

Mapping Trends in Early Childhood Education Research in Support of SDG 4: A Bibliometric Analysis (2015–2025)

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ABSTRACT

This study examines the development of Early Childhood Education (ECE) research in supporting Sustainable Development Goal 4 (SDG 4) through a bibliometric analysis of 661 Scopus-indexed articles and review papers published between 2015 and 2025. Using Biblioshiny and VOSviewer, the study analyzes publication trends, thematic structures, core journals, and international collaboration patterns. The results show that research is primarily centered on established themes such as early childhood education and human development, which serve as key drivers of the field. Core journals play an important role in shaping knowledge dissemination and the intellectual structure of ECE research. However, emerging topics, including digital integration, inclusive education, and community-based approaches, remain underexplored. The findings also reveal that global research collaboration is dominated by developed countries, particularly the United States, Australia, and the United Kingdom, while contributions from developing countries are relatively limited. These results highlight the need to diversify research themes and strengthen international collaboration to enhance the contribution of ECE research toward achieving SDG 4. The study provides useful insights for researchers, policymakers, and practitioners in identifying research gaps and future directions in early childhood education.

Keywords: Early Childhood Education, SDG 4, Bibliometric Analysis, Research Trends, Thematic Mapping, Global Collaboration, Quality Education

INTRODUCTION

Early childhood education (ECE) has been recognised as a strategic foundation for sustainable human resource development. Within the framework of global development, the United Nations, through its Sustainable Development Goals (SDGs) agenda, has positioned education as a key pillar, particularly through Goal 4 (SDG 4), which emphasises the importance of inclusive, equitable and quality education for all (Uğraş et al., 2025). Specifically, Target 4.2 states that access to quality ECE services is a crucial prerequisite for learning readiness and long-term educational success (Erikson, 1993). This indicates that investment in ECE has multidimensional impacts, including on social, economic, and public health aspects (Neumann, 2022). In recent years, academic attention to ECE has seen a significant increase. This is marked by a rise in the number of publications exploring various dimensions of early childhood education, ranging from developmentally-based pedagogy, inclusive education, to the integration of digital technology in learning (Paluck, 2015). This development reflects a paradigm shift from traditional approaches towards a more holistic and interdisciplinary approach to understanding children's learning processes. Furthermore, research also indicates that the quality of teacher-child interactions, the learning environment, and family involvement are key factors in determining the success of ECE programmes (Anderson et al., 2022).

Nevertheless, the increasing number of publications is not always accompanied by a comprehensive understanding of the direction and structure of research developments in this field. Therefore, an approach is required that can systematically identify patterns,

trends and the dynamics of knowledge development. One relevant approach is bibliometric analysis, which enables a quantitative exploration of scientific publications to reveal the intellectual structure of a field of study (Rahmanisa et al., 2021). This method has been widely used across various fields of education to identify dominant themes, collaborative networks, and the evolution of research over time (Aria & Cuccurullo, 2017). In the context of early childhood education (ECE) and SDG 4, a bibliometric approach is crucial for assessing the extent to which existing research has contributed to the global education agenda. Several previous studies have conducted bibliometric analyses in the field of education, but most remain general in nature and have not specifically linked ECE research to the SDG targets (Hallinger & Chatpinyakoo, 2019). Yet, such mapping is necessary to identify research gaps, whether in terms of geographical distribution, thematic focus, or methodological approaches.

The period 2015–2025 is a significant timeframe to examine, given that the implementation of the SDGs began in 2015. During this period, various educational policies and innovations have been developed to support the achievement of SDG 4, including within the early childhood education sector (Yang, 2022). Therefore, an analysis of scientific publications during this period can provide an insight into the academic community's response to this global agenda, as well as the direction of early childhood education research in supporting inclusive and quality education. Against this background, this study aims to map trends in ECE research in support of SDG 4 using a bibliometric approach. Specifically, the study focuses on analysing publication trends, researcher collaboration, geographical distribution, and the evolution of research themes during the 2015–2025 period. Furthermore, this study seeks to identify research gaps that may serve as a basis for future studies. Consequently, the findings of this study are expected to make theoretical and practical contributions to the development of ECE literature and support the formulation of evidence-based education policies.

METHOD

Dataset establishment

This study employed a bibliometric approach to analyse global research trends in early childhood education (ECE) in relation to Sustainable Development Goal 4 (SDG 4). The Scopus database was selected as the primary source of data because it is recognised as one of the largest and most authoritative international databases for peer-reviewed scientific publications, widely used in bibliometric and scientometric studies (Corrales-Garay et al., 2024). The use of a single comprehensive database also ensured consistency in data indexing and citation analysis.

The data search process was conducted systematically on 8 December 2025 using the Scopus advanced search feature. The search strategy was developed to capture publications related to ECE and quality education within the SDG 4 framework. The following search query was applied: TITLE-ABS-KEY (“early childhood education*”) AND (TITLE-ABS-KEY (“quality education*”) OR TITLE-ABS-KEY (“child education*”) OR TITLE-ABS-KEY (“SDG 4”))

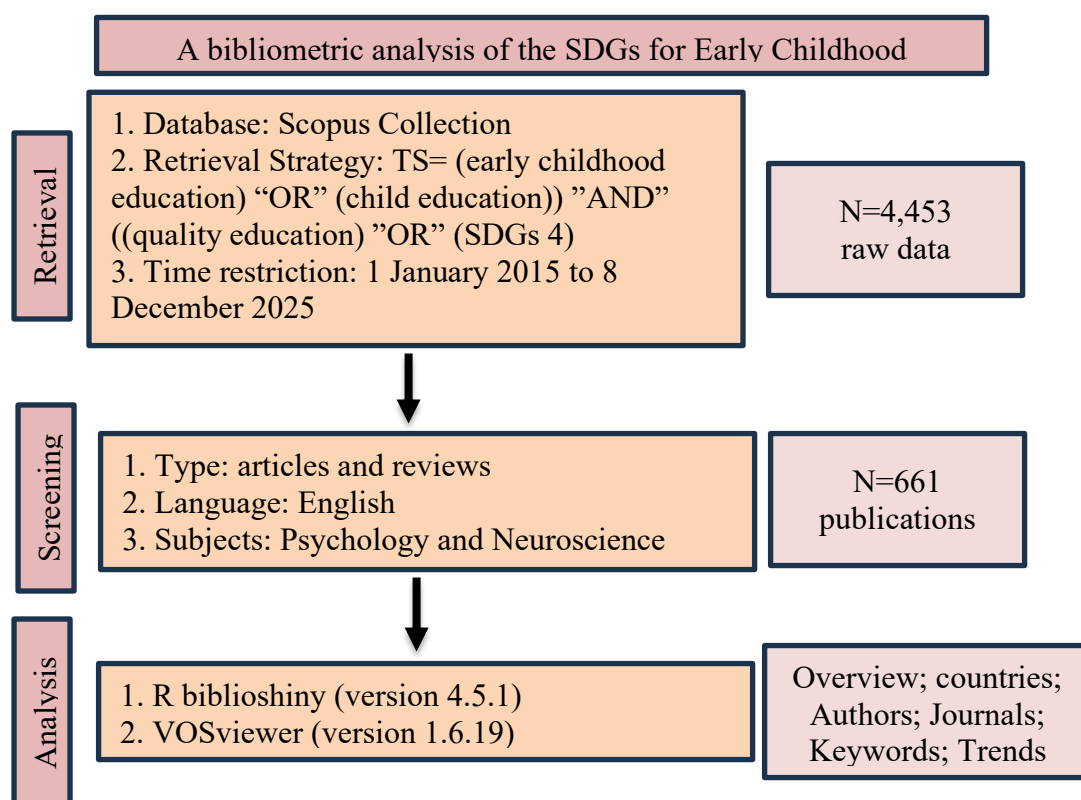


Figure 1. Prisma Flow Chart

The search was limited to publications indexed in the Science Citation Index Expanded (SCIE) to ensure the inclusion of high-quality and internationally recognised scholarly works (Donthu et al., 2021). Furthermore, only documents published in English were included to maintain consistency in analysis and interpretation.

To ensure transparency and replicability, clear inclusion and exclusion criteria were established prior to the screening process. The inclusion criteria were 1) Publications focusing on early childhood education in relation to quality education or SDG 4; 2) Peer-reviewed journal articles and review articles; 3) Publications indexed in Scopus; 4) Publications written in English.

Meanwhile, the exclusion criteria included: 1) Conference proceedings, meeting abstracts, editorials, letters, notes, and book chapters; 2) Unpublished or non-peer-reviewed manuscripts; 3) Duplicate or retracted publications; 4) Publications unrelated to the objectives of the study.

The screening process was conducted independently by two authors (RW and BCJ) to minimise selection bias and improve the reliability of the dataset. Any disagreements regarding publication eligibility were discussed and resolved through consultation with a third author (QYL) (Jiang et al., 2025). This procedure aligns with recommendations from systematic review and bibliometric research methodologies to enhance consistency and objectivity in data selection.

After the screening process, all bibliographic information, including titles, authors, affiliations, abstracts, keywords, citations, and references, was exported in plain text format for further analysis. The overall data collection and screening procedures are presented in Figure 1 using the PRISMA flowchart framework, which provides a transparent overview of the identification, screening, eligibility, and inclusion stages.

Ethical approval was not required for this study because all data were obtained from publicly accessible scientific databases and did not involve human participants.

Database Analysis

The filtered bibliographic data were imported into Biblioshiny and VOSviewer (version 1.6.19) for bibliometric and visual network analysis. Biblioshiny, supported by the Bibliometrix package (version 4.5.1) within the R environment, was used to analyse publication trends, country collaborations, source impact, thematic evolution, keyword trends, and author productivity (Aman & Botte, 2017). The software was selected because it provides comprehensive quantitative bibliometric analysis through an interactive and reproducible interface.

Meanwhile, VOSviewer was utilised to construct and visualise co-occurrence networks, collaboration maps, and thematic relationships among keywords. This software is widely used in bibliometric studies due to its strong capability in mapping scientific knowledge structures and identifying research clusters.

Several bibliometric indicators were employed in this study. Total Publications (TP) were used to measure research productivity, while Total Citations (TC) and Local Citations (LC) were used to assess academic influence both globally and within the specific research field. The Hirsch Index (H-index) was applied to evaluate the productivity and citation impact of authors or sources. In addition, the Multiple Country Publication (MCP) ratio was used to measure the extent of international research collaboration. Journal quality and scientific influence were further examined using Impact Factor (IF) and Journal Citation Reports (JCR) quartile classifications. Bradford's Law was also applied to identify core journals that play a dominant role in disseminating ECE research.

RESULT AND DISCUSSION

Thematic Map

Analysis of the thematic map reveals the intellectual structure of early childhood education (ECE) research in relation to SDG 4 based on two main dimensions: centrality (the relevance of a theme within the research field) and density (the level of thematic development). This mapping produces four quadrants representing the position and maturity of themes within the global ECE research landscape (Albaik & Muhsen, 2025). The themes “early childhood education” and “human” are located in the motor themes quadrant, indicating high centrality and density. This finding suggests that these themes are not only conceptually mature but also highly influential in shaping the direction of ECE research globally. The dominance of these themes reflects the continued emphasis on children's holistic development, including cognitive, social, and emotional growth, which is consistent with constructivist and developmental theories proposed by scholars such as Piaget and Vygotsky, who emphasised the importance of social interaction and developmental readiness in children's learning processes (Widajati & Mahmudah, 2022). Furthermore, this focus strongly aligns with SDG 4, particularly Target 4.2, which highlights the importance of ensuring access to quality early childhood development and pre-primary education.

The relatively large bubble size associated with these themes indicates their high frequency of occurrence in scientific publications, confirming that “early childhood education” has become a mainstream and well-established research area. Similar findings have been reported in previous bibliometric studies, which identified ECE as one of the

most rapidly expanding educational research fields due to growing international concern regarding educational equity and lifelong learning outcomes. However, the concentration on broad and established themes may also suggest that research continues to prioritise general developmental issues rather than exploring more innovative or context-specific topics, such as digital learning environments, culturally responsive pedagogy, or climate-related education for young children.

Meanwhile, themes such as “preschool child” and “child, preschool” appear within the niche themes quadrant, characterised by high density but low centrality. This indicates that these topics are well-developed internally yet remain weakly connected to the broader research structure. These findings imply a strong tendency towards specialised and micro-level studies focusing on individual child development rather than systemic issues such as policy reform, access inequality, or educational sustainability. This pattern is consistent with Bronfenbrenner’s ecological systems theory, which highlights the importance of examining child development within multiple contextual layers. Nevertheless, the limited integration of these themes into broader educational discourse indicates the need for stronger connections between child-centred studies and macro-level educational challenges.

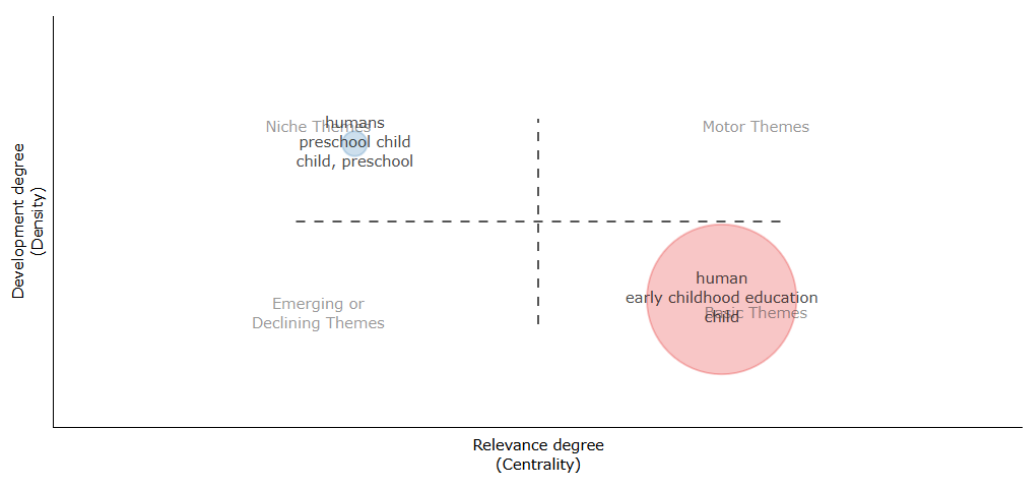


Figure 2. Thematic Map

The emerging or declining themes quadrant appears relatively sparse, indicating limited exploration of new or transformative research directions. This finding may reflect the stability of ECE research themes over time, but it may also suggest insufficient attention to contemporary educational challenges, including inclusive education, digital transformation, artificial intelligence in learning, and community-based educational models (Henry et al., 2024). Previous studies have emphasised that innovation in ECE research is essential for responding to rapid social and technological changes affecting children’s learning environments. Therefore, the lack of dominant emerging themes highlights significant opportunities for future research development.

As for the basic themes quadrant, its relatively weak presence suggests that most central themes in ECE research have already reached a mature stage of conceptual development. However, this may also indicate a limited emergence of new foundational concepts capable of reshaping the field. Overall, the findings demonstrate that global ECE research remains dominated by established and general themes, while innovative and contextually diverse topics remain underdeveloped. These results imply that although ECE research has contributed substantially to the educational dimension of SDG 4,

greater thematic diversification is still required to address issues of inclusivity, technological adaptation, and contextual educational needs.

Thus, the thematic map not only illustrates the current intellectual structure of ECE research but also provides strategic insights for future scholarly development. Future studies should seek to integrate specialised themes into mainstream discourse and expand research on innovative and context-responsive educational approaches. Such efforts are essential for strengthening the contribution of ECE research to the achievement of SDG 4, particularly in promoting inclusive, equitable, and high-quality education for all children.

Core Sources

The visualisation of publication sources demonstrates a pattern consistent with Bradford's Law, whereby a relatively small number of journals contribute the majority of publications within a specific research field. The steep downward curve observed in the graph indicates a strong concentration of ECE research publications within several highly productive journals, followed by a long-tail distribution across many less productive sources. This pattern reflects the existence of a core group of journals that function as the primary channels for scientific communication and knowledge dissemination in ECE research.

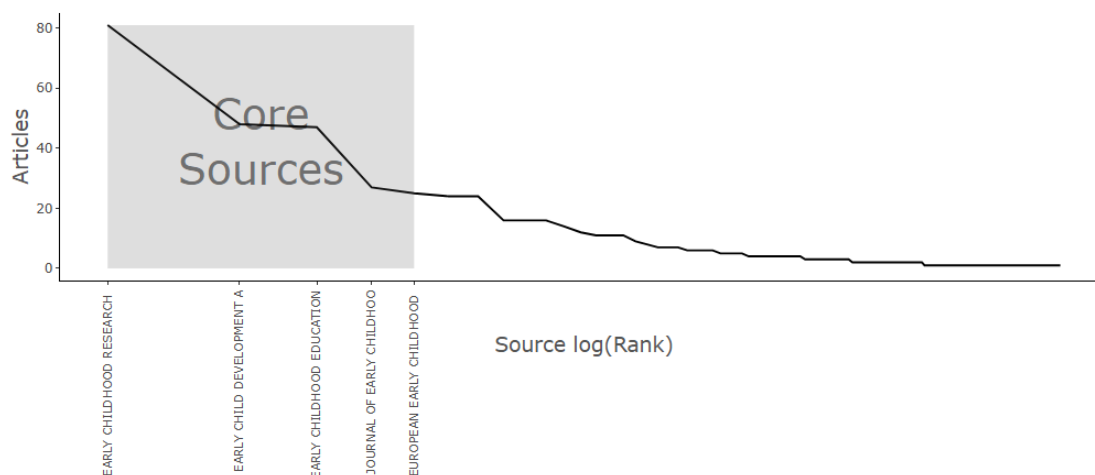


Figure 3. Article Sources

The core journals identified in this analysis, including *Early Childhood Research Quarterly*, *Early Child Development and Care*, *Early Childhood Education Journal*, *Journal of Early Childhood Research*, and *European Early Childhood Education Research Journal*, play a significant role in shaping the theoretical and methodological development of the field. The dominance of these journals reflects their academic credibility, strong peer-review standards, and relevance to current issues in ECE. Previous studies have similarly identified these journals as influential publication outlets due to their high citation impact and international readership. Their prominence also demonstrates how scientific knowledge in ECE tends to be consolidated within specialised academic communities (Okada et al., 2025).

From a theoretical perspective, the concentration of publications within core journals can be interpreted through the lens of scientific communication theory, which suggests that knowledge production is often centralised in highly visible academic platforms that shape research agendas and paradigms. In this context, these journals not only disseminate findings but also influence methodological trends, research priorities,

and policy discussions related to ECE. This is particularly important for advancing SDG 4, as high-quality publication platforms facilitate the global exchange of evidence-based educational practices and innovations.

However, beyond the core journals, the sharp decline and flattening of the curve indicate the widespread distribution of ECE research across multidisciplinary journals. This finding suggests that ECE is increasingly connected to other fields such as developmental psychology, public health, sociology, and educational policy. Such interdisciplinary expansion reflects the complex and multidimensional nature of early childhood education, which cannot be examined solely from a pedagogical perspective (Odagiri et al., 2020). Previous research has shown that interdisciplinary collaboration contributes to broader and more holistic understandings of children's learning and development.

These findings also carry important implications for publication strategies and global research participation. On the one hand, the existence of core journals provides clear guidance for researchers seeking reputable and impactful publication outlets. On the other hand, the concentration of influence within a limited number of journals may create inequalities in research visibility, particularly for scholars from developing countries who may face barriers related to language, publication costs, and limited institutional support. Consequently, researchers from underrepresented regions may struggle to contribute to the global academic discourse despite possessing valuable contextual insights relevant to SDG 4. Therefore, strengthening research quality, international collaboration, and academic capacity-building initiatives is essential to ensure more equitable participation in high-impact publications. Supporting researchers from developing countries is particularly important for generating context-sensitive evidence that addresses local educational challenges, including access inequality, poverty, and educational inclusion.

Overall, this analysis demonstrates that the ECE publication landscape remains centred on several influential journals that shape the global direction of scientific development. At the same time, the growing diversity of publication sources reflects the interdisciplinary and evolving nature of the field. Accordingly, efforts to support SDG 4 should not only prioritise publication in core journals but also encourage broader interdisciplinary collaboration and more inclusive knowledge dissemination practices.

Country Collaborations

The analysis of international collaboration reveals an unequal distribution of scientific contributions within ECE research, with developed countries dominating global publication and collaboration networks. The United States occupies the leading position in both publication output and international collaboration intensity, followed by Australia and the United Kingdom. This dominance reflects strong research infrastructures, substantial funding availability, and extensive academic networks within these countries. Such findings are consistent with global higher education theories, which suggest that countries with greater economic and institutional capacity tend to produce more internationally visible research (Khasanah et al., 2023).

The distinction between Single Country Publications (SCP) and Multiple Country Publications (MCP) further highlights the level of research internationalisation. The United States demonstrates a high proportion of MCPs, indicating strong engagement in cross-national collaboration. Previous studies have shown that international collaboration is positively associated with higher research quality, broader dissemination, and increased citation impact. Collaborative research also facilitates the exchange of diverse

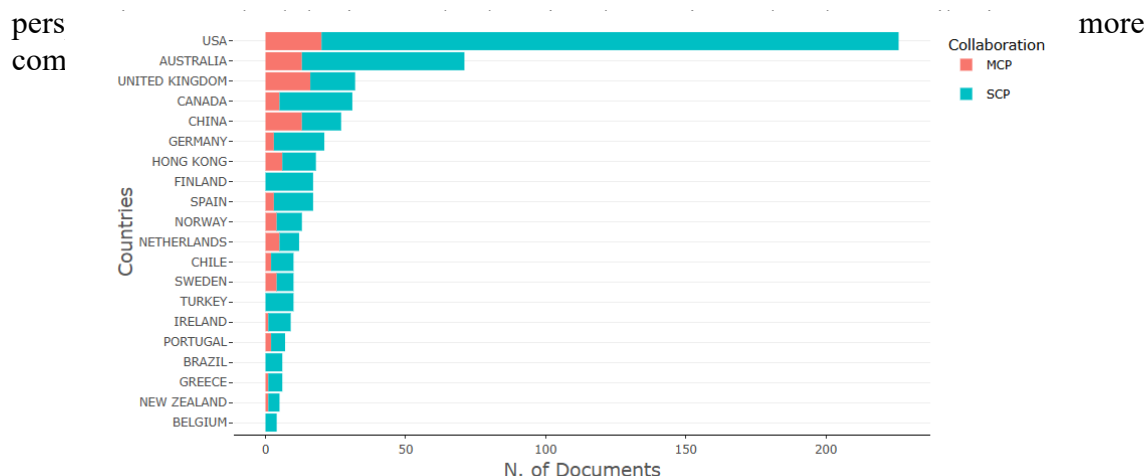


Figure 4. Document Production Over Time

Similarly, Australia and the United Kingdom demonstrate significant collaborative engagement, particularly in areas related to inclusive education, curriculum quality, and child development. The strong collaboration networks among these countries reflect shared educational priorities and long-standing traditions in ECE research. These collaborations contribute to the advancement of evidence-based educational policies and innovative teaching approaches that support children's developmental outcomes.

However, the findings also reveal significant geographical disparities in global knowledge production. Developing countries in Asia, Africa, and Latin America remain underrepresented in international collaboration networks. This imbalance is concerning because educational contexts in these regions often involve unique challenges related to poverty, educational access, teacher quality, and cultural diversity, all of which are highly relevant to the achievement of SDG 4 (Emeka et al., 2025). The limited visibility of research from developing countries suggests that global ECE discourse may not yet fully represent diverse educational realities and needs.

Several factors may explain this disparity, including limited research funding, restricted access to high-impact journals, language barriers, and insufficient international academic networks. From the perspective of equity in knowledge production, these barriers highlight the importance of creating more inclusive global research ecosystems. Previous literature has emphasised that equitable international collaboration is essential not only for academic advancement but also for addressing global educational inequalities through contextually relevant solutions.

The implications of these findings for SDG 4 are substantial. International collaboration enables the sharing of best practices, promotes innovation in educational approaches, and strengthens collective efforts to improve the quality and inclusiveness of ECE systems worldwide (Kang & Xu, 2025). Therefore, increasing participation from developing countries is crucial for ensuring that global educational policies and research outcomes reflect diverse social, cultural, and economic contexts.

To address these disparities, more inclusive collaboration strategies are needed, including cross-border funding schemes, joint research initiatives, academic exchange programmes, and capacity-building support for researchers in developing countries. Such initiatives can strengthen research capabilities and improve the representation of underrepresented regions in global ECE scholarship.

Overall, the analysis demonstrates that international collaboration in ECE research remains heavily concentrated among developed nations with strong academic networks.

Nevertheless, expanding collaboration opportunities for developing countries is essential for building a more inclusive, representative, and contextually responsive research ecosystem. Strengthening global collaboration will ultimately enhance the contribution of ECE research towards achieving SDG 4, particularly in promoting equitable and high-quality education for all children worldwide.

CONCLUSION

This study aims to map trends in early childhood education (ECE) research in support of the Sustainable Development Goals, particularly SDG 4, using a bibliometric approach covering the period 2015–2025. The results of the analysis indicate that the global research landscape on ECE is dominated by established key themes, particularly those related to *early childhood education* and human development, which act as *driving themes* with high levels of relevance and development. This indicates that ECE research has a strong conceptual foundation and makes a significant contribution to the global education agenda. In terms of publication structure, the findings indicate a concentration of articles in a number of core journals (*core sources*) that serve as hubs for the production and dissemination of knowledge. This pattern confirms the existence of dominant publication channels in shaping the direction of early childhood education research, whilst also highlighting the importance of appropriate publication strategies for researchers to enhance visibility and scientific impact. However, the long-tail distribution of publications also reflects the multidisciplinary nature of this field, which opens opportunities for the integration of cross-disciplinary perspectives.

Meanwhile, an analysis of international collaboration reveals geographical disparities in knowledge production, with a dominance of developed nations such as the United States, Australia, and the United Kingdom. The high level of international collaboration in these countries contributes to the strengthening of global academic networks and the improvement of research quality. Conversely, the involvement of developing countries remains relatively limited, necessitating strategic efforts to enhance inclusivity within the global research ecosystem. Overall, this study confirms that whilst the contribution of early childhood education research to SDG 4 has been quite substantial in fundamental aspects, there remain gaps in terms of thematic diversity, geographical distribution and international collaboration. Therefore, future research should focus on developing innovative themes such as inclusive education, the integration of digital technology, and locally-contextualised approaches. Furthermore, strengthening cross-national collaboration, particularly by involving developing countries, is a crucial step towards creating a more equitable and just distribution of knowledge.

Thus, the findings of this study not only provide a comprehensive overview of trends in early childhood education research but also offer strategic implications for the development of research and educational policies that are more responsive to global challenges, whilst making a tangible contribution to realising inclusive, equitable, and high-quality education for all.

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