publications, including journals, conference proceedings, and patents, although other options existed. Its strict selection criterion provides a high-quality methodological soundness of the bibliometric analysis since it consists of high-quality and peer-reviewed papers. It has been established that Scopus is a convenient source of information, which is widely covered in various fields, and therefore, is the appropriate source in the compilation of many scholarly articles that concern the CMALL.

Search and indexing features of this platform give the opportunity to investigate a great number of data points and trends; these may be the number of articles published, the rate of cooperation of the authors, or the rate of citation. Scopus, too, contains plenty of metadata, such as the volume and issue of an article, the affiliations of the author, and the number of times the article has been referenced. This helps the bibliometric evaluation to be more accurate and in-depth. Such a specification allows the identification of major and minor authors, the most important and new issues in CMALL.

To make sure that the data was of scholarly quality, the following criteria were examined: (1) must be published not earlier than 2004, (2) must be written in English, (3) must be published in a final version, (4) must be an article (ar), conference paper (cp), book chapter (ch), review (re), and conference review (cr). The search was narrowed down to journal sources (srctype = "j"). The exclusion criteria were: (1) not in English; (2) not peer-reviewed; (3) publication that was outside of the range of period; (4) editorial material, letters, and comments that do not add scientific value to the analysis. The bibliometric study was powerful because of this careful selection of data.

Data Collection Procedure

To obtain the data to study, the Scopus database was used in March 2024, and it is considered to be a valid and popular tool in bibliometric research. The time frame (2004 to 2024) was chosen due to its importance to the growth and development of CMALL and other related technologies. The researchers chose the following terms to be their main search terms: Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL). This translated into 4,542 and 745 hits, respectively. The search was done with the help of Boolean operators and filtering to refine the dataset by filtering on their accuracy and relevancy. Such strategies were employed in order to extract some bibliographic records that are pertinent to the study goals. The following study was done on the basis of the bibliometric data collected.

Figure 4.

Bibliometric Analysis flowchart using Boolean Operators and filtering techniques.

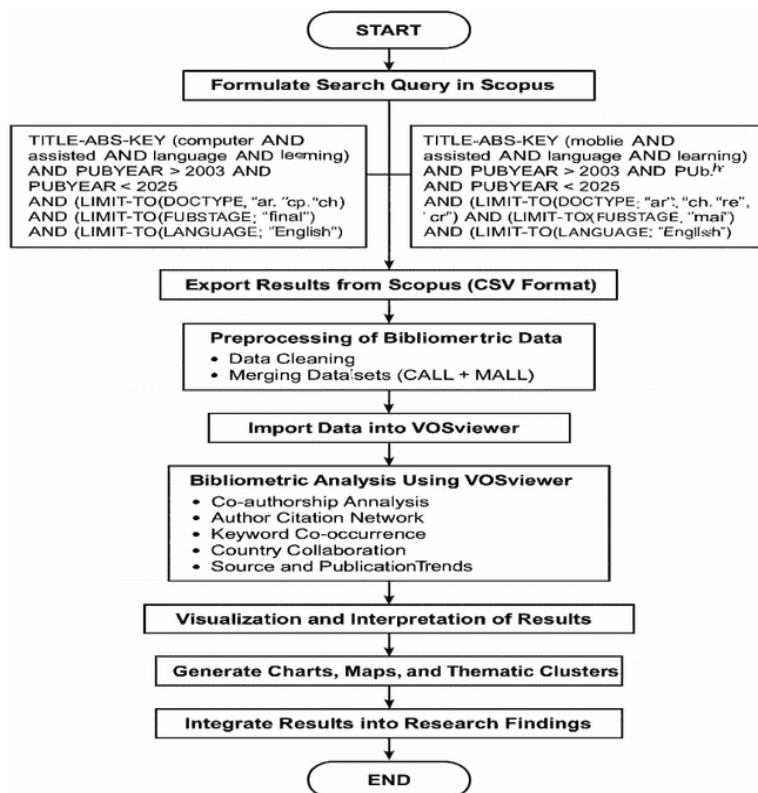


Figure 4 shows the stepwise guide to conducting a bibliometric analysis with the help of Scopus and VOS Viewer. The initial step of the technique is to develop Boolean-based search queries so as to access the required information in Scopus. Then, the data is exported and pretreated in such a way that the bibliographic records are prepared to be analysed. The flowchart will provide the steps of analysis that need to be undertaken, such as co-authorship analysis, co-occurrence mapping of keywords, and theme grouping. These phases collaborate to identify the significant research discoveries and demonstrate the intellectual, social, and conceptual frameworks within the CMALL research context.

Results and Analysis

Networks of Co-authorship

Patterns of researcher collaboration in the CMALL database were displayed with the help of VOSviewer in order to map co-authorship networks. This research paper outlined some of the main factors and explained the impact of the joint activities on the spread and development of CMALL research. The resultant co-authorship map showed many closely related clusters of authors, which indicated great collaborative connections, together with the associated institutions and nations.

The graphic has shown important locations of students collaborating, and Kukulska-Hulme, Warschauer, and Hwang play an important role in the closely connected teams. They are crucial since they undertake extensive research and are associated with projects that unite people of various institutions and countries. The network structure indicates that CMALL is multidisciplinary in that there are high links among clusters with a large geographical coverage

across the world, especially Southeast Asia and the Middle East. These findings substantiate the idea that the influence of academics and innovation in CMALL occurs primarily through the lenses of the collaborative practice of scholarship instead of personal contribution. It demonstrates the importance of interdisciplinary and global collaboration on the subject.

Networks of Citation

Citation coupling was considered with the analysis of the citation to determine the seminal works and publications that most frequently use the seminal works to define the literature of CMALL. Citation networks were used to show how the discursive knowledge disseminates and creates information. In such a way, it was possible to define the most commonly referred publications and authors and better understand the academic importance and the evolution of the research topics over time.

It was discovered by the studies of Kukulska-Hulme, Ellis, and Nation I. S. P. were highly referenced to construct both MALL and CALL frameworks and provide a solid groundwork to the current research on the topic. The citation network showed that there was a large interest in language learning, mobile learning design, and integration of AI technology. All these are places that have been significant in the past and are still of interest to scholars. The volume of the citations within certain clusters shows that the themes merge and that scholars are unanimous that there are important issues. Conversely, peripheral ideas provide the indication that new or specialised fields are currently developing, which may provide promising avenues of future research. This paper outlines some of the influential contributions and clarifies the thematic structure and course of development of CMALL scholarship.

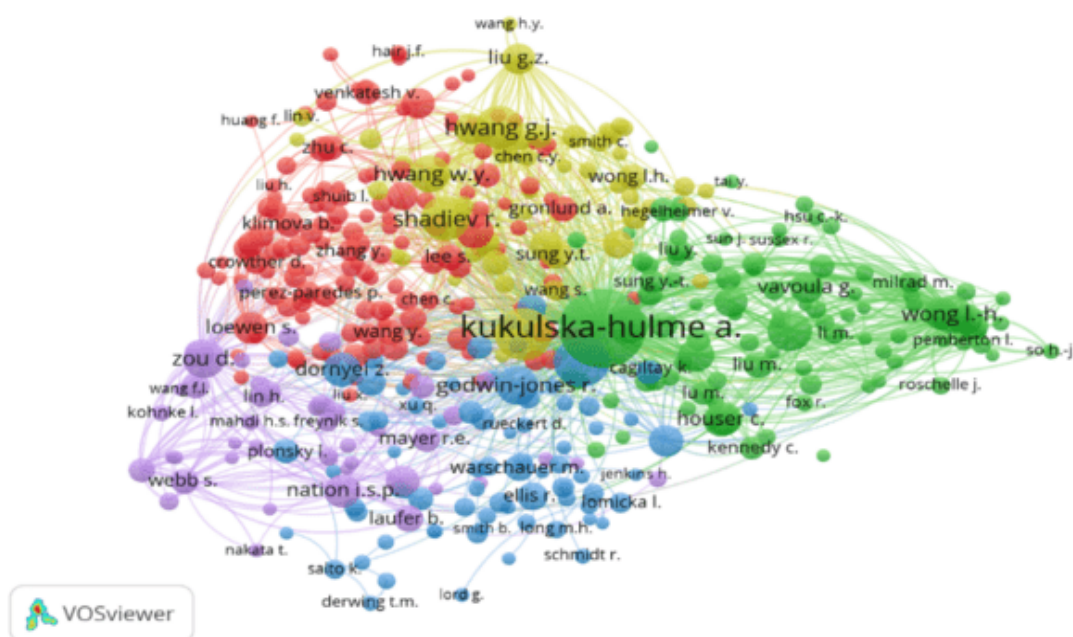
Conceptual Structure

The conceptual framework of the CMALL study was also highlighted using VOSviewer by developing research maps that showed key subjects related to subjects and themes. The maps assisted the study in determining the top issues of concern in the region, current lines of inquiry, and new frontiers of the issues. This concept mapping helped us to familiarize ourselves with the connection between the study subjects and the change of the area of focus over time.

VOSviewer has graphically built the intellectual space of CMALL, e.g., co-citation and co-word networks. Such visualisations helped to attract attention to major authors and research topics, but also provided evidence of the knowledge systems that make up the field. The major themes that were identified during the study include mobile game-based learning, learner autonomy, intelligent systems, and virtual classrooms. These nodes were recurrently linked to each other, signifying that the educational philosophy and the technology pedagogy were coming together. The gradual shift of the traditional multimedia-based Computer-Assisted Language Learning (CALL) to mobile learning and combining it with artificial intelligence reveals the increasing emphasis of research on enhancing engagement, customisation, and learning efficiency. The gaps in the literature were also shown in the literature, and they are pointed out as principal areas of future research, in particular, with respect to inclusivity, accessibility, and cross-cultural applicability of CMALL tools.

Figure 5.

Author Citation Network of MALL



Mobile-Assisted Language Learning (MALL) is a vibrant and networked scientific community that has come to be a real scientific community and has several important scholars in its development (Yang, 2013). Among them, one can name Kukulska-Hulme A., whose name is often mentioned and recognised as the pioneer in the sphere of mobile technology application in language teaching (Yang, 2013). The fact that she has the strongest citation and collaboration networks highlights why she is significant to the progression of the field. The contribution of Hwang G. J., Wong L. H., Shadieff R., Godwin-Jones R., Hwang W. Y., & Warschauer M. to the research on MALL is also significant, as these scholars have made multiple scholarly contributions and have built comprehensive research networks (Dizon & Gayed, 2021; Liu, 2020; Al Hebshi & Gamlo, 2022; Qian & Tang, 2018).

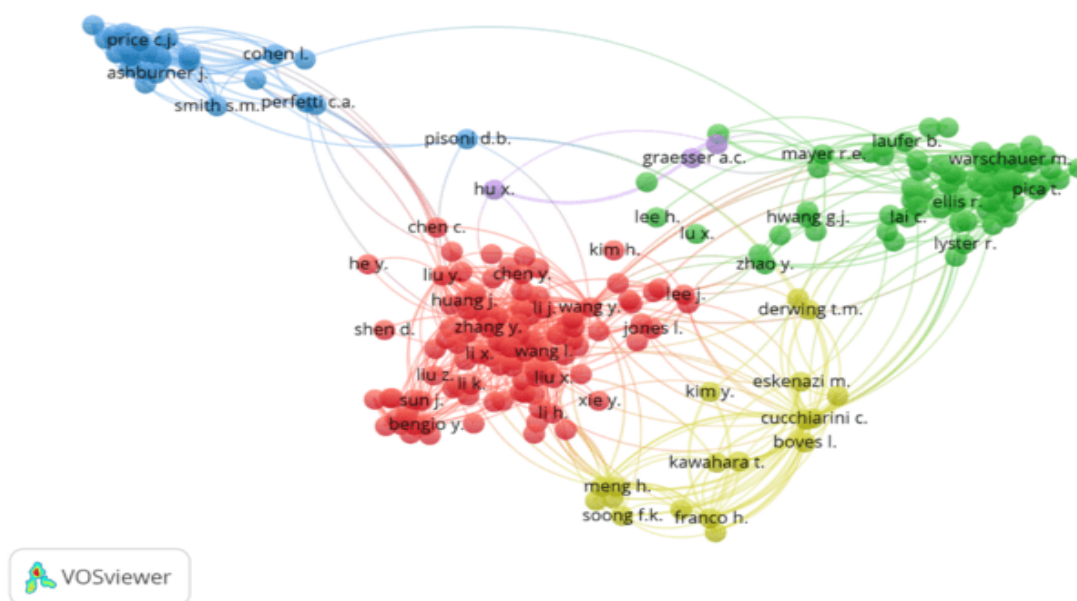
The bibliometric analysis demonstrates that there are a lot of theme clusters - this is the diversity of the MALL research field. One of the united forces of Kukulska-Hulme, the Green Cluster, focuses on the creative use of mobile applications in language learning, highlighting the most recent advances and pedagogic advantages. Contrarily, Red Cluster is a group of researchers (including Hwang G. J. and Shadieff R.) who dwell upon less specific educational technologies and their applications to mobile learning. Such teams are exploring how mobile learning can be compatible with the wide range of pedagogical models and how to align it with the majority of instructional types (Qian and Tang, 2018; Liu, 2020; Al Hebshi and Gamlo, 2022). These categories reflect the advanced nature of the MALL research, intellectual orientation, and scope of subjects of the field.

The Blue Cluster boasts of several renowned scholars, including Nation I. S. P. and Webb S., who write on the theoretical and methodological foundation of language learning. This group is more intrigued by a more sophisticated and critical contemplation of the conceptual design of MALL, models of vocabulary acquisition, instructional design, and evidence-based language teaching (Dizon & Gayed, 2021; Liu, 2020; Al Hebshi and Gamlo, 2022). Their writing gives a critical theoretical basis for the empirical studies in the broadened CMALL world. High

internal density and a high number of inter-cluster interconnections are the structural connections between clusters, and they indicate a high rate of academic cooperation and cross-referencing. This networked organisation underlines the transdisciplinary and highly participatory nature of the MALL research community. The great assimilation of theoretical, technical, and pedagogical perspectives in the clusters proves the maturity of the field and its ongoing commitment to the clarity of concepts and practical invention.

Figure 6.

Author Citation Network of CALL



The Computer-Assisted Language Learning (CALL) research network has many prolific writers who have become well-known as they are often referenced and are an important part of the structural network of the academic community (Su & Zou, 2020). Figure 6 VOSviewer authors like Warschauer M. (1,980+ citations), Ellis R. (1,650 + citations), and Mayer R. E. frequently appear (1,200+ citations) in the co-citation and citation coupling maps. The fact that they are in the middle of the citation network proves their necessity in terms of contributions to the study of CALL, and it shows that they contributed to the evolution of the sphere. The network includes other key actors, such as Smith S. M., Ashburner J., Price C. J., and Cohen L., who have been involved in the production of significant scholarly works in CALL (Han et al., 2021; Chen et al., 2021). The CALL research network can be divided into various subdomains with their respective themes.

The subdomain, M. Warschauer and Ellis R. Anchor the Green Cluster, contains the most content that is useful in applications. It focuses on the CALL practices and their educational applications, especially the application of digital technology in the learning contexts (Cornillie et al., 2012). This cluster is the main research theme in CALL, which connects theory and practice.

Other scholars like Liu Y. belong to the Red Cluster. Chen C. and Chen C. analyse the psychological and cognitive factors of CALL. Their paper is based on the impact of cognition, motivation, and emotion of the learners on the efficacy of the CALL strategies, which offers a

more profound perspective of the user-centred design (Schwienhorst, 2002). The Blue Cluster reminisces about the systems of neurobiological and cognitive science that contribute to the acquisition of language and that encompass such writers as Price C. J. and Cohen L. This subdomain is related to neurocognitive activities to promote second language acquisition, which includes the integration of cognitive science into the CALL model (Chen et al., 2021; Woo and Choi, 2021).

These classifications show how varying and complex CALL research can be. It includes technical, pedagogical, cognitive, and neuroscientific approaches leading to the emergence of new ideas and theories in the domain. The presence of topic clusters within the CALL research network is a high degree of disciplinary integration and interconnectivity that confirms the very essence of multidisciplinary of the sphere (Shrestha, 2014). This combined paradigm is ideal in CALL as there are many different ways one can use it, and it is always ready to accept new ideas and ways.

Most of the authors of the study of MALL and CALL are crucial in the network of citations since they are influential, have numerous citations, and collaborate with numerous individuals. Kukulska-Hulme, Hwang, and Shadiev are crucial persons in MALL since they have contributed a lot in terms of mobile technology in language learning. Meanwhile, renowned scholars, such as Warschauer M., Ellis R., Mayer R. E., and Smith S. M. proceed to contribute to CALL necessarily. Their presence within the network demonstrates the value they have in the development of the theoretical and practical direction of the field. The eminence of these authors is indicative of their remarkable contributions to academia not only in the creation of powerful research but also in the creation of the intellectual pathway of CMALL.

Top Contributing Countries to CALL Publications

Table 1 was compiled on the basis of a review of 4,542 papers and presents the top ten countries that conduct the most research on Computer-Assisted Language Learning (CALL). The United States has the highest number of publications (1,108), and it makes up 24.39 percent of the total. The second and third places of 655 and 332 publications, respectively, are occupied by China and the United Kingdom. Other critical donors are Taiwan (6.36%), Japan (5.88%), Germany (4.60%), Spain (3.96%), Australia (3.89%), Canada (3.87%), and France (2.90%).

This distribution shows that the United States and China are the two dominant countries in CALL research, and this implies that they have made huge investments in educational technology and language teaching. The USA has been committed to academic innovation, research investment, and language instruction digital infrastructure for a long time, which has translated into a leadership role. In the meantime, the increasing influence of China suggests an increased influence on the edtech development and language learning studies worldwide. Other countries like Taiwan and Japan have been investing in language education through strategic decisions to incorporate technology that is supported by strong innovation systems and policies that support bilingual or multilingual education. Overall, the statistics show a regionally broad but unequal distribution of research effort, with concentrated leadership in North America, East Asia, and portions of Europe.

Table 1.

Top 10 countries on CALL publications

S. No	Countries	Number of publications	Percentage calculated from the total number of publications (% of 4542)
1.	USA	1108	24.39454
2.	China	655	14.42096
3.	UK	332	7.309555
4.	Taiwan	289	6.362836
5.	Japan	267	5.878468
6.	Germany	209	4.601497
7.	Spain	180	3.963012
8.	Australia	177	3.896962
9.	Canada	176	3.874945
10.	France	132	2.906209

Top Contributing Countries to MALL Publications

Table 2, based on a total of 745 articles, covers the top 10 countries that are engaged in research about Mobile-Assisted Language Learning (MALL). China has the highest number of articles (112 articles, 15.03%), followed by Taiwan (74 publications, 9.93%) and the United States (86 publications, 11.54%). Iran (8.05%), the United Kingdom (6.30%), Malaysia (6.04%), Hong Kong (5.10%), Spain (4.69%), and Saudi Arabia and Turkey have the biggest share with 33 publications each (4.42%).

This divides to show that China has been at the forefront of MALL research, which is indicative of its mobile-first technical context and government policies to encourage mobile learning, especially in deprived regions. The US and Taiwan are not left behind, and they are also engaging in the pursuit with a long-standing history of language education and computer-mediated learning. The involvement of Iran, Malaysia, and other emerging nations indicates the increasing global attraction towards mobile learning, which is being stimulated by the availability and scalability of mobile technologies. Overall, these tendencies indicate a more widespread democratisation of educational research in MALL, whereby more and more different geographic and economic contexts are involved in it.

Table 2.

Top 10 countries on MALL publications

S. No	Countries	Number of publications	Percentage calculated from the total number of publications (% of 745)
1.	China	112	15.03356
2.	USA	86	11.54362
3.	Taiwan	74	9.932886
4.	Iran	60	8.053691
5.	UK	47	6.308725
6.	Malaysia	45	6.040268
7.	Hongkong	38	5.100671
8.	Spain	35	4.697987
9.	Saudi Arabia	33	4.42953
10.	Turkey	33	4.42953

Comparative Interpretation and Integration of CALL and MALL

As technology becomes more integrated into the modern language learning environment, the results of this study indicate that CALL and MALL are becoming more similar in terms of research output. The literature supports a shift to a unified framework known as Technology-Assisted Language Learning (TALL) that incorporates computer-based and mobile-based strategies. The convergence of CALL and MALL is evidenced by the use of modern digital platforms such as Duolingo and Busuu that combine the organised, desktop-based features of CALL with the customisable, mobile-accessed capabilities of MALL.

The amalgamation of the CALL and MALL ideas resulted in teacher-oriented, flexible educational technologies, which enhance access, interaction, and personalisation. Patterns of research production enable this convergence, particularly in countries such as China, the United States, and Taiwan, which have been the most contributing countries to the two disciplines. The representation of China is high at 15.03 percent of MALL and 14.42 percent of CALL publications. This is a result of its policy-led investment in digital and mobile learning systems that promote innovation and equity in education. Balanced Taiwanese scores, 6.36% in CALL and 9.93% in MALL, indicate the adherence to the concept of multilingual education that does not rely on the platform and encourages the incorporation of technology in the majority of situations. Overall, the current study identifies a worldwide trend toward integrated, multimodal language learning ecologies, facilitated by national policies and technologies, which are becoming more and more fine, with the boundaries between CALL and MALL.

The United States also has the majority of the papers related to CALL; it produces 24.39 percent of the world total, yet it is less involved in the study of MALL; it produces only 11.54 percent. According to this loophole, there exists an implicit dependence on the existing digital capabilities in the US institutions, where traditional platforms and desktop-based platforms dominate. Despite the platform integration currently in operation, there is a slow pace of adopting the mobile-first approach, as it is difficult for traditional academic systems to adapt to the new technology. Other countries with a relatively recent past in CALL, like Iran and Malaysia, are making their way to MALL research. This is due to their greater interest because mobile technology that offers realistic entry-levels to market digital language teaching in underdeveloped countries is available and affordable.

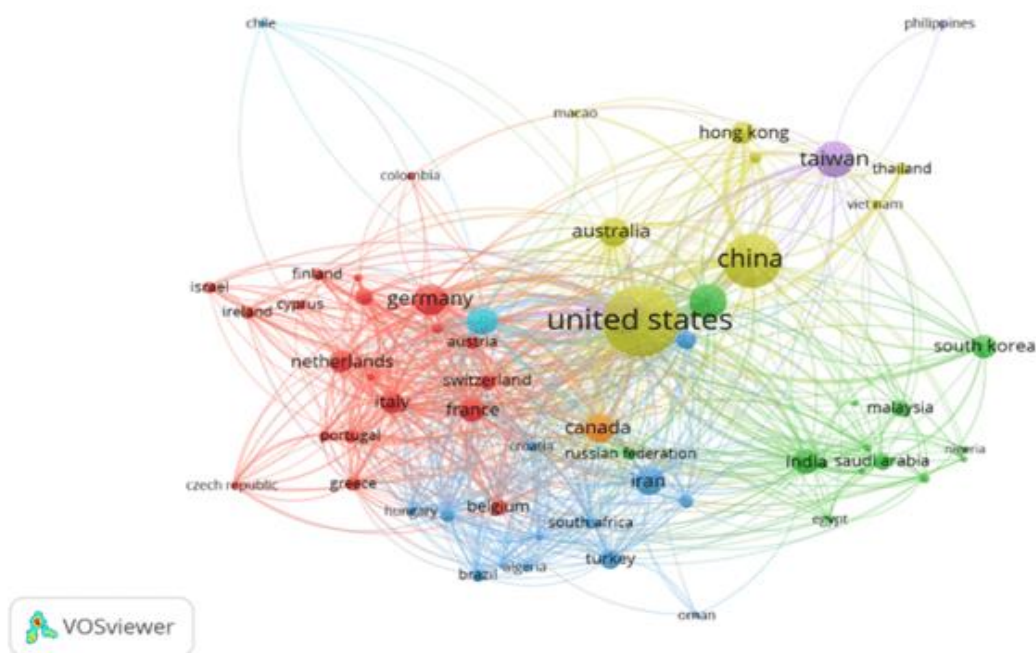
This new environment is a pointer to the diversity of international research input, and this has the consequence that CALL and MALL are becoming closer. The fact that mobile-assisted ways of learning started to emerge in the new field that used to be previously underrepresented indicates that mobile technology can be democratizing, which will widen access to language learning in an extremely diverse set of learning settings. The mixed methods are encouraged, and combinations between CALL and MALL CALL can be regarded as inclined to cross-platform learning environments. These are continuity-based, equality-based, and artificial intelligence-based strategies in making the learning process personalized and more enjoyable.

The pressure on the researchers to develop a means of providing access to all people with regard to the different categories or types of infrastructure and access has been on the rise. This current shift is of broader disposal of a more predisposition towards Technology-Enhanced Language Learning (TELL) that is conducive to the local requirements, technical opportunities, and learning objectives. Finally, by looking at the contributions to CALL and MALL around the world, it is possible to observe that the field is growing and it is beginning to be less judgmental in terms of its methods and social impact. It is introducing the future of language education as something more open and flexible.

Conceptual Structure – Co-authorship by Country

Figure 7.

Co-authorship by Country for CALL



The co-authorship groups of the CALL specialties are most concerned with the countries that produce the most collaborative research. The United States is the role model of a wide range of international collaboration, which is revealed in the yellow cluster. This is due to its well-established research infrastructure, continued investment in educational technologies, and strong traditions in applied linguistics and learning a second language. China, another member of this cluster, shows a similar level of regional and global connectivity. This is due to aggressive digital education policies, the widespread use of mobile technology, and targeted academic funding support for both CALL and MALL initiatives, especially those that help people learn English.

Germany, shown in the red cluster, works well with other countries in the region. This is assisted by well-coordinated university systems and an increasing EU-wide interest in bilingual education. There has been a great effort by many institutions to ensure that their academic programs are consistent and compatible across Europe. This is what has made their collaboration such a success.

The increasing contributors are the blue cluster comprising Brazil, South Africa, and Iran. These nations are creating more research on CALL, and one can attribute this to increased spending on the integration of ICT in education and the expansion of international academic networks. South Africa and Brazil, in particular, are using digital technology to address inequalities in education, and the increasing influence of Iran demonstrates how mobile technology can democratise language learning. Overall, all these associations of these clusters indicate the interdisciplinary and international character of CALL research. The co-authorship networks demonstrate that academic cooperation is not geographically restricted, which demonstrates

that it is a very interconnected field of research with some common research points and growing geographic diversity. Such trends demonstrate the international significance of CALL and the evolution of the same by undertaking academic activities in a collaborative manner.

Figure 8.

Co-authorship by Country for MALL

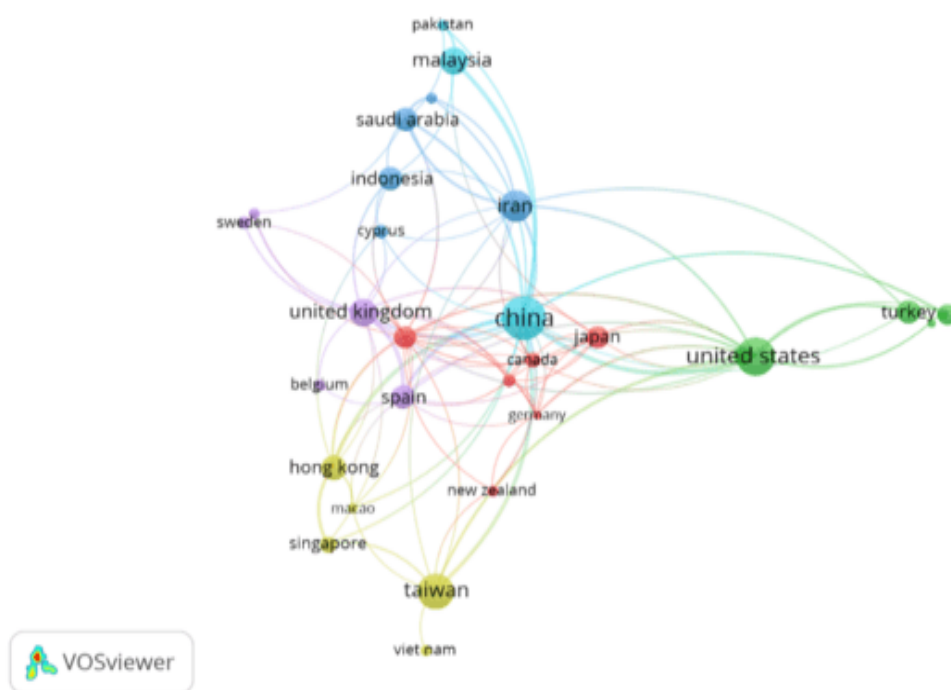


Figure 8 illustrates the co-authorship network by country of MALL-related papers, with China, the United States, and Iran being of the greatest significance. The United States is in the green cluster and has a great tendency regarding international cooperation, which means that it is one of the leaders in research cooperation around the world. China, located on the blue cluster, is a regional and international player, as it exhibits its solid investment in educational technology and a focus on mobile learning solutions.

The cluster of Iran and its neighbouring countries is thick, dark blue, which means that the co-authorship activities are high. Iran is a key player in the MALL network due to its strategic application of mobile learning technologies in its reaction to the lack of infrastructure and the emergent need to use distance-based and flexible education methods. The evidence of the national activities to improve the English language teaching in accordance with the international requirements in both academic and economic aspects is expressed by the increase in the number of participants. The fact that there are so many co-authorship networks alone is a pointer that MALL has much to boast of in terms of inter-border academic collaboration and exchange of information. This collaborative model introduces the relevance of mobile-assisted language learning in the global society and collaboration among researchers to effectively solve the problems of education concerning language acquisition strategies that can be of importance to a wide range of subjects.

Implications

The result-oriented input of the specified study to the theoretical knowledge of CMALL is significant. The bibliometric analysis applied to the current paper could trace out the literature as a whole in the history of CMALL research and isolate the most high-profile authors, along with prioritizing important networks of collaboration (Fu, 2018). It also talks about the present-day inclination of the epistemological sphere and how postmodern technologies such as artificial intelligence, mobile learning, and virtual reality are becoming increasingly important in language training.

The findings of the given research play an important role in the theoretical understanding of CMALL. The literature mapping, which was conducted in the given publication, was aimed at mapping the literature as a whole through the history of CMALL research and the most prominent authors and significant collaboration networks (Fu, 2018). It also mentions the contemporary trends in the epistemological field and the growing popularity of postmodern technologies in language teaching, like artificial intelligence, mobile learning, and virtual reality. Furthermore, the study identifies the traditional CALL models with the modern MALL practices by identifying the areas of overlap and transition. Notably, it lays out opportunities on how the concepts of sustainability can be incorporated into the technological environment of language teaching, and points to the direction in which more egalitarian and future-oriented systems of learning can be developed. With the increasing use of information technology in institutions of learning, the study findings of this research would be useful in informing the level of digital preparedness in language learning programmes. As the mobile and computer-based learning environments are becoming increasingly connected to didactic planning, business is not only encouraged to invest in the technology infrastructure, but it also encourages the formation of faculty to competently use such devices.

The results of this bibliometric research can be applied by curriculum developers and academic heads to develop student-centered, dynamic models of learning that appeal to and enhance student engagement and learning. Moreover, as sustainability is a matter of concern in education, the research findings are particularly applicable in the framework of linking technology language learning programmes to extensive sustainable development objectives. This entails the build-up of facilities which would unlock the optimum of the resources and also the building of teaching and learning conditions that would react to the dynamic needs of the society. Lastly, the paper recommends the convergence of a pedagogical innovation, technological development, and sustainability in defining the future of language teaching.

Limitations of the study

The limitations of this research include some limitations that make it play a significant contributory role. To begin with, the bibliometric analysis takes into consideration the information that is provided by the Scopus database only. This database is very familiar, and it has a lot of data in it, yet it might not be a complete picture of the CMALL research. It would have been more fruitful to add more databases, including Google Scholar or Web of Science, and find some new patterns or key publications not in Scopus. Second, the study merely introduces quantitative cues which are appropriate in the description of the trend in publishing and co-authorship networks, but it does not consider the qualitative issues of language learning strategies competitive to culture and implementation of context-based and emergent practices. The attributes are essential in the evaluation of the impacts of CMALL on different learning and geographical structures.

Scope for future study

This work also has certain interesting points that demand further research. To begin with, a bibliometric analysis would be a better choice with a greater number of sources (Web of Science and Google Scholar) to obtain a better image of the CMALL research environment. It could be implemented with the multi-database technique to disclose the new trends in citation, to form collaborative networks, and to demonstrate the problem in a more detailed and encompassing image. In addition, in future research, the effectiveness of particular technologies and methods of learning in various learning institutions can be investigated with the help of qualitative designs. This kind of study would illuminate the use, acculturation, and attitude to CMALL tools in different institutional and cultural contexts.

Since these changes can possibly influence the processes of how the future generation will acquire languages, apply new technologies, such as artificial intelligence, augmented reality, and adaptive learning algorithms, future research is necessary to find out their teaching possibilities and the problems that arise in their applications of these technologies. Lastly, the impact of CMALL in facilitating the achievement of the United Nations Sustainable Development Goals (SDGs), particularly in ensuring that all people have access to quality education, needs to be investigated in future studies. A study concerning the role of technology-mediated language learning in the formation of the conditions of sustainable and inclusive learners would contribute to the construction of academic research and future policy concerning global educational reform.

Conclusion

The current bibliometric review of CALL and MALL provided an overview of the history, focus, and diversity of the research in the field of foreign language acquisition. Kukulska-Hulme, Warschauer, and Ellis are famous names in the citation networks. This demonstrates the effectiveness of their work in developing the theories, practices, and practical applications of CALL and MALL (Liu, 2020). The intellectual direction of the region has been shaped by their contributions, which still influence the development of CALL and MALL. Thematic groups of citation networks are examined, and they attest to a wide scope of subjects of study. They are the combination of mobile and e-learning, cognitive consideration of second language learning, and neuroscience towards language learning (Yang 2013). These clusters not only increase the number of areas of research but also show the relationship between the research topics, which suggests the complexities and multidisciplinary nature of the issue (Dizon & Gayed, 2021).

Cross-border and cross-institutional cooperation is also emphasized in the report as another essential action with a view to advancing the study of CALL and MALL. The signs of intense foreign cooperation could be regarded to verify that the academic consistency can help to create innovative concepts and make the process of exchanging methods easier, more efficient, and productive in terms of the overall research results (Al Hebshi and Gamlo, 2022). This is a collaborative setting that highlights the significance of CMALL on the global level and confirms it as a vibrant and integrated field of technology-based language learning. New contributors from places like Iran, Brazil, and South Africa are joining the CALL and MALL research ecosystems. This marks the start of a new generation of worldwide participants. This development contributes to the establishment of a more inclusive and diverse research foundation, in accordance with modern academic mandates to integrate varied perspectives and underrepresented voices into global scholarship. The increasing number of international

partnerships and collaborative publications illustrates that CALL and MALL are evolving fields that continually adapt to address emerging educational challenges and leverage opportunities presented by technological and geopolitical developments.

These findings raise many recommendations for future research. To begin with, the fact that research networks have been known to be interconnected is important in the further development of CALL and MALL because it highlights the importance of multidisciplinary approaches. Researchers are urged to work together in disciplines and intertwine the viewpoints of linguistics, education, computer science, cognitive psychology, and sustainability studies in addressing both theoretical and practical matters in instruction. Second, the expansion of the participation of specialists from various regions of the world is evidence of the necessity to enhance cooperation on the international level. People worldwide must collaborate to get a complete picture of the issues, requirements, and advances in language learning in different educational, cultural, and technological environments. Briefly, the bibliometric analysis promotes the current research and development of CALL and MALL. It requires increased global collaboration, interdisciplinary research, and paradigms that cooperate to enable the field to become better and enhance language pedagogy across the globe.

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