



Trends in Ethnoscience Based Learning and Implications for SDGs: A Systematic Literature Review

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ABSTRACT

Purpose of the study: Ethnoscience Based Learning (EBL) integrates indigenous knowledge into science education to promote scientific literacy, cultural identity, and sustainable development. Despite its growing implementation, evidence regarding global publication trends, collaboration patterns, thematic evolution, and its contribution to the SDGs remains fragmented. Therefore, this study aims to systematically map the development of EBL research, identify research gaps, and examine its implications for the SDGs.

Methodology: This study employed a Systematic Literature Review (SLR) following the PRISMA 2020 guidelines. A total of 39 Scopus indexed articles published between 2019 and 2026 were analyzed using bibliometric techniques with VOSviewer to examine publication trends, collaboration networks, research themes, and research gaps.

Main Findings: EBL publications increased substantially after 2023, with Indonesia leading publication output and international collaboration. Keyword co-occurrence analysis identified ethnoscience as the central research theme, closely associated with culture, science education, learning models, environmental awareness, and sustainability. The review also revealed several research gaps, including limited international collaboration, inadequate integration of digital technologies, underrepresentation of higher and vocational education, and the absence of comprehensive SDGs oriented evaluation frameworks.

Novelty/Originality of this study: Unlike previous reviews, this study integrates systematic literature review and bibliometric analysis to provide a comprehensive overview of global EBL research while explicitly linking its development to the SDGs. The findings offer strategic directions for strengthening multidisciplinary collaboration, digital technology integration, and SDGs oriented evaluation frameworks. This review is limited to Scopus indexed publications, which may not fully represent relevant studies available in other international databases.

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1. INTRODUCTION

Ethnoscience-Based Learning (EBL) has emerged as an increasingly important research area at the intersection of science education, culturally responsive pedagogy, and Education for Sustainable Development (ESD). The growing body of research reflects a broader shift in science education from decontextualized transmission of scientific concepts toward learning approaches that recognize learners' cultural backgrounds, indigenous knowledge, and local wisdom as meaningful resources for constructing scientific understanding [1]. By connecting scientific concepts with students' cultural and environmental contexts, EBL has demonstrated potential to enhance scientific literacy, critical thinking, creativity, environmental awareness, and cultural literacy [1], [3], [4]. This development is particularly relevant to contemporary educational priorities, in which science education is expected not only to develop disciplinary knowledge but also to foster competencies that enable learners to respond critically and responsibly to complex social, cultural, and environmental challenges.

The conceptual development of EBL has also expanded beyond the preservation and transmission of indigenous knowledge. Recent studies have increasingly integrated ethnoscience principles with innovative pedagogical approaches, including Project-Based Learning (PjBL), inquiry-based learning, and STEM-based learning [1]. Such integration indicates that ethnoscience can function not merely as cultural content but also as a pedagogical framework for contextualizing scientific inquiry and developing twenty-first-century competencies. In this regard, EBL has increasingly been positioned as a potential contributor to Education for Sustainable Development because it can connect scientific knowledge with local environmental practices, cultural values, community-based knowledge, and sustainability challenges [5], [6]. Thus, the growing interest in EBL reflects a broader transformation in science education toward learning models that are culturally grounded, environmentally responsive, and oriented toward sustainable development.

The effectiveness of EBL has also received empirical support from quantitative synthesis. Meta-analytic evidence indicates that EBL can produce significant positive effects on students' learning outcomes and scientific literacy compared with conventional instructional approaches [7]–[9]. These findings strengthen the argument that the incorporation of ethnoscientific knowledge into science learning can improve both cognitive outcomes and students' ability to interpret scientific phenomena within meaningful real-world contexts. However, the rapid expansion of EBL research has simultaneously generated a highly heterogeneous body of literature. Studies have been conducted across different educational levels, geographical contexts, scientific disciplines, cultural settings, and methodological traditions, resulting in a fragmented research landscape [1], [10]. Consequently, although the effectiveness of EBL has increasingly been demonstrated, the broader structure and intellectual development of the research field remain insufficiently understood.

A particularly important issue concerns the lack of systematic knowledge regarding how EBL research has developed over time, who the major contributors are, how international and institutional collaborations have evolved, which themes have become dominant, and how EBL has been connected to the SDGs. Existing studies tend to concentrate on particular outcomes, such as scientific literacy, learning achievement, environmental awareness, or local wisdom-based conservation, rather than examining the development of EBL as a global research field [2], [10]. This creates a substantial knowledge gap because the growth of publications alone does not necessarily indicate the maturity, direction, or internationalization of a research domain. Understanding publication trajectories, influential authors and institutions, geographical distributions, collaboration structures, and thematic evolution is essential for determining where the field has been concentrated and where important research opportunities remain.

This gap is particularly significant in the context of ESD and the SDGs. Although several studies have associated ethnoscience with environmental awareness, sustainability, local ecological knowledge, and culturally responsive education [5], [6], the extent to which EBL research explicitly contributes to the SDGs has not yet been systematically mapped. The relationship between EBL and sustainable development therefore requires further investigation, particularly to determine which SDG dimensions have received substantial scholarly attention and which remain underrepresented. A comprehensive mapping of this relationship could reveal whether EBL research is primarily concentrated on SDG 4 (Quality Education), or whether its contributions also extend to environmental sustainability, responsible consumption, climate action, biodiversity, cultural sustainability, and other interconnected SDG targets.

A Systematic Literature Review (SLR) provides an appropriate methodological framework for addressing these limitations because it enables researchers to systematically identify, evaluate, and synthesize existing evidence while maintaining transparency and reproducibility. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines provide a structured framework for reporting the identification, screening, eligibility assessment, and inclusion of relevant studies [11]. However, a conventional SLR alone may not adequately capture the intellectual and structural characteristics of a rapidly expanding research field. Integrating SLR with bibliometric analysis can therefore provide a more comprehensive perspective by combining evidence synthesis with quantitative mapping of scholarly production, collaboration, and thematic development [11]–[13].

Despite the increasing number of studies on EBL, a clear methodological and knowledge gap remains. Previous reviews have primarily examined EBL in relation to scientific literacy, primary education, local wisdom, or conservation [2], [10]. While these studies provide valuable conceptual and empirical insights, they do not comprehensively explain the global research architecture of EBL. More specifically, there remains limited evidence integrating publication trends, author and institutional productivity, country-level contributions, citation patterns, scientific collaboration networks, keyword co-occurrence, thematic clusters, thematic evolution, and explicit connections between EBL and the SDGs within a single systematic research framework. Moreover, the absence of an integrated analysis makes it difficult to identify emerging research fronts, underrepresented geographical contexts, methodological limitations, and future research priorities.

Therefore, the principal research gap addressed by this study is the absence of a comprehensive, evidence-based mapping that simultaneously examines the intellectual structure, collaboration patterns, thematic evolution, and sustainability orientation of EBL research. Addressing this gap is important because the rapid growth of EBL research requires a field-level synthesis capable of moving beyond isolated findings toward a more integrated understanding of how ethnoscience-based approaches are evolving and contributing to contemporary science education and sustainable development.

The novelty of this study lies in its integration of PRISMA 2020-guided systematic literature review and bibliometric analysis to provide a multidimensional mapping of Scopus-indexed research on EBL. Unlike previous reviews that have primarily focused on specific educational outcomes or contexts [2], [10], this study simultaneously investigates (1) publication growth and research trends; (2) the productivity and influence of authors, institutions, and countries; (3) international and institutional collaboration networks; (4) dominant and emerging research themes; (5) thematic evolution across different periods; and (6) the relationship between EBL research and the Sustainable Development Goals. This integrated approach enables the study to identify not only what has been investigated but also how the field has evolved, where research concentrations and disparities exist, and which directions remain insufficiently explored.

Accordingly, this study aims to conduct a systematic review and bibliometric analysis of Scopus-indexed publications on Ethnoscience-Based Learning. Specifically, the study seeks to: (1) map the temporal development and publication trends of EBL research; (2) identify the most productive and influential authors, institutions, countries, and sources; (3) analyze scientific collaboration and knowledge networks; (4) identify dominant, emerging, and underexplored research themes; (5) examine the thematic evolution of EBL research over time; and (6) investigate the extent to which EBL research contributes to the achievement of the SDGs. By addressing these objectives, the study is expected to provide a comprehensive evidence base for understanding the current intellectual landscape of EBL, identifying critical research gaps, and establishing a future research agenda for culturally responsive, scientifically rigorous, and sustainability-oriented science education [1], [3], [8].

Ultimately, this study positions EBL not simply as an instructional strategy for integrating local wisdom into science education, but as an evolving research domain with potential implications for scientific literacy, cultural sustainability, environmental responsibility, educational equity, and the broader SDG agenda. The resulting synthesis is expected to benefit researchers, educators, policymakers, and educational institutions by providing evidence-based directions for developing future EBL research and strengthening its contribution to quality, inclusive, culturally responsive, and sustainable education.

2. RESEARCH METHOD

Research on ethnoscience based learning (EBL) has shown a substantial increase in recent years, reflecting the growing interest in culturally responsive education and Education for Sustainable Development (ESD) [1]. Numerous studies have demonstrated that EBL enhances students' scientific literacy, critical thinking skills, creativity, environmental awareness, and cultural literacy by integrating indigenous knowledge and local wisdom into science learning [2]-[4]. Furthermore, the implementation of EBL has evolved through its integration with innovative instructional approaches, including project based learning (PjBL), inquiry based learning, and STEM based learning [1]. Consequently, EBL is no longer viewed merely as a means of preserving cultural heritage but has emerged as a strategic approach for fostering twenty first century competencies while supporting the achievement of the Sustainable Development Goals (SDGs) [5], [6]. Meta analytic evidence further confirms that EBL has a significant positive effect on students' learning outcomes and scientific literacy compared with conventional instructional approaches [7]-[9]. Nevertheless, existing studies remain fragmented across diverse educational contexts, educational levels, and methodological approaches, limiting a comprehensive understanding of the field, particularly regarding publication trends, scientific collaboration, thematic evolution, and its contribution to achieving the SDGs [1], [10].

A systematic literature review (SLR) provides a rigorous approach for synthesizing scientific evidence, identifying research trends, evaluating methodological characteristics, and uncovering research gaps that remain insufficiently explored. By adopting the Preferred Reporting Items for Systematic Reviews and Meta Analyses

(PRISMA 2020) guidelines [11] in combination with bibliometric analysis, an SLR offers a more transparent, objective, and comprehensive synthesis than conventional literature reviews [11]–[13]. Although previous studies have reviewed EBL from the perspectives of scientific literacy, primary education, and local wisdom based conservation [2], [10], no study has comprehensively integrated bibliometric analysis with a systematic review to map publication trends, the productivity of authors, institutions, and countries, scientific collaboration networks, thematic evolution, and the implications of EBL for achieving the Sustainable Development Goals (SDGs). Therefore, this study conducts a systematic literature review of scopus indexed publications on EBL to examine research developments, identify research gaps and future research agendas, and explore the contribution of EBL to promoting quality, inclusive, and sustainable education [1], [3], [8].

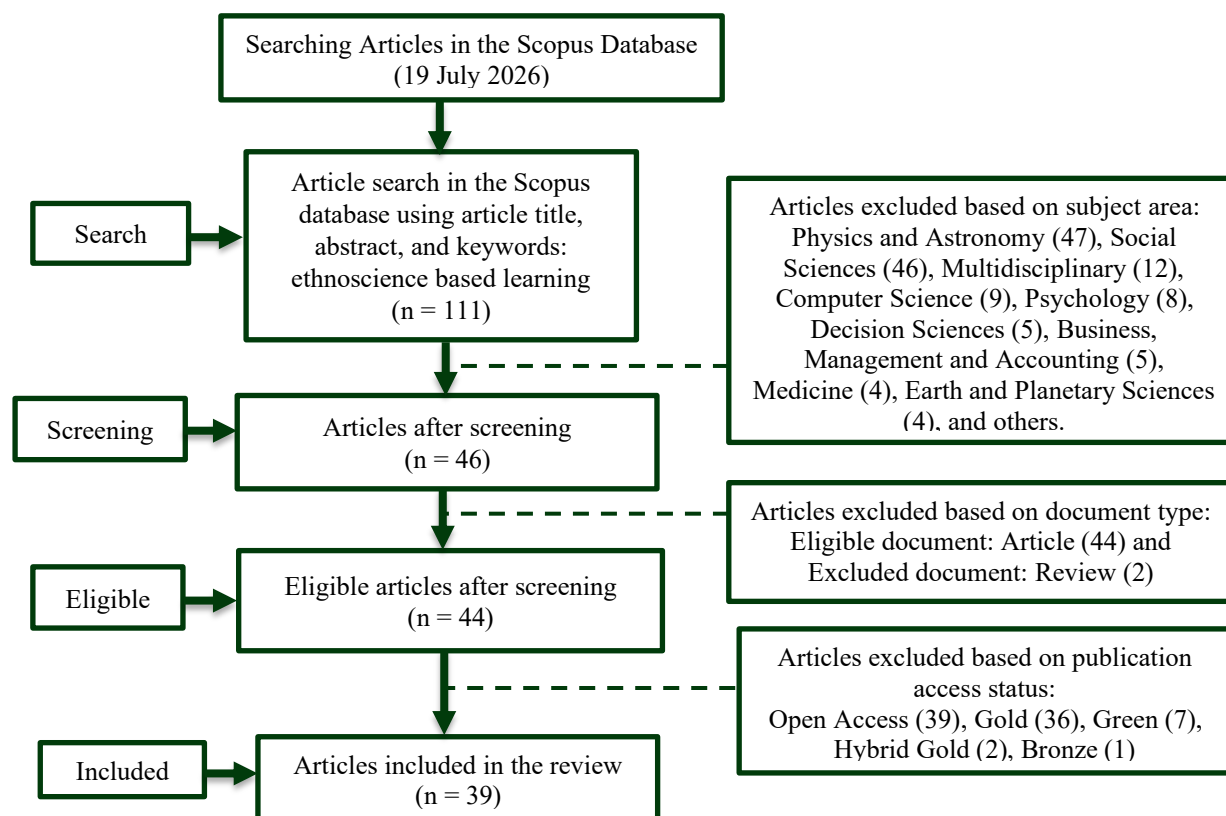


Figure 1. Systematic Literature Review Information flow using PRISMA

The literature search was conducted using the Scopus database on 19 July 2026 by applying the keyword “ethnoscience based learning” to the article title, abstract, and keywords. During the identification stage, 111 articles relevant to the research topic were retrieved. Subsequently, at the screening stage, articles were filtered based on their subject area, and those outside the scope of this study were excluded, including Physics and Astronomy (47 articles), Social Sciences (46), Multidisciplinary (12), Computer Science (9), Psychology (8), Decision Sciences (5), Business, Management and Accounting (5), Medicine (4), Earth and Planetary Sciences (4), as well as other subject areas. After this screening process, 46 articles remained for further evaluation.

The eligibility stage involved screening the articles according to their document type. At this stage, only publications classified as research articles were retained, while two review articles were excluded, resulting in 44 eligible articles. The remaining studies were subsequently assessed based on their publication access status. Among these, 39 Open Access articles met the inclusion criteria, comprising 36 Gold Open Access, 7 Green Open Access, 2 Hybrid Gold Open Access, and 1 Bronze Open Access article. Following the completion of all selection procedures, 39 articles satisfied the inclusion criteria and were included in the systematic literature review (SLR). The complete process of identification, screening, eligibility assessment, and study inclusion is illustrated in the PRISMA flow diagram, as presented in figure 1.

3. RESULTS AND DISCUSSION

3.1 Publication Trends by Year

Based on the documents by year analysis, publications on ethnoscience based learning (EBL) exhibited an overall upward trend during the 2019–2026 period, despite several fluctuations across individual years. At the

beginning of the observation period, only two publications were recorded in 2019, while no publications were identified in 2020. The number of publications began to increase in 2021 and 2022, with three articles published in each year, indicating the growing academic interest in EBL. A more substantial increase was observed in 2023, with nine publications, although the number temporarily declined to four publications in 2024. The publication trend then rose sharply in 2025, reaching 12 publications, the highest annual output during the study period. In 2026, six publications were identified. This lower number is likely attributable to the incomplete indexing process, as the data were collected in the middle of the year, meaning that not all recently published articles had yet been indexed in the scopus database.

Overall, these publication trends indicate that ethnoscience based learning has gained increasing scholarly attention as a research topic in education, particularly in relation to the integration of indigenous knowledge, the enhancement of scientific literacy, and its contribution to achieving the Sustainable Development Goals (SDGs). The annual distribution of publications is presented in figure 2.

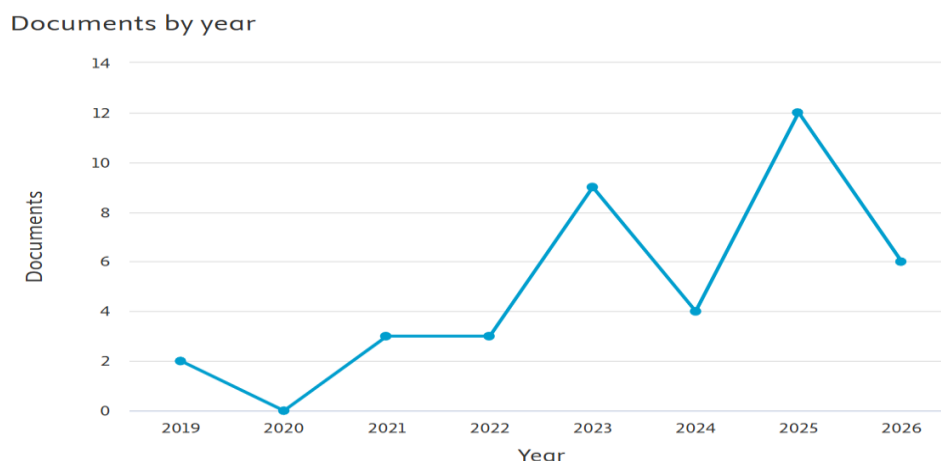


Figure 2. Annual Publication Trends on Ethnoscience Based Learning (2019–2026)

3.2 Research Distribution by Country

The distribution of publications on ethnoscience based learning (EBL) by country indicates that Indonesia is the leading contributor, with 38 publications, substantially outperforming all other countries. Indonesia's dominance reflects the strong commitment of its academic community to advancing EBL, supported by the country's rich cultural diversity, indigenous knowledge, and ethnic heritage, which serve as essential resources for integrating local wisdom into science education. These findings highlight Indonesia's strategic role in advancing EBL research at the international level. Outside Indonesia, Taiwan ranks second with five publications, indicating considerable scholarly interest in incorporating indigenous knowledge into science education. Germany, Malaysia, and South Africa each contributed two publications, while Brunei Darussalam, New Zealand, Nigeria, the Philippines, and Poland each produced one publication. Although the publication output of these countries remains relatively limited, the distribution demonstrates that research on EBL has begun to expand across different regions, including Asia, Europe, Africa, and Oceania.

Overall, the distribution of publications reveals that research on ethnoscience based learning remains highly concentrated in Indonesia, whereas contributions from other countries are still relatively limited. This finding suggests considerable opportunities for strengthening international research collaboration to broaden perspectives on the integration of indigenous knowledge into education. Enhanced international collaboration is expected to facilitate the wider implementation of EBL across diverse cultural and educational contexts while reinforcing its contribution to improving educational quality, preserving local wisdom, and supporting the achievement of the Sustainable Development Goals (SDGs). The distribution of publications by country or territory is presented in figure 3.

Documents by country or territory

Compare the document counts for up to 15 countries/territories.

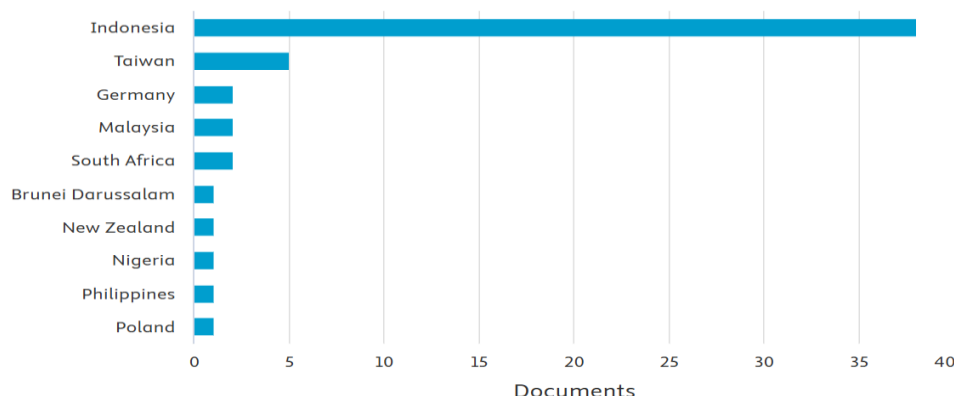


Figure 3. Top 10 Documents by Country or Territory

3.3 Research Trends Based on Keyword Co-occurrence

The keyword co-occurrence analysis reveals that ethnoscience is strongly associated with several prominent research themes, including science education, local wisdom, critical thinking, project based learning, critical thinking skills, context based learning, sustainability, conceptual understanding, virtual technology, virtual simulation, edutainment, and culture. These relationships indicate that research on EBL extends beyond the integration of indigenous knowledge into science education. Instead, it increasingly focuses on enhancing students' critical thinking skills, conceptual understanding, the development of innovative instructional models, and the integration of digital technologies into teaching and learning practices.

Furthermore, the keyword network reveals several interconnected research clusters. The cluster centered on science education and local wisdom highlights that the integration of indigenous knowledge remains a primary focus in the development of EBL. Meanwhile, the emergence of keywords such as project based learning, critical thinking skills, and context based learning reflects a growing research emphasis on promoting twenty first century competencies through contextualized and student centered instructional approaches. In addition, the close association with the keyword culture underscores that cultural values continue to serve as the fundamental basis for implementing EBL.

Overall, the keyword co-occurrence analysis demonstrates that research on EBL has evolved into a multidisciplinary field that integrates cultural perspectives, science education, educational technology, and higher order thinking skills. The interconnected keyword network further suggests that future research is increasingly oriented toward the integration of indigenous knowledge, pedagogical innovation, and sustainable education to support the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), while simultaneously promoting cultural preservation and sustainable development. The visualization of the keyword co-occurrence network is presented in figure 4.

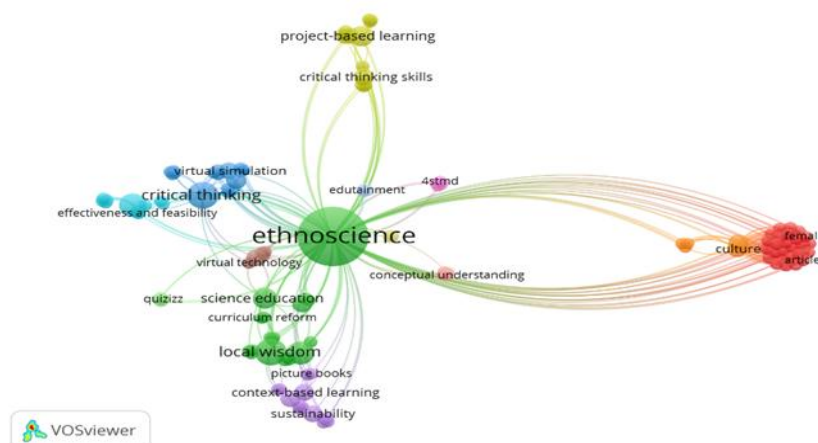


Figure 4. Research Trends Based on Keyword Co-occurrence

Table 1. Keywords and total link strength

No.	Keyword	Total Link Strength
1.	Ethnoscience	124
2.	Culture	35
3.	learning model	35
4.	Adolescent	30
5.	Article	30
6.	Awareness	30
7.	controlled study	30
8.	cultural anthropology	30
9.	Environment	30
10.	Environmental awareness and etc	30

Based on the data presented in table 1, the keyword ethnoscience has the highest total link strength (124) in the bibliometric analysis, indicating that it serves as the central concept within the research network and represents the core theme of EBL studies. The keywords culture and learning model each have a total link strength of 35, reflecting the strong relationship between ethnoscience-based learning, the integration of local culture, and the development of instructional models. Other keywords, including adolescent, article, awareness, controlled study, cultural anthropology, environment, environmental awareness, ethno-socioscientific issues, female, high school student, human, human experiment, humans, Javanese (people), Javanese culture, and learning, each have a total link strength of 30, indicating relatively balanced connections within the research network. Overall, these findings suggest that research on EBL has developed as a multidisciplinary field, emphasizing the integration of local culture, innovative instructional models, science education, and environmental awareness to support the achievement of the Sustainable Development Goals (SDGs).

3.4 Research Trends Based on International Collaboration Networks

The co-authorship network analysis by country, generated using VOSviewer, indicates that Indonesia serves as the central hub of international collaboration in EBL research. This is evidenced by the largest node size, which reflects Indonesia's leading contribution in terms of both publication output and international research collaboration. As the principal collaboration hub, Indonesia connects the majority of the international research network in this field.

The collaboration network further reveals that Indonesia has established research partnerships with several countries, including Taiwan, Malaysia, Germany, the Philippines, Brunei Darussalam, Poland, and South Africa. The strongest collaborative relationship is observed between Indonesia and Taiwan, as indicated by the close proximity of the two nodes and the thicker connecting link compared with those of other countries. Indonesia also functions as the primary connector linking countries that have not yet established substantial direct collaboration with one another. In addition, Germany acts as a secondary collaboration hub, bridging the research network between Indonesia and South Africa. Meanwhile, countries such as Malaysia, Brunei Darussalam, the Philippines, Poland, and New Zealand exhibit relatively limited collaboration and are connected primarily through Indonesia.

Overall, the collaboration network demonstrates that research on EBL remains concentrated around a single international collaboration hub, namely Indonesia, while collaboration among other countries is still relatively limited. These findings highlight significant opportunities to strengthen international collaboration through joint research projects, academic exchange programs, and cross country collaborative publications. Expanding international research networks is expected to enhance research quality, broaden perspectives on the integration of indigenous knowledge into education, and promote the wider implementation of EBL as an educational approach that supports the achievement of the Sustainable Development Goals (SDGs). The visualization of the international collaboration network is presented in Figure 5.

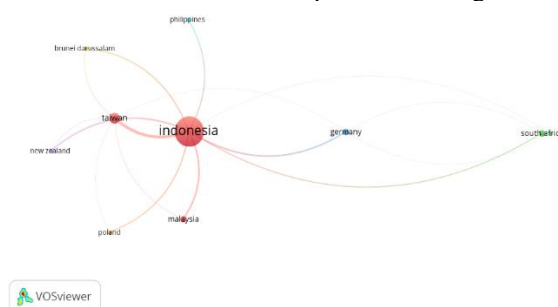


Figure 5. Visualization of Development Based on Inter Country Clusters

3.5 Research Developments by Affiliation

The distribution of publications by author affiliation indicates that research on EBL is predominantly conducted by higher education institutions in Indonesia. Universitas Negeri Semarang ranks first with seven publications, followed by Universitas Negeri Surabaya with six publications and Universitas Negeri Padang with five publications. University of Mataram contributed four publications, while Universitas Sebelas Maret, Universitas Negeri Yogyakarta, and Universitas Jambi each produced three publications. In addition, Universitas Mataram, Universitas Pendidikan Mandalika, and Universität Bremen each contributed two publications.

These findings indicate that research on EBL has been widely developed across higher education institutions, particularly in Indonesia, with the involvement of one international institution, Universität Bremen in Germany. The dominance of Indonesian universities reflects the close relationship between EBL and the country's rich cultural diversity, indigenous knowledge, and ethnic heritage, which provide a strong foundation for integrating local wisdom into science education. This context has encouraged many universities to develop research that incorporates indigenous knowledge into science learning as an innovative educational approach. Moreover, the diversity of institutional affiliations demonstrates that research on EBL has expanded across various regions of Indonesia, thereby enriching both the perspectives and contextual applications of EBL.

Overall, the distribution of publications by institutional affiliation shows that research on EBL is still dominated by Indonesian higher education institutions, while the contribution of international institutions remains relatively limited. This finding highlights the need to strengthen research collaboration among universities at both the national and international levels to enhance publication quality, expand academic networks, and promote the broader implementation of EBL in supporting educational innovation and the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education). The distribution of publications by author affiliation is presented in Figure 6.

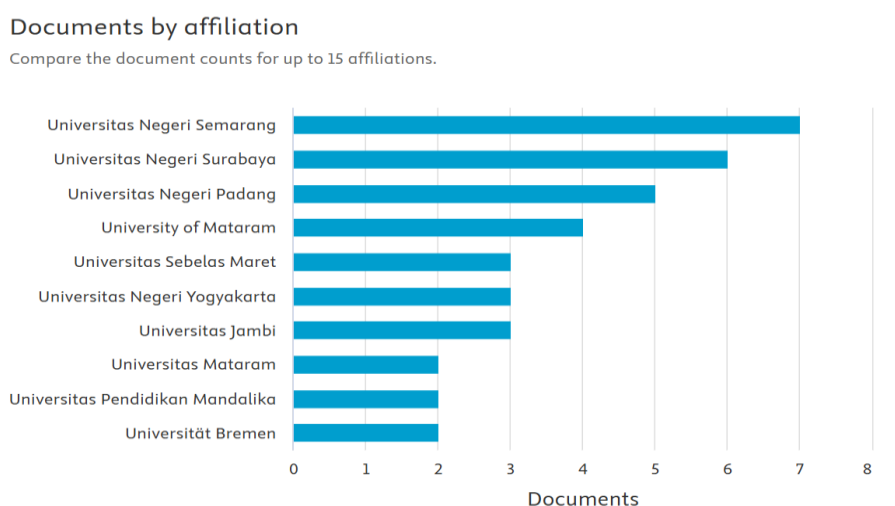


Figure 6. Visualization of Research Development Based on Affiliation

3.6 Research Trends by Journal Source

The distribution of publications by journal source indicates that research on EBL has been disseminated through a wide range of national and international journals. Jurnal Pendidikan IPA Indonesia is the leading publication source, contributing 10 articles, substantially exceeding all other journals. This dominance suggests that the journal serves as one of the primary outlets for research on EBL, particularly within the field of science education. In addition to having the highest publication output, the journal has maintained a relatively consistent publication trend since 2019, with a noticeable increase in 2023 and reaching its highest annual output of three articles in 2025, before declining slightly to two articles in 2026. Following Jurnal Pendidikan IPA Indonesia, the Journal of Turkish Science Education and TEM Journal each published three articles. Meanwhile, the International Journal of Learning, Teaching and Educational Research and Lumat each contributed two articles. Beyond these leading journals, several other journals including Africa Education Review and the Amplitudo Journal of Science and Technology Innovation each published one article, indicating that research on Ethnoscience-Based Learning has been disseminated across journals representing diverse academic disciplines and educational contexts.

Overall, the distribution of publications by journal source demonstrates that research on EBL remains concentrated in a limited number of journals specializing in science education, educational innovation, and educational research. The prominence of Jurnal Pendidikan IPA Indonesia highlights its important role as a primary platform for disseminating research findings in this field. At the same time, the presence of publications in several international journals indicates that EBL is gaining increasing recognition within the global academic

community. This trend provides opportunities to expand the dissemination of future research through high impact international journals, thereby enhancing the visibility, scientific impact, and global contribution of EBL to educational innovation and the achievement of the Sustainable Development Goals (SDGs). The distribution of publications by journal source is presented in figure 7.

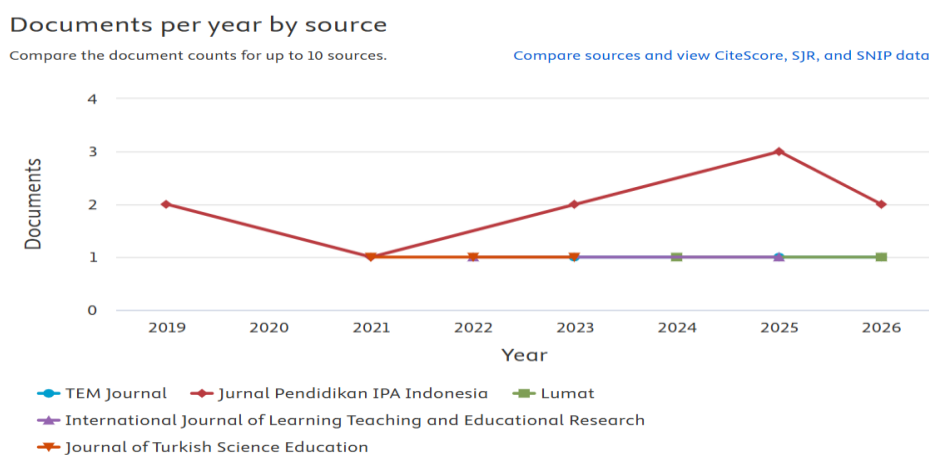


Figure 7. Visualization of Research Development Based on Journal Sources

3.7 Research Trends by Author

The distribution of publications by author indicates that research on EBL has been advanced by several scholars who have made substantial contributions to this field. Diliarosta, S. [17]-[21] and Verawati, N. N. S. P. [23]-[26] are the most prolific authors, each contributing four publications. Their publication records demonstrate significant scholarly contributions to the advancement of EBL, particularly in the integration of indigenous knowledge into science education and the development of culturally responsive instructional innovations.

Several other authors have also made notable contributions, including Ariyatun [17], [19], Asyhar [17], [20], Festiyed [21], [22], Gummah [23], [25], Harjono [27], [25], Islamiyah [28], [29], Khoiri [30], [31], and Lufri [21], [34], each of whom has published two articles. Although their publication outputs are lower than those of the two leading authors, their contributions indicate that EBL research has evolved through the active involvement of scholars from diverse institutions and research groups. This pattern suggests that the advancement of the field is not dependent on a single researcher but is supported by collaborative efforts among academics who share a common interest in integrating local wisdom, science education, and pedagogical innovation.

The distribution of publications by author demonstrates that scholarly productivity in EBL research is relatively balanced among several active researchers. The absence of a substantial disparity between the most productive authors and other contributors indicates that this research field is still in a stage of continuous development, with contributions distributed across a broad range of scholars. This condition presents considerable opportunities to strengthen research collaboration, increase co authored publications, and further advance both the theoretical and practical foundations of EBL in support of educational innovation and the achievement of the Sustainable Development Goals (SDGs). The distribution of publications by author is presented in figure 8.

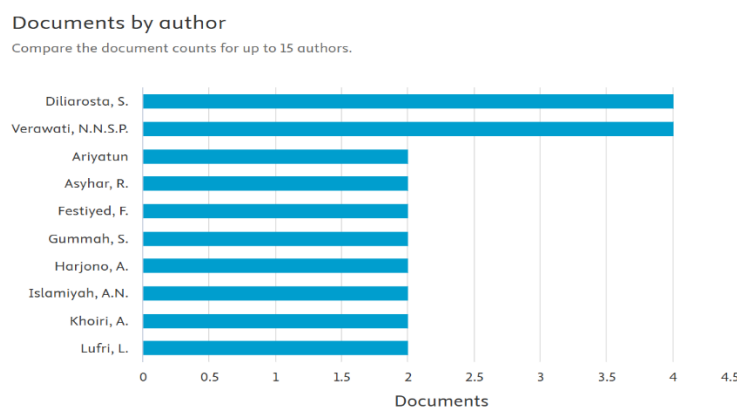


Figure 8. Visualization of Research Development by Author

3.8 Research Trends by Subject Area

The distribution of publications by subject area indicates that research on EBL is inherently multidisciplinary, although it is predominantly concentrated within the Social Sciences. Among the publications analyzed, social sciences accounted for the largest proportion, with 39 documents (52.0%), indicating that EBL has primarily been investigated in the contexts of education, curriculum development, culturally responsive pedagogy, and the integration of indigenous knowledge into educational practices. The prominence of this subject area is consistent with the fundamental characteristics of EBL, which positions education as the primary medium for transforming local wisdom into meaningful and contextual learning resources.

The second largest subject area was computer science, with 8 documents (10.7%), followed by psychology, with 6 documents (8.0%). The contribution of computer science reflects the growing integration of digital technologies, educational media, virtual simulations, and technology enhanced learning platforms into the implementation of EBL. Meanwhile, the involvement of psychology suggests that current research extends beyond cognitive outcomes to encompass learning motivation, attitudes, critical thinking skills, and students' developmental processes within EBL settings. Furthermore, business, management and accounting and decision sciences each contributed 4 documents (5.3%), while Arts and humanities accounted for 3 documents (4.0%). In addition, medicine, nursing, and physics and astronomy each contributed 2 documents (2.7%), whereas biochemistry, genetics and molecular biology was represented by 1 document (1.3%). The Other category accounted for approximately 5.3% of the total publications, indicating that EBL has also begun to be explored across a broader range of academic disciplines.

The subject area distribution demonstrates that research on EBL has expanded beyond the field of education and is increasingly being adopted across diverse scientific disciplines. Although social sciences remains the dominant research area, the growing contributions from computer science, psychology, decision sciences, and medicine highlight the interdisciplinary nature of EBL and its relevance to multiple research contexts. These findings suggest that EBL holds substantial potential for further development through interdisciplinary collaboration, thereby fostering educational innovation, preserving indigenous knowledge, and contributing to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure), and SDG 11 (Sustainable Cities and Communities). The distribution of publications by subject area is presented in figure 9.

Documents by subject area

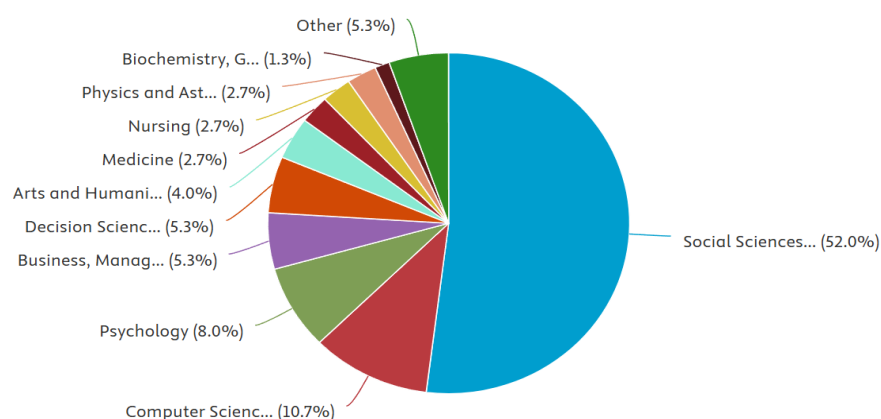


Figure 9. Visualization of Research Development by Subject Area

3.9 Trends in Ethnoscience-Based Learning Research

The bibliometric analysis revealed a substantial increase in publications on EBL during the 2019–2026 period, particularly from 2023, with publication output reaching its peak in 2025. This trend indicates that Ethnoscience-Based Learning has gained increasing recognition as an innovative approach to science education. The growing number of publications not only reflects the expanding scholarly interest in integrating indigenous knowledge into educational practices [21], but also signifies a paradigm shift from traditional knowledge transmission toward contextual, participatory, and student centered learning approaches [34]. From the perspective of social constructivism, knowledge is constructed through interactions between individuals and their social and cultural environments; therefore, learning experiences grounded in students' everyday realities foster deeper conceptual understanding [35]. Consistent with this perspective [36], [37] argued that integrating indigenous knowledge with modern science narrows the gap between scientific concepts and community cultural

experiences, enabling students to connect scientific knowledge more effectively with real-world phenomena encountered in their daily lives [9]. Consequently, the increasing research interest in Ethnoscience-Based Learning suggests that this approach is increasingly recognized as a pedagogical alternative capable of enhancing the social, cultural, and environmental relevance of science education [19], [38].

This development is also closely associated with the growing global emphasis on Education for Sustainable Development (ESD) [39], which recognizes education as a key instrument for achieving sustainable development. Numerous studies have demonstrated that EBL contributes significantly to improving scientific literacy, critical thinking, creativity, problem solving skills, and environmental awareness by utilizing local wisdom as an authentic learning resource [2], [37], [40], [41]. These findings are consistent with evidence from educational meta-analyses showing that character-based educational approaches contribute positively to students' learning outcomes and holistic competence development [56]. These relationships indicate that the focus of research has evolved beyond merely documenting indigenous cultural knowledge toward developing instructional models that integrate cultural values with twenty first century competencies. Fitria et al. [33] further argued that the increasing integration of Indigenous Knowledge Systems into STEM education represents a response to the growing demand for educational practices that are more inclusive, contextually relevant, and sustainability oriented.

The increasing publication trend on EBL reflects not only the maturation of this research field but also its growing contribution to achieving the Sustainable Development Goals (SDGs). Specifically, EBL supports SDG 4 (Quality Education) by promoting inclusive and high quality learning, SDG 11 (Sustainable Cities and Communities) through the preservation of local cultural heritage, and SDG 13 (Climate Action) by fostering environmental awareness and ecological responsibility within educational practices. These findings underscore the strategic role of EBL as a culturally responsive and sustainability oriented educational approach capable of addressing contemporary educational challenges while supporting the global sustainable development agenda.

3.10 Indonesia's Dominance in the Development of Ethnoscience Based Learning

The bibliometric analysis indicates that Indonesia is the leading contributor to publications and serves as the central hub of international research collaboration in EBL. This dominance is reflected in the high research productivity of several Indonesian universities, including Universitas Negeri Semarang, Universitas Negeri Surabaya, Universitas Negeri Padang, and Universitas Mataram. These findings demonstrate Indonesia's strong capacity to advance ethnoscience research, supported by its rich cultural diversity, linguistic heritage, and indigenous knowledge systems, which provide valuable resources for contextualized science education. The country's cultural richness offers an ideal setting for integrating local wisdom into science learning, enabling students to develop a deeper understanding of scientific concepts through authentic learning experiences rooted in their everyday lives [9]. Furthermore, the implementation of the Merdeka Curriculum, which emphasizes contextual, student-centered, and culturally responsive learning, has further accelerated the development of EBL research in Indonesia [15].

Although Indonesia has emerged as the primary center of research development, the bibliometric findings reveal that international collaboration remains relatively limited and is largely concentrated around Indonesian researchers and institutions [23], [31], [42], [43]. This pattern suggests considerable opportunities to expand EBL research through cross national collaboration, particularly with countries that possess rich indigenous knowledge systems and cultural heritage. Strengthening international partnerships would broaden research perspectives, enhance publication quality, and facilitate the wider implementation of EBL across diverse educational and cultural contexts. Therefore, Indonesia's leadership in this field reflects not only its high scientific productivity but also its strategic potential to position EBL as an educational approach that contributes to the achievement of SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), and SDG 17 (Partnerships for the Goals) [44], [46].

3.11 Evolution of Research Themes Based on Keyword Co-occurrence

The keyword co-occurrence analysis revealed that ethnoscience is the dominant keyword, with the highest Total Link Strength (124), indicating its central role within the research network. The strong associations between ethnoscience and related keywords including culture, learning model, environment, environmental awareness, cultural anthropology, and learning suggest that research in this field has evolved beyond the exploration of indigenous knowledge alone [9]. Instead, it increasingly emphasizes the development of instructional models that integrate cultural values, environmental perspectives, and science education [20], [25]. These findings indicate that EBL has emerged as a contextual pedagogical approach that connects scientific knowledge with community cultural practices, thereby making learning experiences more meaningful and relevant to students' everyday lives [34].

The evolution of research themes also reflects a shift from a primary focus on cultural preservation toward educational approaches that foster twenty first century competencies [33] and promote sustainable development [44]. The close relationship between ethnoscience and keywords such as environmental awareness

and learning model indicates that recent studies increasingly emphasize learning approaches that not only enhance students' understanding of scientific concepts but also cultivate ecological awareness, critical thinking, and responsible decision making skills [33], [45], [46]. These findings are consistent with the principles of Education for Sustainable Development (ESD), which recognizes education as a key mechanism for enabling learners to understand the interconnections among social, cultural, economic, and environmental dimensions of sustainable development (UNESCO, 2020). Consequently, EBL demonstrates considerable potential to contribute to SDG 4 (Quality Education) by promoting inclusive, culturally responsive, and context-based learning, as well as to SDG 13 (Climate Action) by strengthening environmental awareness through the integration of indigenous knowledge and local wisdom [48].

3.12 Ethnoscience-Based Learning as a Multidisciplinary Educational Approach

The growing development of EBL is closely associated with the increasing global emphasis on Education for Sustainable Development (ESD), which recognizes education as a fundamental instrument for achieving sustainable development. Numerous studies have demonstrated that EBL makes significant contributions to improving scientific literacy, critical thinking, creativity, problem solving skills, and environmental awareness through the integration of indigenous knowledge and local wisdom as authentic learning resources [2], [20]. These findings are further supported by the keyword co-occurrence analysis conducted in the present study, which revealed strong associations between ethnoscience and keywords such as culture, learning model, science education, critical thinking, and sustainability. These relationships indicate that the focus of research has evolved from merely documenting local cultural knowledge toward developing instructional models that integrate cultural values with twenty first century competencies [45], [47]. This trend also reflects the growing incorporation of Indigenous Knowledge Systems into STEM education as a response to the increasing demand for educational practices that are more inclusive, contextually relevant, and sustainability oriented.

Furthermore, the bibliometric findings reveal that EBL has evolved into a multidisciplinary research field, extending beyond science education to encompass disciplines such as computer science, psychology, arts and humanities, decision sciences, business and management, and medicine. This multidisciplinary expansion demonstrates the broad applicability of EBL in addressing complex educational challenges through the integration of diverse disciplinary perspectives. The incorporation of digital technologies, educational psychology, cultural studies, and interdisciplinary pedagogical approaches has further strengthened the relevance of EBL in contemporary education.

Overall, the increasing publication trend on EBL reflects not only the academic advancement of this field but also its growing contribution to achieving the Sustainable Development Goals (SDGs). In particular, EBL supports SDG 4 (Quality Education) by promoting inclusive, culturally responsive, and high quality learning experiences; SDG 11 (Sustainable Cities and Communities) by preserving and revitalizing local cultural heritage; and SDG 13 (Climate Action) by fostering environmental awareness and ecological responsibility through the integration of indigenous knowledge into educational practices [44], [48]. These findings underscore the strategic role of EBL as a multidisciplinary educational approach that bridges scientific knowledge, cultural heritage, technological innovation, and sustainability, thereby contributing to the development of more inclusive and resilient education systems.

3.13 The Contribution of Ethnoscience-Based Learning to the Sustainable Development Goals (SDGs)

The bibliometric analysis demonstrates that the development of EBL research has made increasingly significant contributions to the achievement of the Sustainable Development Goals (SDGs), particularly in the areas of education, cultural preservation, and environmental sustainability. This trend is reflected in the growing number of publications, the prominence of keywords such as culture, environmental awareness, and learning model, and the expansion of research across multiple disciplinary fields. These findings indicate that EBL is no longer viewed merely as an approach for integrating local cultural knowledge into science education. Instead, it has evolved into an educational strategy that promotes scientific literacy, critical thinking, ecological awareness, and appreciation of indigenous knowledge and local wisdom [57], [58], [60]. This perspective aligns closely with the principles of Education for Sustainable Development (ESD), which recognizes education as a fundamental mechanism for empowering individuals with the knowledge, skills, values, and attitudes necessary to address sustainable development challenges [49], [50].

In relation to the implementation of the SDGs, EBL contributes most directly to SDG 4 (Quality Education) by fostering inclusive, contextualized, and learner centered educational practices grounded in authentic learning experiences [55], [58], [60]. Moreover, the integration of indigenous knowledge into educational settings supports SDG 11 (Sustainable Cities and Communities) by preserving cultural heritage and strengthening local identity, while also advancing SDG 13 (Climate Action) through the promotion of environmental awareness and the application of traditional ecological knowledge in natural resource management. Previous studies have further demonstrated that incorporating indigenous knowledge into

education enhances student engagement, strengthens sustainability literacy, and develops learners' capacity to make informed decisions that balance social, cultural, and environmental considerations [44], [55], [59], [60]. Consequently, EBL holds considerable potential as an educational model that not only improves the quality of education but also advances the broader sustainable development agenda by fostering meaningful connections among scientific knowledge, cultural heritage, and environmental sustainability.

Although research on EBL has grown substantially in recent years, the bibliometric analysis identifies several research gaps that warrant further investigation. First, the existing literature is largely dominated by descriptive studies and the development of instructional materials within classroom settings [19], [20], [52], whereas longitudinal studies, meta analyses, and experimental research remain relatively scarce. As a result, empirical evidence regarding the long-term effects of EBL on students' competencies including scientific literacy, critical thinking, creativity, and sustainability awareness remains limited. Furthermore, most studies have focused on primary and secondary education [30], [49], while its implementation in higher education and vocational education has received considerably less attention. Given the strategic role of these educational levels in preparing graduates capable of integrating indigenous knowledge with scientific and technological innovation, further research in these contexts is highly recommended.

The bibliometric findings also reveal an uneven geographical distribution of research, with Indonesia accounting for the majority of publications, whereas contributions from Africa, Latin America, and the Middle East remain relatively limited. This imbalance suggests that the current body of literature does not fully represent the diversity of indigenous knowledge systems across different cultural and geographical contexts. Since each region possesses unique cultural traditions, local practices, and indigenous knowledge that could enrich both the theoretical foundations and practical implementation of EBL [32], [52], [53], future studies should promote cross-national comparative research and strengthen international research collaborations to develop more adaptive, culturally responsive, and globally applicable educational models.

In addition to methodological and geographical limitations, the keyword co-occurrence analysis indicates that the integration of Ethnoscience-Based Learning with emerging educational technologies remains underexplored. Keywords related to Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), and Learning Analytics have yet to emerge as prominent themes within the research network, suggesting that the digital transformation of EBL is still in its early stages. Future research should therefore investigate how intelligent technologies can be integrated with indigenous knowledge to create more interactive, personalized, and adaptive learning experiences while simultaneously supporting the digital documentation and preservation of traditional knowledge. Promising research directions include the development of AI-assisted ethnoscience learning, VR/AR based immersive learning environments, and the application of learning analytics to monitor and assess students' cognitive and sustainability-related competencies.

Another important research gap concerns the limited number of studies that explicitly evaluate the contribution of EBL to the achievement of the Sustainable Development Goals (SDGs) [25], [42], [52]. Most existing studies merely position the SDGs as a conceptual framework without developing appropriate indicators or assessment instruments to measure their educational, cultural, and environmental impacts. Future research should therefore focus on developing SDG based evaluation frameworks capable of systematically assessing the contributions of EBL to educational quality, cultural preservation, and environmental sustainability. Such efforts are expected not only to strengthen the empirical foundation of this field but also to inform educational policy, promote pedagogical innovation, and enhance the contribution of Ethnoscience-Based Learning to the global sustainable development agenda.

4. CONCLUSION

This study provides a comprehensive synthesis of the development of Ethnoscience-Based Learning (EBL) through a Systematic Literature Review (SLR) combined with bibliometric analysis of 44 Scopus-indexed publications published between 2019 and 2026. The findings indicate that research on EBL has experienced substantial growth, with Indonesia emerging as the leading contributor, while ethnoscience has become the central research theme, closely associated with culture, science education, instructional models, and sustainability. These findings demonstrate that EBL has evolved from a cultural preservation approach into a pedagogical strategy that supports the development of twenty first century competencies and contributes to the achievement of the Sustainable Development Goals (SDGs). The review also identifies several important research gaps, including limited international collaboration, insufficient integration of digital technologies and artificial intelligence, the underrepresentation of higher education and vocational education contexts, and the lack of comprehensive evaluation frameworks for assessing the contribution of EBL to the SDGs. Accordingly, this study contributes theoretically by mapping the current landscape and future direction of EBL research while providing valuable insights for researchers, educators, and policymakers seeking to develop culturally responsive, context-based, and sustainable science education. Future research should expand the scope of literature sources, incorporate meta-analytic approaches, and develop more comprehensive implementation and

evaluation frameworks to strengthen the contribution of Ethnoscience-Based Learning to the achievement of the Sustainable Development Goals.

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AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

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USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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