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Bibliometric analysis of collaboration networks at the intersection of bilingual education and artificial intelligence

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RESEARCH ARTICLE

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ABSTRACT

This study aimed to examine research on the relationship between bilingual education and artificial intelligence in a holistic manner and to reveal research trends in the field through bibliometric analysis. The development of artificial intelligence technologies has transformed instructional processes in bilingual education, as it has in every area, leading to a rapidly increasing number of studies in this field. Therefore, it is important to map the structures of these studies, their collaboration networks, and their research concentrations. In this research, 54 studies published between 2020 and 2025 in the Web of Science database were analyzed. The data were examined in terms of collaboration at the author, country, and university levels. The findings show that collaboration among authors has a highly clustered and dispersed structure. It was found that collaborations intensified during certain periods, but the overall network had yet to become fully integrated. When international collaboration was analyzed, some countries occupied a central position while others pursued a more independent line of research. The inter-university collaboration network, on the other hand, exhibits a multi-centered structure, with strong institutional clusters yet to be established. Research on the use of artificial intelligence in bilingual education is a rapidly expanding field that will require more integrated collaboration models in the future. Future studies should use larger datasets, conduct network analyses in a comparative manner across different periods, and examine thematic trends in greater depth. Additionally, increasing international and institutional collaborations may be an important step in supporting the development of this field.

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1 INTRODUCTION

In recent years, the rapid development of artificial intelligence (AI) technologies has profoundly changed language education. Bilingual education is one area affected by these developments. AI has enabled the emergence of new research and perspectives in this field. The increase in AI-based systems and generative artificial intelligence capacity has transformed language-education processes (Zhang & Dong, 2024). Wei (2023) found that AI-assisted language education increases participation, offers personalized learning experiences, enhances motivation, and promotes self-regulated learning. Mohebbi's (2025) findings also revealed that AI-powered tools significantly improve language learning outcomes by encouraging participation, providing instant feedback, and facilitating personalized learning experiences. In this respect, artificial intelligence has reshaped the language teaching process and has become one of the key variables of innovation in contemporary language pedagogy.

Bilingual education is a complex process that requires individuals to use two languages, both functionally and cognitively (Bialystok & Craik, 2022; Blom et al., 2017). Therefore, the role of artificial intelligence applications in this process has become increasingly significant. Artificial intelligence technologies present new opportunities to enrich the learning experiences of bilingual students while raising important questions about cultural sensitivity and inclusivity (Ma, 2024). In this context, researchers have extensively addressed the potential of AI tools to support bilingualism development at both the pedagogical and cognitive levels (Alméciga et al., 2025; Bo, 2024; Chen et al., 2020; Rivero & Yin, 2025). Alongside its rapid growth, the field has become increasingly interdisciplinary, drawing insights from education, linguistics, cognitive science, and computer science. This diversity has resulted in a proliferation of studies with different methodological approaches, themes, and geographical distributions. This makes it difficult to obtain a coherent picture of the field's evolution. The overall landscape of research in this field, patterns of collaboration, and research directions have yet to be systematically mapped within a holistic framework.

Bibliometric analysis is an important method that examines scientific outputs, such as articles, authors, keywords, and journals in a research area, revealing how the field has developed over time and how relationships between studies have taken shape (Donthu et al., 2021). In this regard, understanding the current state of scientific production at the intersection of bilingual education and artificial intelligence, identifying research clusters and collaborations at the country and institution levels, and making thematic concentrations visible are all of critical importance. Such an analysis is particularly timely given the unprecedented acceleration in generative AI research and applications in the post-2020 period, which has intensified scholarly attention to AI-supported language learning and bilingual education. Mapping this recent body of work can clarify how research communities are forming, identify which regions and institutions are leading the field, and pinpoint potential gaps and opportunities for collaboration. Therefore, a bibliometric analysis of the literature on AI-supported bilingual education reveals the structural characteristics of current research trends and contributes to the determination of strategic orientations for future studies. In this context, this study aims to present a holistic overview of academic studies that examine the relationship between artificial intelligence and bilingual education. More specifically, it aims to reveal how scholars collaborate, how knowledge is disseminated across countries and institutions, and how the field is structured as an emerging area of research. This study seeks to answer the following questions:

1. What kind of relationship exists among the authors of studies on AI-supported bilingual education?
2. What kind of relationship exists among the countries in studies on AI-supported bilingual education?
3. What kind of relationship exists among universities in studies on AI-supported bilingual education?

2 METHODOLOGY

This study was designed using a quantitative approach. Since the aim was to analyze studies examining artificial intelligence applications in bilingual education environments, a bibliometric analysis approach was used. Through bibliometric analysis, a map of scientific output at the intersection of artificial intelligence and bilingual education was generated. Making network relationships among relevant studies visible provides valuable insights into understanding the interactions within the field. In addition, network maps demonstrating the connections among key terms will serve as a guide to identify focal points for future research. To identify studies on artificial intelligence applications in bilingual education environments, research was conducted in the Web of Science (WoS) database. The following terms were used to search for articles on the subject:

TS= ((“bilingualism” OR “bilinguality” OR “bilingual competence” OR “bilingualization” OR “bilingual education” OR “bilingual development”) AND ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR "neural network*" OR "natural language processing" OR "NLP" OR "generative AI" OR "ChatGPT" OR "large language model*" OR "LLM" OR "automated system*" OR "intelligent tutor*" OR "AI-powered" OR "AI-based" OR "AI-assisted" OR "conversational AI" OR "chatbot*" OR "adaptive learning" OR "intelligent system*"))

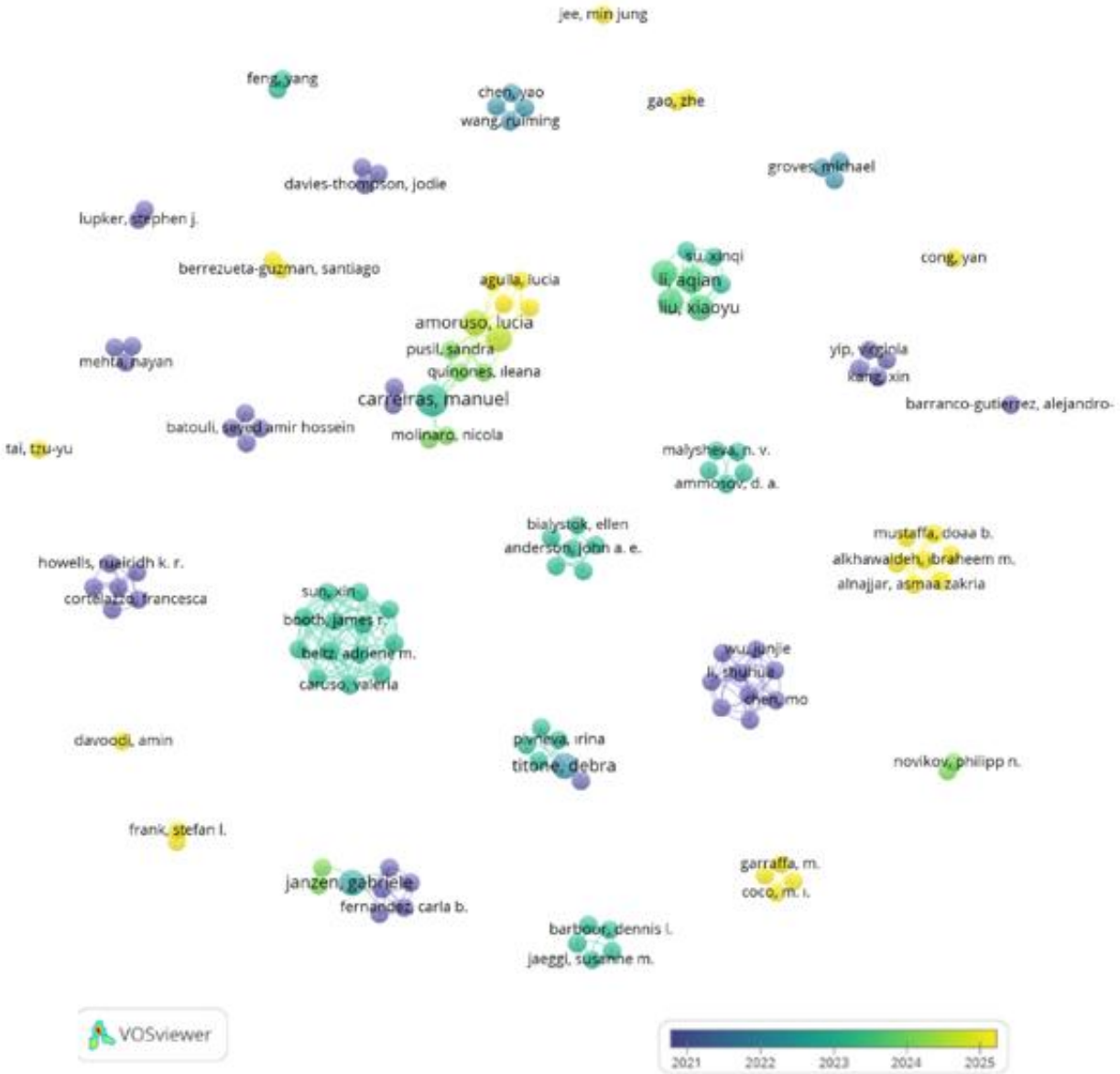
In the initial search of the WoS database, 154 studies were identified. These 154 studies consisted of 119 articles, 11 review articles, 3 book chapters, 14 conference proceedings, 5 early access publications, and 2 editorials. The selected studies spanned 2006 to 2025. Only studies from 2020 onwards, when generative artificial intelligence became widespread, were included in the analysis. This inclusion criterion ensured access to the most recent literature in the field. Only articles written in English were included, while those in other languages (three in Spanish, two in Portuguese, and one in Russian) were excluded. After applying these criteria, 64 articles remained for review. Of these, 10 studies were outside the scope of this research. Therefore, 54 studies were included in the final analysis. In the final stage, the data were analyzed in the VOSviewer application in terms of distribution by country, key concepts, and inter-university relationships. The findings obtained as a result of the analysis were interpreted.

3 FINDINGS

3.1 Artificial Intelligence-Supported Bilingual Education Research Author Collaboration Network

A total of 54 studies in the dataset were published by 128 authors. The authors collaborating in these studies and those who were not involved in collaborations are shown in Figure 1.

FIGURE 1
Author collaboration network



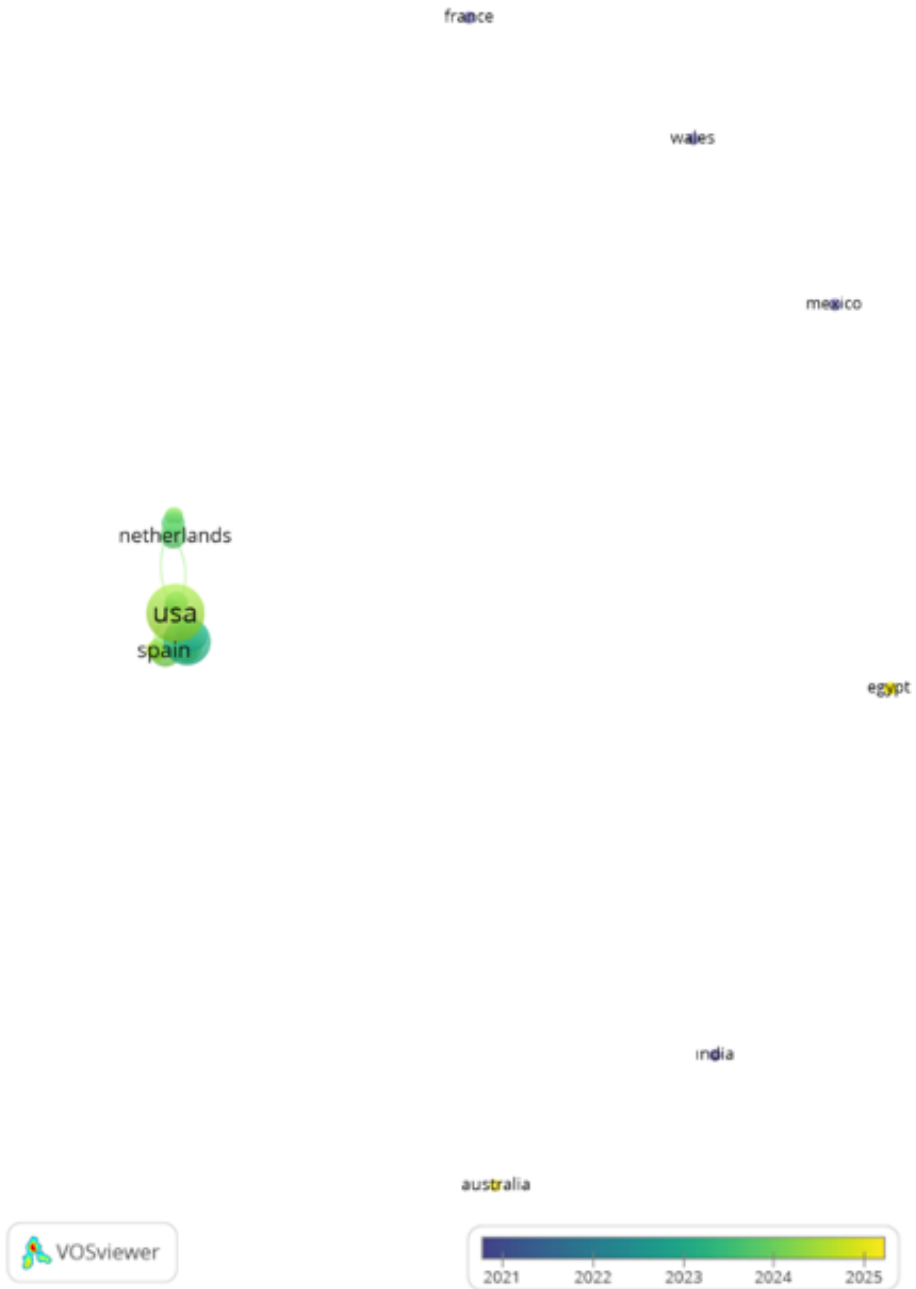
When examining the author collaboration network in artificial intelligence research in bilingual education during the 2021-2025 period, it is observed that the field displays a heterogeneous and multi-clustered structure. At the center of the network, Carreiras and Manuel stand out as the most prominent nodes, and the dense green-hued cluster formed with authors such as Nara, Molinaro, Timofeeva, and Pusil indicates that this group was the most productive research community in the field during 2022-2023. The central position of the Carreiras group and its numerous connections reveal that this group plays a leading role at the intersection of bilingual education and artificial intelligence. Soto and Sheikh, represented in purple hues and positioned close to the central cluster, indicate that these researchers were active during the 2021-2022 period and collaborated with the Carreiras group. The cluster comprising Deameh, Mustaffa, Amro, Hamad, Amro, Amin, and Alnajjar, located in the bottom right region of the network and represented by yellow tones, signifies an emerging research group in the 2024-2025 period. Similarly, the appearance of the Dolon-poza and Berrezueta-Guzman groups, as well as the Garraffa, Smith, Coco, and Spelorzi clusters in yellow tones at the lower right, demonstrates that new research groups joined the field in the 2024-2025 period. The presence of authors such as Tai, Jee, Davoodi, Cong,

and Barranco-Gutierrez, who are in isolated positions, indicates that there are also individual researchers in the field who have not yet established relationships with the main collaboration networks. Overall, considering the color transitions and clustering in the 2021-2025 period, it can be seen that research in bilingual education and artificial intelligence is undergoing a dynamic development process, that new researcher groups are joining the field, and that researchers are forming their own collaboration networks.

3.2 Artificial Intelligence-Supported Bilingual Education Research Countries Collaboration Network

The studies in the dataset were published in 24 countries. International collaborations and unrelated countries are shown in Figure 2.

FIGURE 2
International cooperation network

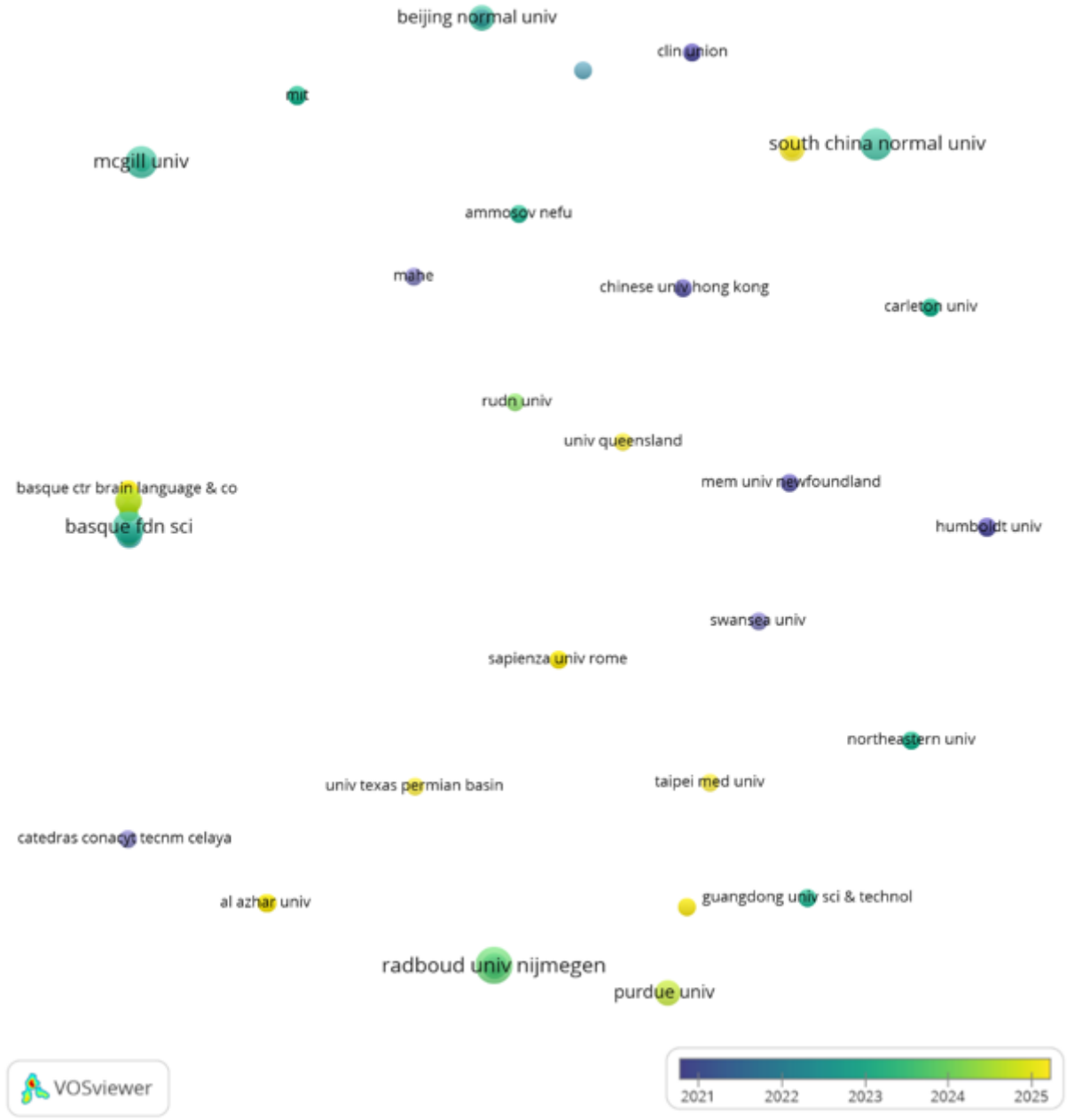


When examining the international collaboration network in artificial intelligence research within bilingual education, it was observed that global studies were concentrated around certain centers. The fact that the United States is positioned at the center of the network as the largest node and is represented with a green color tone indicates that this country is the leader in the field, both quantitatively and qualitatively. The presence of direct connections between the United States and countries such as the People's Republic of China and Russia reveals that the U.S. functions as the central node of the global research network. An important finding that stands out in the network structure is that the People's Republic of China is located close to the United States, and there is a strong connection between them. This demonstrates that the two major economies are engaged in intensive scientific collaboration in bilingual education and artificial intelligence research. Russia's inclusion in this central cluster also indicates that the field has become a shared research area among the three major powers. Conversely, countries found in isolated positions in the visualization also provide significant findings. Countries such as Australia, India, Egypt, Mexico, and France appear as independent clusters, indicating that they have not yet been integrated into the main research network. The existence of these isolated countries reveals that research on bilingual education and artificial intelligence has not yet fully globalized, and independent research traditions continue in certain geographical regions.

3.3 Artificial Intelligence-Supported Bilingual Education Research Inter-University Collaboration Network

The studies in the dataset were published by 80 universities in total. Some inter-university collaborations in these publications are presented in Figure 3.

FIGURE 3
University Collaboration Network



When examining the institutional collaboration network of artificial intelligence research in bilingual education, global universities exhibit a complex and multi-layered pattern of interaction. The positioning of Radboud, Beijing Normal, South China, and McGill University as the largest nodes at the center of the network, represented by shades of green, indicates that these institutions have been among the most productive and influential research centers in the field during the 2020-2024 period. Another significant finding highlighted in the network structure is the central position occupied by American and European universities. Similarly, the prominence of Beijing Normal, Al Azhar, Hong Kong, and South China University points to the increasing presence of research along the Asia-Middle East axis. The presence of the University of Washington, University of British Columbia, and Tianjin University indicates that the research network has an intercontinental structure; however, these connections have not yet been fully established. The depiction of institutions such as Swansea and Humboldt University in purple shade suggests that these universities were active in the early research

phases, but their activity has declined in the current period. In contrast, the representation of institutions such as Al Azhar, Sapienza, and Hong Kong Polytechnic in yellow shades demonstrates that these institutions have joined the field in recent years. Overall, the scattered and multi-centered appearance of the network structure reveals that a dominant institutional framework has not yet been formed in bilingual education and artificial intelligence research, and that the field continues to evolve in a competitive manner.

4 CONCLUSIONS

This study aimed to present an overview of the scientific output related to AI-supported bilingual education and examine collaboration patterns in the field through bibliometric analysis. The findings indicate that the field is rapidly developing and diversifying, both in terms of the distribution of studies and the structural characteristics of collaboration. The prevailing trends suggest that the field encompasses a growing research structure spanning both pedagogical and technological dimensions. This finding aligns with studies emphasizing that AI is taking on an increasingly central role in language education. For example, Zhang and Dong (2024) demonstrated that generative artificial intelligence creates structures that transform both the pedagogical and technological dimensions of language learning processes. Similarly, Alméciga et al. (2025) argue that AI-supported bilingual education needs to be reconsidered within a meaningful learning framework. In this context, the diversified and expanding structure revealed by the current study shows that the field is not only growing quantitatively; it is also evolving into a multidimensional area of research in which pedagogical approaches and technological innovations are intricately intertwined.

Based on the findings regarding the author collaboration network, it can be said that production in the field displays a highly clustered and fragmented structure, while collaborations develop within a dynamic network that intensifies during certain periods. These findings show that research communities have yet to achieve a fully integrated structure, but the discipline may evolve into a stronger and more sustainable research network over time. Bibliometric studies in the literature show that collaboration networks generally emerge in fragmented and clustered structures in new and rapidly developing fields (Donthu et al., 2021). This situation is even more pronounced in interdisciplinary fields such as AI and bilingual education, as researchers come from different academic traditions. The fragmented structure observed in this study suggests that the field is still maturing. However, periods of intensified collaboration indicate that more integrated and sustainable research communities may emerge in the future.

Findings on the international collaboration network reveal that certain countries hold a central position in scientific output, while many others continue their research activities independently of them. This indicates that bilingual education and AI research have yet to achieve a truly global collaboration model. This result parallels the core-periphery structure observed in artificial intelligence research in general. The findings indicate that AI-assisted bilingual education has not yet fully evolved into a global research network, with knowledge production concentrated in certain geographic regions. This situation also brings the risk that different sociocultural contexts may not be adequately represented.

Regarding inter-university collaboration, the findings reveal that the field is developing in a highly decentralized and competitive structure, and although research networks display intercontinental mobility, they remain only partially integrated. This may be due to academic collaborations among higher education institutions in rapidly developing areas such as AI and bilingual education, which are largely shaped by the distribution of resources, research infrastructure, and expertise. Therefore, the findings demonstrate that a dominant institutional network for inter-university collaboration has not been formed and that, in the coming years, the field may evolve toward more integrated research centers.

5 PRACTICAL IMPLICATIONS

The findings indicate that research output in the field of AI-supported bilingual education is rapidly increasing; however, the author demonstrates that collaborations at the author, country, and institutional levels largely exhibit a fragmented and multi-centred structure. This structure reveals that the development of the field requires not only the production of new studies but also the more systematic application of existing knowledge. From the teachers' perspective, the classroom use of AI-supported bilingual teaching applications should be clearly linked to pedagogical goals. The findings show that the pedagogical and technological dimensions of the field are developing together. In this regard, teachers should use AI tools not merely as assistive technologies, but as conscious pedagogical tools aimed at balancing the two languages, providing personalised feedback, and supporting students' cognitive processes. School-based professional development activities can be structured to strengthen teachers' abilities to integrate these tools into their lesson plans, interpret the outcomes, and reflect them in their classroom decisions. The findings point to the importance of institutional coordination for the widespread adoption of AI-supported bilingual applications, particularly for school administrators and institutions. Due to the fragmented structure of research networks, partnerships between schools and universities could facilitate the sharing of good practices, the development of common materials, and the systematic accumulation of teacher experiences. Thus, an institutional learning culture can reflect the fragmented knowledge production in the field more consistently. These findings indicate that universities and teacher training programs should integrate courses and modules addressing bilingual education and artificial intelligence into their programs. Teacher candidates who gain AI literacy and learn to use these technologies for bilingual pedagogical purposes can directly improve the quality of classroom practices after graduation. Thus, the field's multi-centered structure can transform into an integrative perspective within the teacher training process. The study indicates to policymakers and decision-makers that AI-supported bilingual education requires not only technological investments, but also pedagogical guidance and implementation frameworks. Central-level guidelines, ethical principles, and usage standards can help teachers and institutions use these technologies more safely and effectively. Furthermore, platforms for sharing best practices that emerge in different countries and institutions could contribute to a more cohesive implementation structure in the field.

6 LIMITATIONS AND FUTURE DIRECTIONS

This research is limited to the bibliometric analysis method and includes only English articles indexed in the Web of Science Database. Therefore, studies published in different databases, research conducted in other languages, and various academic outputs such as books, theses, or conferences were not included in the analysis, which may have constrained a fully comprehensive outlook of the results. Additionally, because this study focuses on the period after 2020, the developmental trajectory of the relationship between artificial intelligence and bilingual education in previous years was excluded. The technical limitations of the software used to identify collaboration networks, as well as the fact that certain types of relationships are more strongly reflected in visualizations, may also have affected the depth of the analysis. Considering these limitations, while the results provide a general overview of current trends, they do not offer a comprehensive representation of the entire field. Therefore, future research could offer a more holistic view by combining different databases, examining broader time periods, and including multilingual content in the analysis. From teachers' perspectives, increasing empirical studies that investigate the classroom effectiveness of AI-supported bilingual teaching practices could support teachers' pedagogical decision-making and enhance their capacity to consciously use technology. Researchers, on the other hand, could conduct qualitative and mixed-methods studies that question the reasons behind the fragmented collaboration structures observed at the author, country, and institutional levels. They could also develop new collaborative models that provide deeper analyses of thematic trends.

DECLARATIONS

Author Contributions

MB: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – Original Draft, Writing – Review & Editing, Visualization, Supervision, Project administration.

Conflict of Interest

The author declares no potential conflicts of interest.

Ethics Committee Approval

Not applicable.

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AI Declaration

No AI tools were used in this study.

Data Availability Statement

The datasets analyzed during the current study are available from the author on reasonable request.

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