Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Vol. 12, No. 3 : September 2026
E-ISSN: 2442-7667
pp. 1152-1162
Email: jklppm@undikma.ac.id

From Ethnocultural Knowledge to Systems Thinking: Mapping Global Research on Ethno-ESD in Elementary Education

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Abstract: This study aims to analyze global research trends, thematic evolution, and research characteristics related to Ethno-ESD and systems thinking in elementary education using a bibliometric approach. The study employed bibliometric analysis using Biblioshiny within the Bibliometrix package in RStudio. A total of 44 documents published between 2017 and 2026 were retrieved from the Scopus database and analyzed, representing 33 sources. The analysis focused on publication trends, authorship patterns, citation metrics, and thematic mapping based on keyword co-occurrence. Thematic analysis was conducted to identify and interpret recurring themes and patterns across research topics and keywords. The findings revealed an annual growth rate of 8.01%, indicating increasing scholarly interest in the topic. The dominant motor themes were sustainable development, education, and learning, suggesting that sustainability-oriented educational practices remain central to current research. The collaboration index indicated a moderate level of international research collaboration. These findings suggest that research on Ethno-ESD and systems thinking in elementary education is evolving toward interdisciplinary and sustainability-focused learning approaches. This study contributes to the identification of future research directions and provides a scientific basis for integrating local wisdom and systems thinking into sustainable elementary education practices.

Article History
Received: 28-06-2026
Revised: 30-07-2026
Accepted: 16-08-2026
Published: 20-09-2026

Key Words:
Ethno-ESD; System Thinking; Elementary Education; SDG 4; Bibliometric Analysis.

How to Cite: Mulyadiprana, A., Hamdu, G., Merliana, A., Mulyati, S., Yulianto, A., & Hamzah, R. M. (2026). From Ethnocultural Knowledge to Systems Thinking: Mapping Global Research on Ethno-ESD in Elementary Education. *Jurnal Kependidikan : Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran, Dan Pembelajaran*, *12*(3), 1152-1162. https://doi.org/10.33394/jk.v12i3.22094

https://doi.org/10.33394/jk.v12i3.22094

Introduction

Education in the twenty-first century is shifting from knowledge transmission toward holistic and transformative learning that develops learners' capacity to respond to complex social, environmental, and cultural challenges. This transformation is closely aligned with Education for Sustainable Development (ESD) and the Sustainable Development Goals (SDGs), particularly SDG 4, which emphasizes inclusive, equitable, and quality education (Verma & Dhaigude, 2026). Beyond transmitting sustainability-related knowledge, contemporary ESD increasingly emphasizes contextual learning, learner agency, critical thinking, and competencies that enable students to understand and respond to interconnected sustainability challenges (Sari et al., 2025). Consequently, sustainability education requires approaches that connect global sustainability agendas with learners' immediate cultural, social, and ecological realities.

Within this context, Ethno-Education for Sustainable Development (Ethno-ESD) provides an important pathway for grounding sustainability education in indigenous knowledge, local wisdom, and culturally embedded practices. Local knowledge accumulated across generations contains ecological and social understandings that can support environmental conservation, sustainable resource management, and cultural continuity. Its

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integration into education can therefore make sustainability learning more meaningful by connecting curricular concepts with students' everyday environments and cultural experiences (Marsandi et al., 2025). Rather than positioning local wisdom merely as cultural content, Ethno-ESD can function as a contextual foundation through which students examine how communities interact with and depend upon their surrounding socio-ecological systems.

However, contextualizing sustainability through local wisdom alone may not be sufficient to address the complexity of contemporary sustainability problems. Issues such as climate change, biodiversity loss, and resource depletion involve multiple interacting factors, feedback processes, and consequences across social, economic, and environmental dimensions. Systems Thinking is therefore particularly relevant to ESD because it enables learners to examine relationships, patterns, interdependencies, and consequences rather than viewing sustainability issues as isolated problems. Recent research demonstrates the growing role of Systems Thinking in sustainability education and its potential to strengthen interdisciplinary learning, inquiry, problem-solving, and higher-order thinking (Bozkurt & Bozkurt, 2024; Nguyen et al., 2026; Peretz, 2025). Importantly, empirical evidence indicates that Systems Thinking can be developed at the elementary level when students engage with accessible qualitative system models and contextual learning experiences (Frey et al., 2025).

The integration of Ethno-ESD and Systems Thinking is particularly important at the elementary education level because young learners benefit from learning experiences that connect abstract ideas with familiar social, cultural, and environmental contexts (Yulianto et al., 2026). Ethno-ESD provides meaningful local contexts through which students can observe relationships between people, culture, resources, and the environment, while Systems Thinking provides a cognitive lens for interpreting these relationships. Ethno-ESD therefore requires Systems Thinking to move beyond the transmission of local practices toward understanding their ecological, social, and long-term sustainability implications. Conversely, Systems Thinking benefits from Ethno-ESD because local wisdom provides concrete and culturally meaningful contexts through which otherwise abstract system relationships can be explored. Their integration consequently creates a complementary relationship in which local wisdom serves as a contextual foundation for developing Systems Thinking, while Systems Thinking supports the interpretation, evaluation, and continued relevance of local wisdom in addressing contemporary sustainability challenges (Thian et al., 2026).

Recent research trends further indicate increasing scholarly attention to sustainability education, Systems Thinking, critical thinking, environmental education, social justice, and culturally responsive learning (Tafese & Kopp, 2025; E. Bozkurt, 2023; Yakub et al., 2025). This convergence suggests a broader movement toward integrated educational frameworks that connect sustainability competencies with contextual and culturally responsive pedagogies. Nevertheless, research examining the intersection of Ethno-ESD and Systems Thinking remains limited, particularly in elementary education. Existing studies tend to examine indigenous or local knowledge integration and Systems Thinking as separate educational approaches, leaving insufficient understanding of how their integration can support sustainability-oriented learning among young learners.

Therefore, this study addresses the emerging research gap by examining the relationship between Ethno-ESD and Systems Thinking in elementary education. Specifically, it seeks to map the development of research in this intersection, identify influential publications, authors, and collaboration patterns, and examine emerging thematic directions through bibliometric and thematic analysis. By identifying how these concepts have been connected in the existing literature, the study aims to provide a foundation for future research and educational development that positions local wisdom and Systems

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Thinking as mutually reinforcing components of sustainability-oriented elementary education.

Research Method

This study uses bibliometric methods to understand global research trends in a specific field based on academic publications in the Scopus database. In this study, bibliometric methods are used to identify and explain research trends on Ethno-ESD and systems thinking skills in elementary school education. The main topic of this study is research articles contained in abstracts and titles related to ethnoscience, ESD, systems thinking, and elementary school education. The oldest publication was in 2017 and the latest publication was in 2026 with the following search code: (TITLE-ABS-KEY "System* Thinking" OR "Systems Thinking")) AND TITLE-ABS-KEY ("Ethnoscience" OR "Ethno-ESD" OR "Indigenous Knowledge" OR "Local Wisdom") AND TITLE-ABS-KEY (("ESD" OR "Education for Sustainable Development") AND TITLE-ABS-KEY ("Elementary School" OR "Primary Education" OR "Primary School")). The data was then filtered based on title, abstract, and keywords. Data collection was limited to research published between 2017-2026. For more details, it is presented in the following Figure 1.

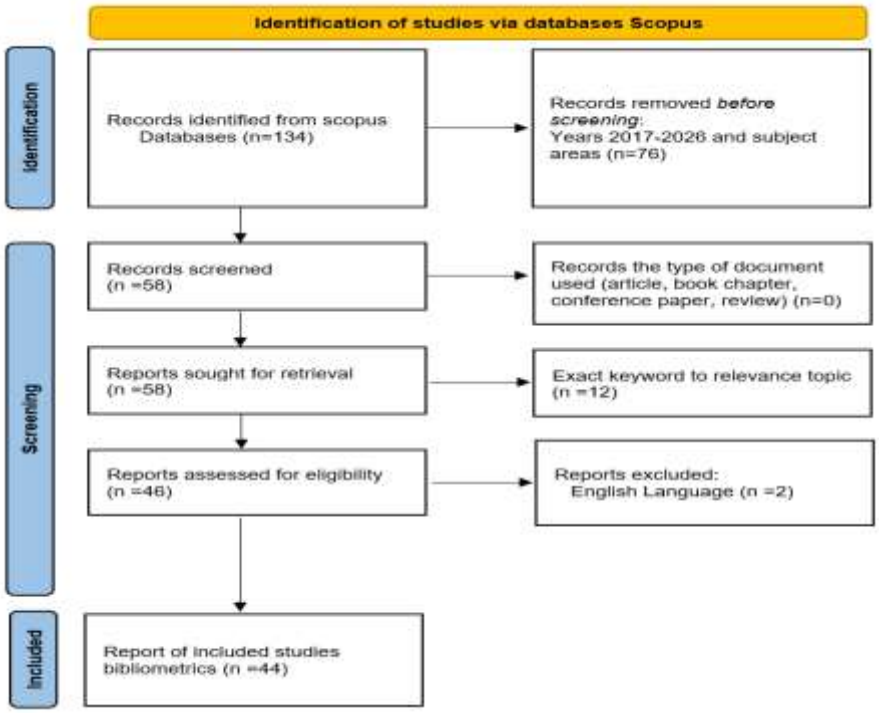

Figure 1. Article Selection Flowchart

A total of 134 records were initially retrieved from the Scopus database. During the screening process, 18 duplicate records were removed, leaving 116 records for further screening. Based on the predefined inclusion criteria, including publication year (2017–2026) and relevant subject areas, 58 records were excluded. The remaining 58 records were assessed based on document type and keyword relevance. No records were excluded based on document type, whereas 12 records were excluded because their keywords were not sufficiently relevant to the research topic. Subsequently, 2 records were excluded because they were not published in English. Finally, 44 studies met all eligibility criteria and were included in the bibliometric analysis.

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The articles obtained were then processed with the help of the R bibliometric package application to analyze the main information, annual scientific publication, article citation per year, sankey diagram, and thematic map. In the bibliometric summary and the creation of a visual network summary directly inform the writing of the paper to support what is written in the next paper. The retrieved articles were analyzed using Biblioshiny from the Bibliometrix package in R Studio. The analysis included descriptive bibliometric analysis of the main information, annual scientific production, citation patterns, authorship, and collaboration networks, followed by thematic analysis to identify, organize, and interpret recurring themes and research patterns based on authors' keywords and keyword co-occurrence. Thematic analysis was further supported by bibliometric visualizations, including the Sankey diagram and thematic map, which were used to examine relationships among countries, authors, keywords, and thematic structures and to inform the analytical discussion.

Results and Discussion

This section presents the findings of the bibliometric analysis conducted using Biblioshiny to examine global research trends on Ethno-ESD and systems thinking in elementary education. The analysis includes the main characteristics of the dataset, annual scientific production, citation patterns, collaboration networks, and thematic structures. These findings provide a comprehensive understanding of the development of the field, reveal its intellectual structure, and identify emerging themes and research opportunities that may guide future investigations. Table 1 provides a general overview of the bibliometric characteristics of the documents analyzed in this study.

Table 1. The Main Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2017:2026
Sources (Journals, Books, etc)	33
Documents	44
Annual Growth Rate %	8.01
Document Average Age	3.3
Average citations per doc	9.568
References	2479
DOCUMENT CONTENTS	
Keywords Plus (ID)	70
Author's Keywords (DE)	166
AUTHORS	
Authors	109
Authors of single-authored docs	10
AUTHORS COLLABORATION	
Single-authored docs	10
Co-Authors per Doc	2.73
International co-authorships %	15.91
DOCUMENT TYPES	
article	34
book chapter	6

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Description	Results
conference paper	2
review	2

Based on Table 1, although the number of publications remains relatively limited, the positive growth trend demonstrates that the integration of indigenous knowledge, Education for Sustainable Development (ESD), and systems thinking is becoming increasingly relevant within contemporary educational research. Similar growth patterns have also been identified in broader ESD studies, which have shown a continuous increase in publications over the last two decades (Blom & Karrow, 2024; Ichinose, 2025). Research concerning Ethno-ESD and systems thinking in elementary education is still evolving and remains in an emerging stage. The relatively young literature provides opportunities for further theoretical and empirical development and reflects the dynamic nature of sustainability-oriented educational research (Probst, 2022). The citation profile and extensive reference base indicate that research on Ethno-ESD and systems thinking in elementary education is developing a substantive and interdisciplinary knowledge foundation. This interdisciplinarity reflects the convergence of educational research, indigenous and local knowledge, environmental studies, and sustainability science. Such integration provides a foundation for developing more coherent frameworks that connect culturally grounded sustainability education with systems-oriented understanding of socio-ecological relationships (Horn et al., 2022).

The diversity of authors' keywords reflects the broad conceptual scope of research connecting sustainability education, indigenous knowledge, and systems thinking. This diversity likely arises because the field draws on multiple disciplinary perspectives and addresses varied cultural, environmental, and educational contexts. Similarly, the predominance of co-authored research can be attributed to the interdisciplinary nature of sustainability studies, which requires researchers to combine complementary expertise across education, environmental science, cultural knowledge, and sustainability research. These patterns indicate that the field is developing through conceptual diversification and collaborative knowledge production rather than within a single disciplinary tradition (Gorski et al., 2023; Lõhmus et al., 2025).

The limited international collaboration may reflect the strong contextual and culturally specific nature of research on Ethno-ESD, as studies often focus on local knowledge, indigenous practices, and national educational settings. This contextual orientation can constrain cross-country collaboration, although comparative international research could broaden understanding of how local wisdom and systems thinking operate across diverse socio-cultural environments. The dominance of journal publications, meanwhile, suggests that the field is primarily developing through peer-reviewed scholarly communication, which supports the systematic accumulation and dissemination of emerging knowledge. Together, these patterns indicate a research field that remains nationally grounded while gradually developing opportunities for broader international exchange and comparative inquiry (Aksnes & Sivertsen, 2023; Marco-Lajara et al., 2023). Overall, the information presented in Table 1 demonstrates that research on Ethno-ESD and systems thinking in elementary education represents a relatively young but rapidly developing field characterized by increasing publication growth, recent literature, moderate citation impact, and collaborative authorship patterns. The findings also reveal that the field possesses strong interdisciplinary characteristics and considerable opportunities for future development, particularly through expanded international collaboration and broader integration of diverse cultural perspectives.

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The trend of annual scientific production in the field of Ethno-ESD and systems thinking in elementary education during the period 2017–2026 is presented in Figure 2.

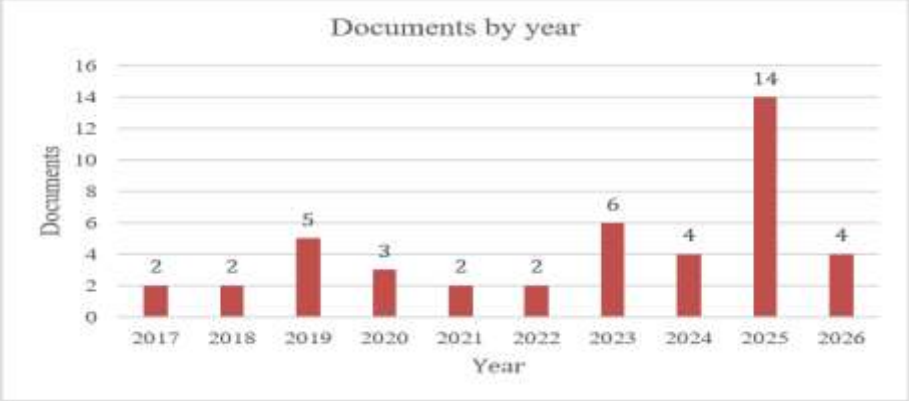

Figure 2. Annual Scientific Publication

The upward trend in scientific production indicates growing interest in the intersection of Ethno-ESD and Systems Thinking, driven by the increasing emphasis on sustainability competencies, local knowledge, and culturally responsive education. This convergence strengthens the interdisciplinary nature of the field and creates opportunities for further theoretical and empirical development (Abera, 2023; Eichentopf & Kasperidus, 2025). To examine the scholarly impact of the publications, citation metrics were analyzed based on publication year. Table 2 summarizes the average citations per article, the number of publications, and the average citations received per year, providing insights into the temporal development and academic influence of research on Ethno-ESD and systems thinking in elementary education.

Table 2. Article Citation Per Year

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2017	10	2	1	10
2018	43	2	4.78	9
2019	12.6	5	1.57	8
2020	5	3	0.71	7
2021	14	2	2.33	6
2022	22.5	2	4.5	5
2023	5.67	6	1.42	4
2024	21.25	4	7.08	3
2025	2.86	14	1.43	2
2026	1.25	4	1.25	1

The variation in citation impact across publication years is largely associated with differences in publication age and the time available for scholarly uptake. Earlier studies are more likely to accumulate citations because they have had longer exposure to the research community and greater opportunity to become conceptual or empirical references for subsequent studies (Hoang, 2025). The relatively strong citation performance of some publications from the middle of the study period may also reflect the increasing relevance of sustainability education and systems thinking following the global emphasis on the SDGs and ESD (Vadhera et al., 2022). In contrast, the lower citation impact of the most recent publications should not be interpreted as lower scholarly relevance, because these studies have had insufficient time to accumulate citations. Overall, the pattern suggests a field that is simultaneously building an intellectual foundation through earlier research and expanding its

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contemporary research agenda in response to emerging sustainability challenges (Dorta-González & Gómez-Déniz, 2022). To better understand the intellectual connections within the literature, a Sankey diagram was generated to visualize the relationships among contributing countries, authors' keywords, and authors. As shown in Figure 3, the diagram highlights the flow of research contributions and reveals how specific themes are linked to particular geographical regions and research communities.

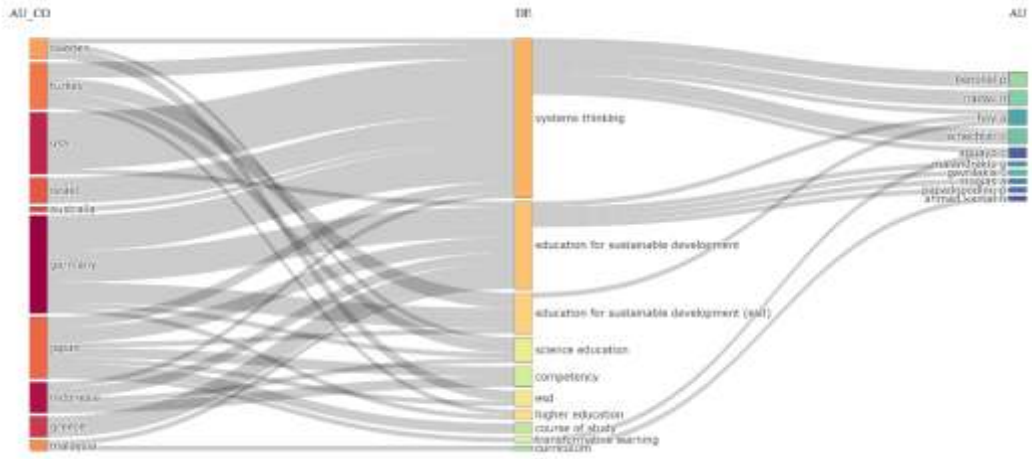

Figure 3. Sankey Diagram

The Sankey diagram indicates that Systems Thinking and Education for Sustainable Development (ESD) function as central themes connecting research across countries, authors, and keywords. Their prominence reflects the increasing emphasis on sustainability-oriented learning that connects interconnected systems with educational practice. The presence of countries such as Indonesia and Malaysia also highlights growing attention to culturally grounded approaches, particularly the use of local and traditional knowledge as resources for sustainable development (Jakes, 2024). This orientation is relevant to elementary education, where local wisdom can be integrated into learning to connect sustainability concepts with students' cultural and environmental contexts (Fairus et al., 2024). Overall, the pattern suggests an emerging convergence between Systems Thinking and culturally grounded sustainability education. To better understand the intellectual structure and thematic development of the field, a thematic map was generated using Biblioshiny based on authors' keyword co-occurrence. As shown in Figure 4, the map classifies themes into four quadrants—Motor Themes, Niche Themes, Emerging or Declining Themes, and Basic Themes according to their relevance and level of development within the research domain.

Figure 4 presents the thematic map of research on Ethno-ESD and systems thinking in elementary education based on keyword co-occurrence analysis. The map classifies themes into four quadrants according to their centrality and density, reflecting their importance and level of development within the research field (Jang et al., 2023). The Motor Themes include sustainable development, education, and learning, reflecting well-developed and central themes that shape research on Ethno-ESD and Systems Thinking. Their prominence confirms the central role of sustainability-oriented learning in the field. (Zhang & Wang, 2022). The Niche Themes include teacher, transformation, and Systems Thinking, indicating well-developed but relatively specialized research areas. The position of Systems Thinking suggests that its application remains concentrated in specific sustainability education contexts (Çetinkaya et al., 2025). The Emerging or Declining Themes include sustainability and higher education, indicating areas that are less central and less developed within the current research landscape. The presence of higher education suggests a potential gap in connecting

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sustainability-oriented and systems-based approaches with the specific needs of elementary education (Costa et al., 2024). Meanwhile, the Basic Themes quadrant (lower-right) is represented by teaching, which shows high centrality but lower density. This position indicates that teaching serves as a foundational theme connected to many research topics, although its conceptual development remains relatively limited. As a core educational process, teaching plays a crucial role in linking sustainability education, systems thinking, and local wisdom integration within elementary education contexts (Lestari & Suyanto, 2024). Overall, the thematic map shows that research is centered on sustainable development and learning, while Systems Thinking remains an emerging specialized area. These findings highlight the need for elementary education to integrate Systems Thinking, local wisdom, and sustainability competencies through interdisciplinary, contextual, and culturally responsive learning.

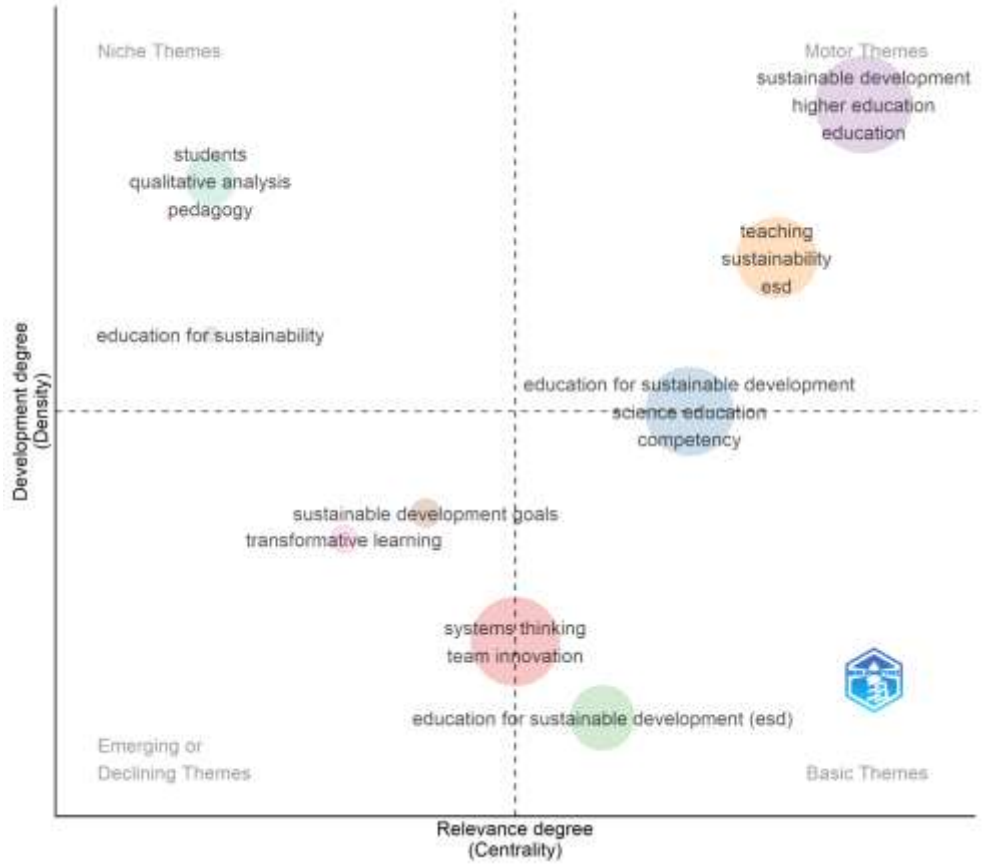

Figure 4. Thematic Map

Conclusion

This bibliometric study shows that research on Ethno-Education for Sustainable Development (Ethno-ESD) and Systems Thinking in elementary education has grown steadily from 2017 to 2026. Sustainable development, education, and learning remain the dominant themes, while Systems Thinking is emerging as an important specialized area. The findings highlight the need to integrate local wisdom, Systems Thinking, and sustainability competencies into elementary education through contextual and culturally responsive learning. Future research should focus on empirical classroom implementation, diverse cultural contexts, stronger international collaboration, and the development of effective instructional and assessment frameworks.

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Recommendation

Overall, educational policymakers and curriculum developers, Teacher Training Institutions (LPTKs), and future researchers should strengthen the development of elementary education by integrating Systems Thinking, local wisdom, and sustainability competencies through interdisciplinary, contextual, and culturally responsive learning. Policies and curricula should provide opportunities to incorporate local knowledge into sustainability education, while LPTKs should equip prospective teachers with the capacity to design and implement learning that connects local wisdom with students' understanding of relationships and interdependencies within social, cultural, and environmental issues. Furthermore, future research should move beyond bibliometric mapping toward the empirical development and testing of Ethno-ESD learning models based on Systems Thinking in elementary schools, including studies across diverse cultural and geographical contexts to strengthen the evidence base for this approach.

Acknowledgements

This research is funded by the Universitas Pendidikan Indonesia through the research scheme/program of Research Group Development with Contract No. 92 /UN40.F7/PT.01.01/2026).

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