ORIGINAL

A Decade of Local Culture Integration in Mathematics Learning: A Bibliometric Analysis of Scopus-Indexed Publications (2015-2024)

Una década de integración de la cultura local en el aprendizaje de las matemáticas: un análisis bibliométrico de las publicaciones indexadas en Scopus (2015-2024)

Edwin Musdi[1] ✉, Devi Khairani[1] , Daharnis[2] , Elita Jamaan[1] , Muth Mainnah Rangkuti[1] , Nurul Syifa Riztavia[1]

[1]Universitas Negeri Padang, Department of Mathematics Education. Padang, Indonesia.
[2]Universitas Negeri Padang, Department of Guidance and Counseling. Padang, Indonesia.

ABSTRACT

Research on the integration of local culture into mathematics learning has gained growing international attention because of its potential to promote contextual, meaningful, and culturally relevant learning, yet systematic mapping of its scholarly progress and thematic directions is still limited. This study aims to examine the development, research trends, and institutional collaborations in culture integrated mathematics education over the last decade. A bibliometric analysis of 129 Scopus indexed journal articles published between 2015 and 2024 was conducted using VOSviewer 1.6.20 to visualize publication patterns, keyword cooccurrence structures, and collaboration networks. The results show a substantial increase in publications, particularly after 2018, with the highest output recorded in 2024. Thematic mapping identified three dominant clusters: culturally responsive pedagogical strategies, reinforcement of mathematical understanding through indigenous and local knowledge systems, and digital innovations such as augmented reality and STEM based tools supporting cultural preservation and learning. Indonesia emerged as the most prolific contributor, followed by the United States and the United Kingdom, indicating strong regional research engagement supported by international collaboration. Overall, the findings demonstrate the growing significance of culturally grounded mathematics education and provide an empirical foundation for future studies, the development of culturally responsive curricula, and policy formulation aligned with inclusive and multicultural educational practices.

Keywords: Local Culture; Ethnomathematics; Bibliometric Analysis; Mathematics Learning; Scopus.

RESUMEN

La La investigación sobre la integración de la cultura local en el aprendizaje de las matemáticas ha ganado cada vez más atención internacional debido a su potencial para promover un aprendizaje contextual, significativo y culturalmente relevante, pero el mapeo sistemático de su progreso académico y sus orientaciones temáticas sigue siendo limitado. El objetivo de este estudio es examinar el desarrollo, las tendencias de investigación y las colaboraciones institucionales en la educación matemática integrada en la cultura durante la última década. Se realizó un análisis bibliométrico de 129 artículos de revistas indexadas en Scopus publicados entre 2015 y 2024 utilizando VOSviewer 1.6.20 para visualizar los patrones de publicación, las estructuras de coocurrencia de palabras clave y las redes de colaboración. Los resultados muestran un aumento sustancial de las publicaciones, especialmente después de 2018, con la mayor producción registrada en 2024. El mapeo temático identificó tres grupos dominantes: estrategias pedagógicas sensibles a las diferencias culturales,

refuerzo de la comprensión matemática a través de sistemas de conocimiento indígenas y locales, e innovaciones digitales como la realidad aumentada y herramientas basadas en STEM que apoyan la preservación cultural y el aprendizaje. Indonesia se perfiló como el contribuyente más prolífico, seguido de Estados Unidos y Reino Unido, lo que indica un fuerte compromiso regional con la investigación respaldada por la colaboración internacional. En general, los resultados demuestran la creciente importancia de la educación matemática basada en la cultura y proporcionan una base empírica para futuros estudios, el desarrollo de planes de estudio sensibles a las diferencias culturales y la formulación de políticas alineadas con prácticas educativas inclusivas y multiculturales.

Palabras clave: Cultura Local; Etnomatemática; Análisis Bibliométrico; Aprendizaje de Matemáticas; Scopus.

INTRODUCTION

The integration of local culture into mathematics education is growing in popularity due to its potential to create contextual and meaningful learning experiences. This pedagogical paradigm is grounded in the belief that mathematical knowledge is not merely abstract, but is also constructed through social and cultural interactions.[1] Numerous studies have substantiated the benefits of culturally relevant approaches in enhancing students' mathematical comprehension. For instance, augmented reality comics inspired by the architecture of the Al-Akbar Mosque in Surabaya have been shown to significantly improve students' numeracy and geometric reasoning.[2] Through her investigation of customary land management systems, identified embedded mathematical structures in indigenous knowledge.[3] further demonstrated that traditional Timorese games and weaving practices positively influence students' mathematical literacy, especially in integer operations.[4] However, challenges remain; highlighted the need to improve mathematical communication across cognitive, affective, and psychomotor domains.[5] Additionally emphasized the limited development of students' creative mathematical thinking across various learning profiles, indicating a disconnect between cultural integration and higher-order thinking skills.[6]

Beyond mathematics, culture-based education has proven valuable in other disciplines. Strated that integrating Malangan batik dyeing into chemistry lessons enhanced both conceptual mastery and cultural identity within a STEAM-2C framework.[7] These findings underscore the necessity of cultural integration as a core pedagogical strategy rather than a supplementary method, particularly within the framework of Indonesia's Merdeka Curriculum.[8] Nevertheless, a bibliometric study over the last ten years revealed that 72 % of mathematics education research remains focused on basic cognitive abilities, with minimal integration of cultural or technological components.[9] Furthermore, identified inconsistencies and gaps in the implementation of local culture integration in mathematics instruction across Indonesia.[10] Hence, bibliometric analysis serves as a critical tool to trace scholarly evolution, identify.

METHOD

This study employed a bibliometric analysis to examine publication patterns, collaborative structures, and thematic developments in research integrating local culture into mathematics education.[11,12,13,14,15] The method enabled the systematic identification of influential authors, institutions, and research fronts within the field.

Data Source

Data were retrieved from the Scopus database, selected for its comprehensive coverage of peer-reviewed scholarly publications, structured metadata, and robust citation indexing. Scopus was chosen over alternative databases such as Web of Science and IEEE Xplore due to access limitations, while Google Scholar was excluded because of metadata inconsistencies and duplicate indexing. Although Scopus offers extensive international coverage, it may underrepresent non-English or regionally indexed publications; this limitation is acknowledged.

Search Strategy and Query FormulationThe

The dataset was obtained through a structured search conducted on June 15, 2025, using an iterative process to refine the query for both recall (comprehensiveness) and precision (relevance). The final search string applied to the Title, Abstract, and Keywords fields in Scopus was as follows: (TITLE-ABS-KEY("local culture" AND "mathematics learning") OR TITLE-ABS-KEY("ethnomathematics")). This query aimed to capture all publications discussing the integration of cultural aspects into mathematics education. The initial search yielded 239 records, including journal articles, proceedings, reviews, book chapters, and monographs.

Inclusion and Exclusion Criteria

A multi-stage screening process was conducted to refine the dataset. Inclusion and exclusion criteria were defined to ensure that only relevant, peer-reviewed, and high-quality articles were analyzed (table 1).

Table 1. Inclusion and Exclusion Criteria	
Inclusion Criteria	**Exclusion Criteria**
Articles published in Scopus-indexed journals	Publications not in final form (e.g., preprints, conference abstracts)
Peer-reviewed articles	Non-peer-reviewed materials
Articles written in English	Non-English publications
Articles discussing the use of local culture in mathematics learning	Articles unrelated to local culture in mathematics education
Articles published between 2015 and 2024	Articles published before 2015 or after 2024

After applying these filters, 117 records were excluded, resulting in 122 documents remaining.

Data Extraction and Pre-processing

The bibliographic data were exported from Scopus in CSV format and included essential metadata such as titles, authors, affiliations, publication years, source titles, document types, author keywords, abstracts, and citation counts. A comprehensive data-cleaning procedure was conducted, consisting of author name disambiguation to merge variant spellings, affiliation standardization to ensure institutional consistency, and keyword harmonization through a VOSviewer thesaurus file. Records with incomplete or missing metadata were removed to maintain analytical reliability. The cleaned dataset was subsequently imported into VOSviewer version 1.6.20, which was selected for its robust capacity to visualize coauthorship, cooccurrence, and citation networks. The analysis comprised both performance analysis examining annual publication trends, journal distribution, and citation patterns and science mapping, which involved co-authorship analysis at the author and institutional levels to uncover collaboration structures, keyword co occurrence analysis using the association strength normalization method to identify thematic clusters, and citation analysis to determine the most influential publications and outlets. All network and density visualizations were generated and interpreted through VOSviewer to illustrate the intellectual structure and thematic evolution of research on local culture integration in mathematics learning from 2015 to 2024.

Study Protocol and Workflow

The research workflow followed a four-stage structure Identification, Screening, Eligibility, and Inclusion adapted from the PRISMA framework for bibliometric studies. The process is visualized in figure 1, summarizing document selection and filtering. Of the initial 239 records, 117 were removed for not meeting the inclusion criteria, resulting in 122 final journal articles used in the analysis.
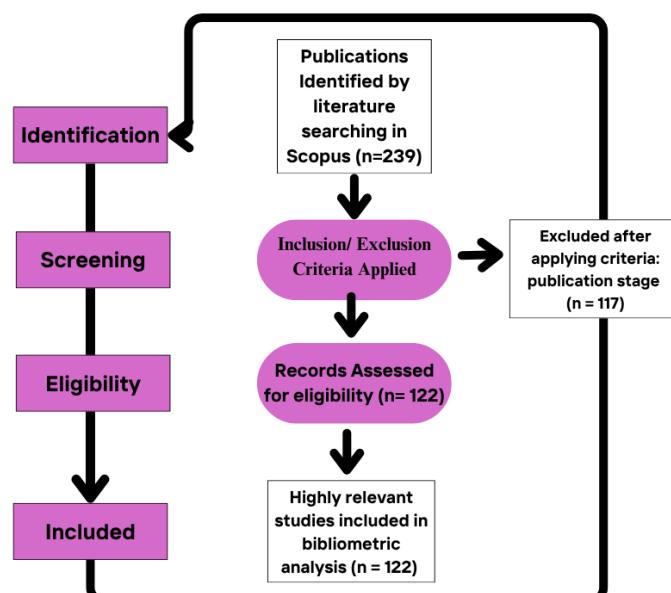

Figure 1. Flowchart of Four-Stage Data Extraction and Filtering

Data Availability Statement

The bibliometric data supporting the findings of this study were obtained from the Scopus database. Due to Scopus licensing restrictions, raw data cannot be publicly shared. However, the cleaned and processed dataset, along with the analysis scripts used in VOSviewer, are available from the corresponding author upon reasonable request.

RESULTS

The literature search on the Scopus database resulted in 239 documents related to the integration of local culture in mathematics learning. After applying the defined inclusion and exclusion criteria, 122 peer-reviewed journal articles were retained for bibliometric analysis (figure 1). This number confirms significant scientific attention to the issue of local culture in mathematics education during the period 2015-2024.

Figure 2 presents the distribution of document types. Journal articles represented the majority (51,5 %), establishing their role as the dominant medium for disseminating research in this domain. Conference papers constituted 34,3 %, reflecting the significance of academic symposiums as platforms for presenting innovative findings. Book chapters (8,9 %), reviews (2,1 %), books (2,1 %), and scientific notes (0,8 %) collectively contributed to the broader literature.
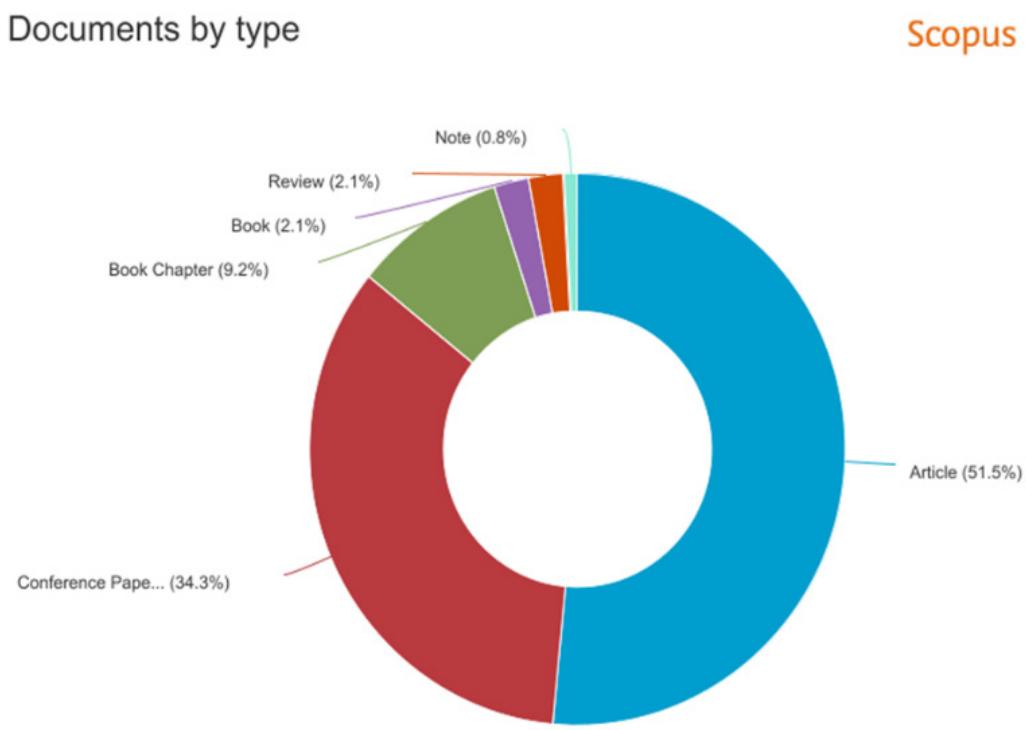
Figure 2. Document Type

Figure 3 illustrates the annual publication trends from 2015 to 2024. The number of publications declined slightly in 2016 and 2017, followed by a steady increase from 2018 onward. A significant spike occurred in 2020, which may correlate with the global shift to remote learning during the COVID-19 pandemic. The highest peak was observed in 2024 with 44 published articles, indicating intensified interest in contextualized and culturally rooted learning approaches.

The analysis of journal sources (figure 4) revealed that the Journal of Physics: Conference Series emerged as the most prolific outlet between 2019 and 2021. Other prominent venues included AIP Conference Proceedings and the ASEE Annual Conference Proceedings. Educational journals such as the Journal on Mathematics Education and the Mathematics Teaching Research Journal contributed consistently, albeit in smaller quantities.

The subject area distribution (figure 5) indicates the interdisciplinary nature of the research. Social Sciences dominated the field (30,4 %), followed by Physics and Astronomy (15,1 %), Mathematics (10,6 %), Engineering (8,6 %), and Computer Science (7,3 %). This distribution highlights the intersection between pedagogical strategies, mathematical content, technological tools, and cultural perspectives. Additional contributions from the humanities, psychology, and environmental sciences further emphasize the need for a multidisciplinary approach to cultural integration in mathematics learning.

Documents by year
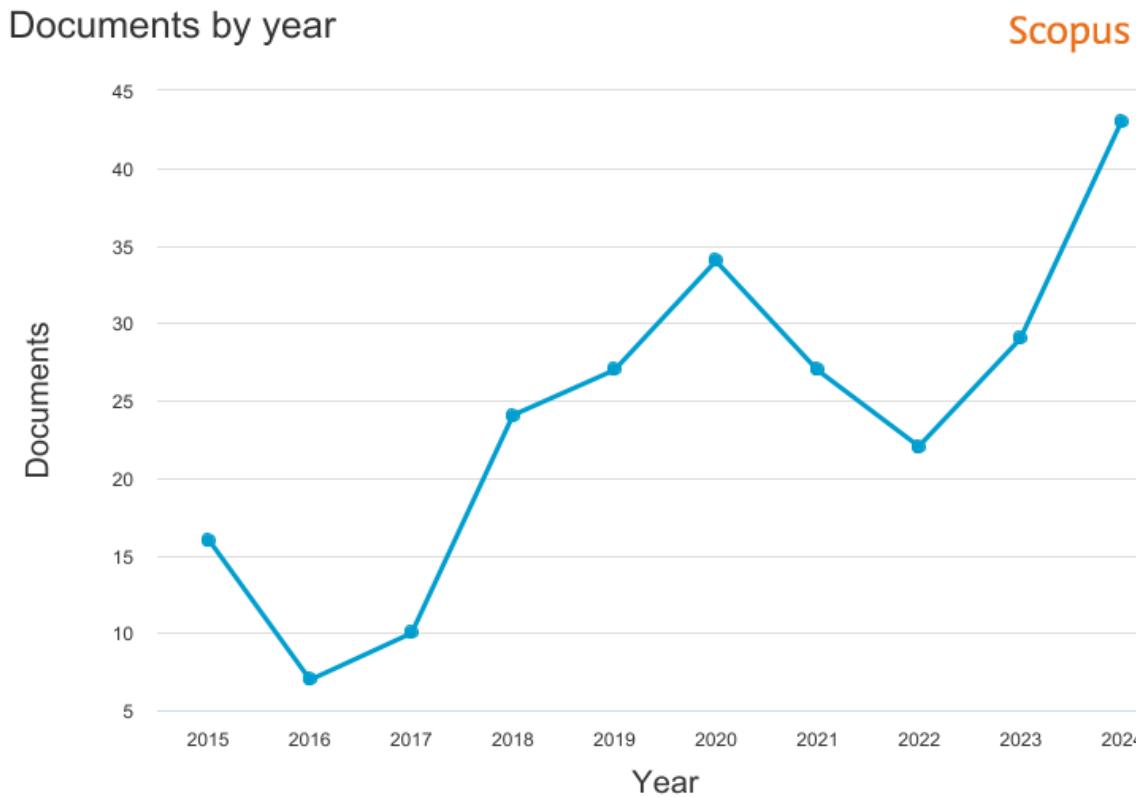
Scopus

Figure 3. Publication Trends from 2015 to 2024

Documents per year by source

Scopus

Compare the document counts for up to 10 sources.Compare sources and view CiteScore, SJR, and SNIP data

- ASEE Annual Conference And Exposition Conference Proceedings
- Journal On Mathematics Education
- Mathematics Teaching Research Journal
- Aip Conference Proceedings
- Journal Of Physics Conference Series
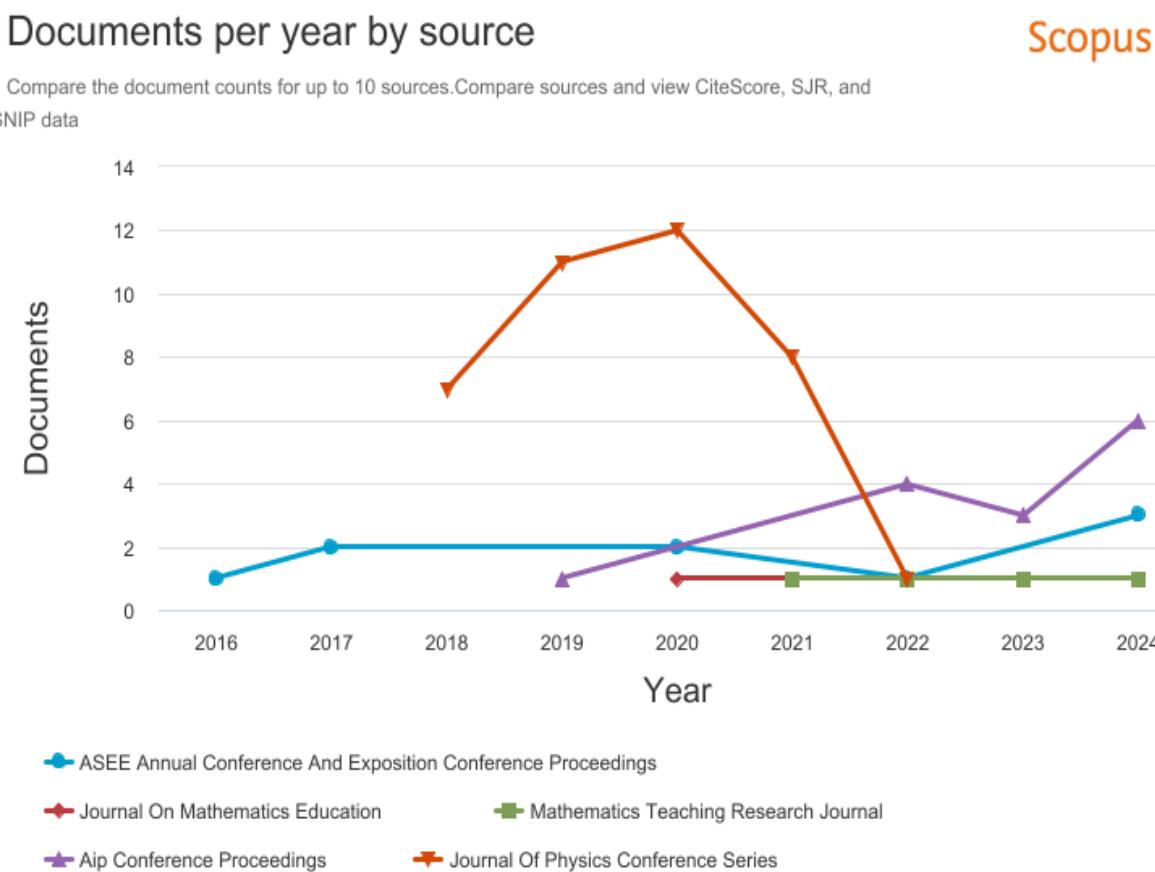
Figure 4. Analysis by Journal Source

Documents by subject area

Scopus
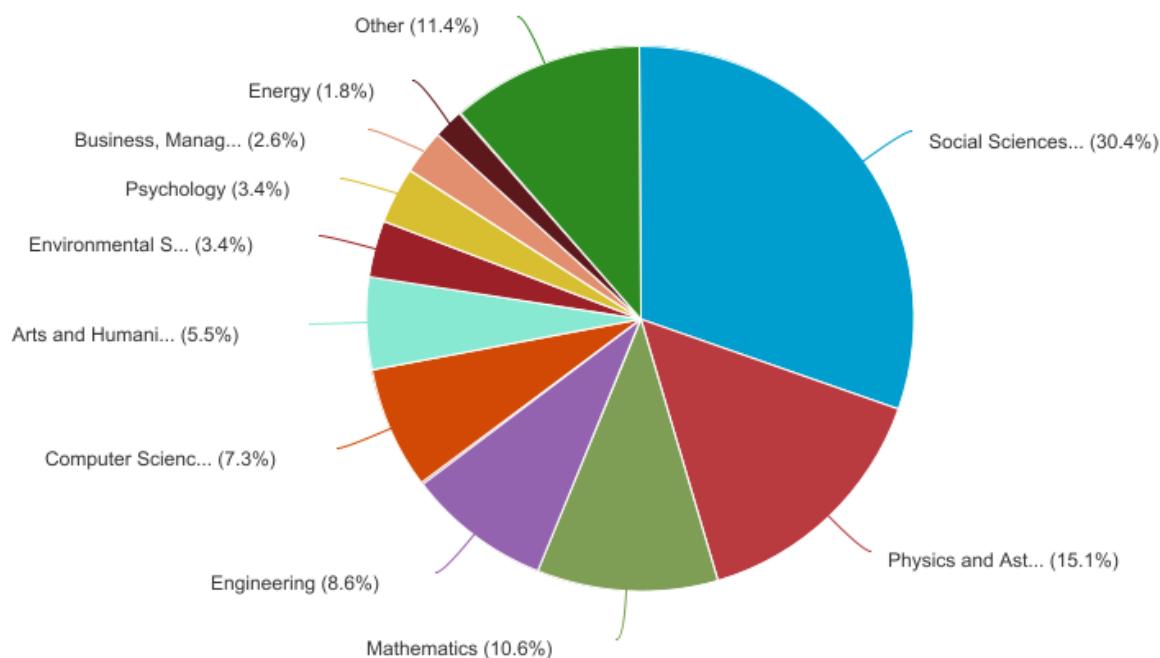
- Other (11.4%)
- Energy (1.8%)
- Business, Manag... (2.6%)
- Psychology (3.4%)
- Environmental S... (3.4%)
- Arts and Humani... (5.5%)
- Computer Scienc... (7.3%)
- Engineering (8.6%)
- Mathematics (10.6%)
- Physics and Ast... (15.1%)
- Social Sciences... (30.4%)

Figure 5. Distribution of Subject Areas

Documents by affiliation

Scopus

Compare the document counts for up to 15 affiliations.
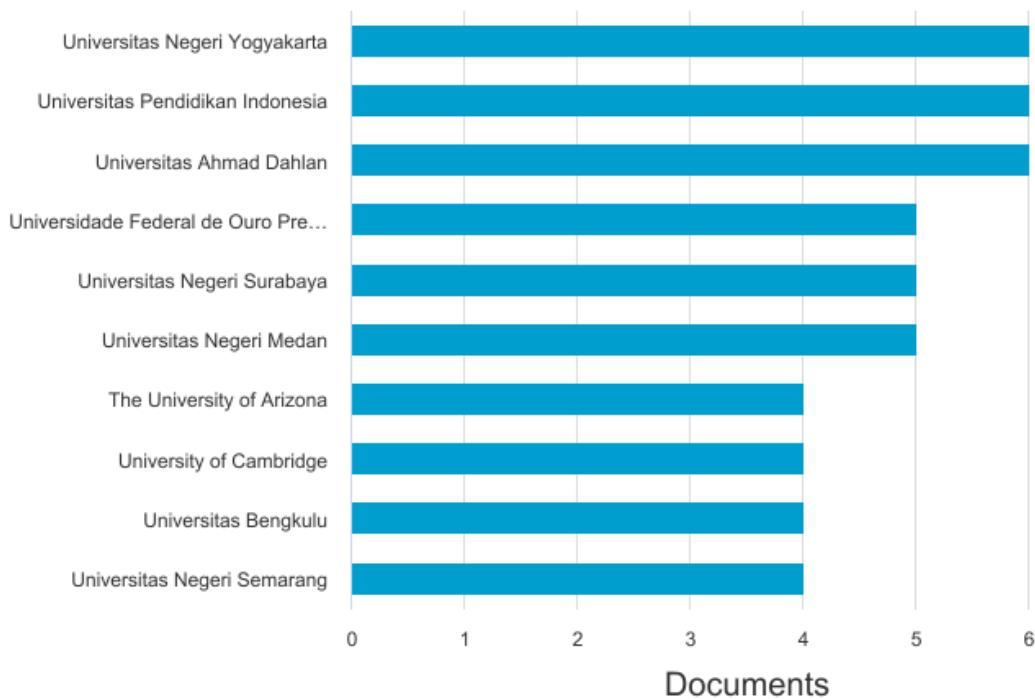
Figure 6. Institutional Analysis

Institutional affiliation analysis (figure 6) showed that Indonesian universities led the field, with *Universitas Negeri Yogyakarta*, *Universitas Pendidikan Indonesia*, and *Universitas Ahmad Dahlan* as the most active contributors. Other institutions such as *Universitas Negeri Surabaya* and *Universitas Negeri Semarang* also made substantial contributions, indicating a geographically dispersed research landscape. Furthermore, international institutions including *Universidade Federal de Ouro Preto* (Brazil), *The University of Arizona* (USA), and *University of Cambridge* (UK) participated, affirming the global relevance of this topic in multicultural education contexts.

From a country perspective, as shown in figure 7, Indonesia tops the list with the highest number of publications, followed by the United States and the United Kingdom. Indonesia's dominance is reasonable given its cultural diversity and the urgency of the relevance of contextualized learning. Other countries such as Brazil, China, Australia, as well as Spain and Malaysia also contributed, showing that this issue has become a global concern across regions.


Documents by country or territory

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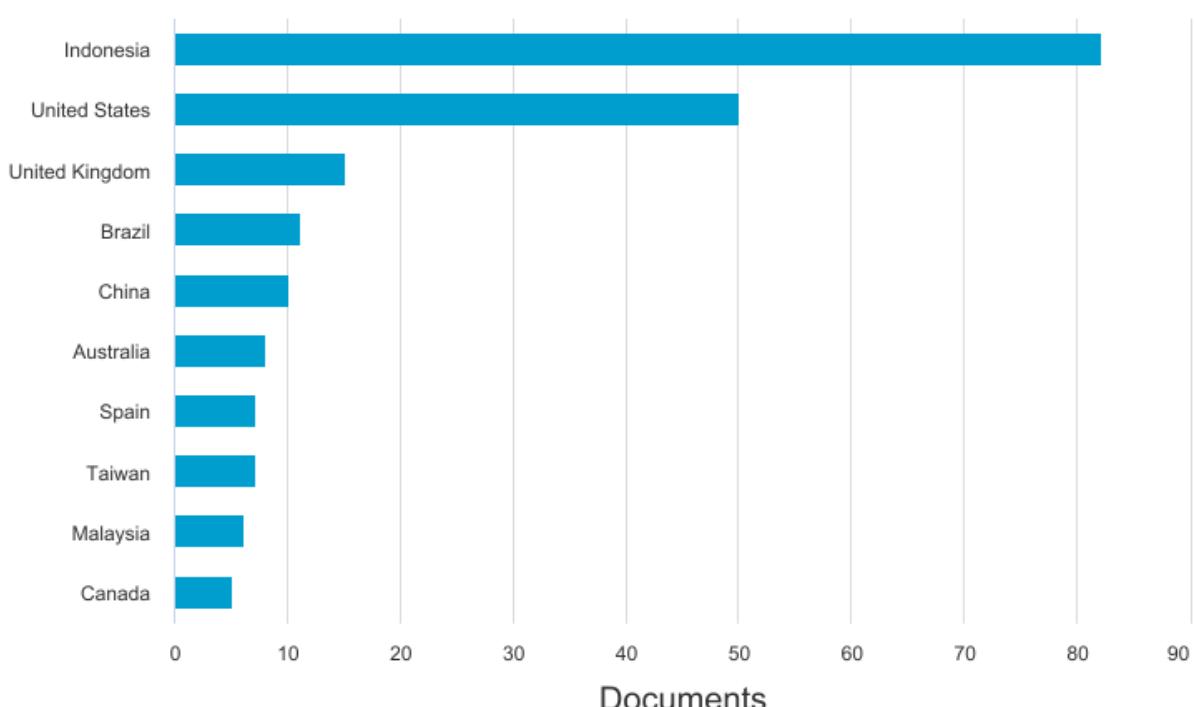
Scopus

Figure 7. Document Distribution by Author

The results of keyword mapping (figure 8) using VOSviewer reveal a complex thematic structure in research on the integration of local culture in mathematics learning. The visualization shows four main clusters: (1) ethnomathematics and contextual geometry (blue), (2) implementation of learning methods (green), (3) application in primary-middle education (red), and (4) technology integration (yellow). The most prominent keywords were *culture*, *mathematics*, and *student*, signifying the central focus of this body of research. The appearance of terms such as STEM and android indicates an emerging emphasis on digital transformation in culturally responsive education. These findings confirm that research on the integration of local culture in mathematics education is not only expanding in volume but also diversifying in focus, methodology, and institutional reach.

To complete the bibliometric analysis and provide a deeper insight into the thematic content and contributions of previous research, the authors identified the ten most relevant and influential articles in the field of local culture integration in mathematics learning. The selection of these articles was based on the number of citations, journal quality and relevance to the research focus. Each article was analyzed based on the main findings and recommendations provided, so that it can be a reference in the development of contextual and culture-based mathematics learning. A summary of the analysis results is presented in table 2 below.
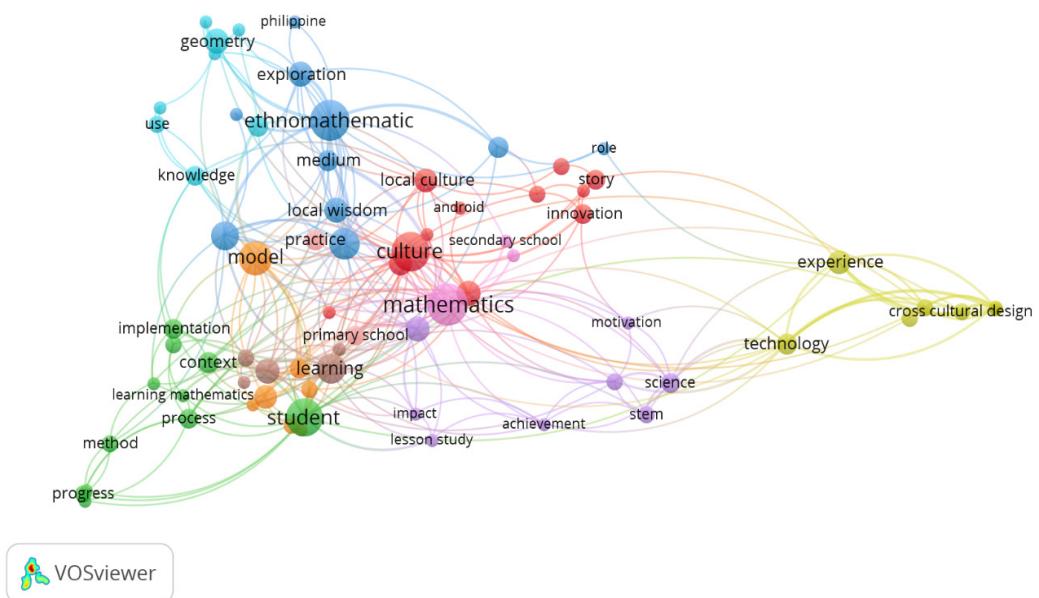
Figure 8. Keyword Visualization

No	Penulis & Tahun	Article title	Number of citations	Temuan Utama	Rekomendasi
		Table 2. Most Cited Articles on Cultural Integration in Mathematics Education (2015-2024)			
1	[16]	Learning geometry and values from patterns: Ethnomathematics on the batik patterns of yogyakarta, indonesia	68	Batik motifs contain transformations geometry and cultural values local	Integrate batik in learning geometry and value culture
2	[17]	Realistic mathematics learning based on the ethnomathematics in Bengkulu to improve students' cognitive level	42	Ethnomathematics and the realistic Improve understanding students	Effectiveness ethnomathematics Very dependent On method teaching, training teacher & design curriculum based culture local
3	[18]	Ethnomathematics: Pranatamangsa system and the birth-death ceremonial in yogyakarta	36	System dating traditional contains Model math	Context culture Very effective As point starting point learning math
4	[19]	Developing culturally responsive mathematics teachers: secondary teachers' evolving conceptions of knowing students	27	Teacher training enhance awareness of social context and culture students	Integrate approach culturally responsive teaching in teacher training
5	[20]	Culture-based contextual learning to increase problem-solving ability of first year university student	26	Contextualization culture increase ability problem solving student	Development Material lecture based culture very effective
6	[21]	The ethnomathematics of the Kabihug tribe in Jose Panganiban, Camarines Norte, Philippines	19	Knowledge mathematics local rich in cultural practices	Collaboration between Educators and society indige nous people to create materials teaching materials learning math which more inclusive and relevant
7	[22]	Cross cultural analysis of an Iranian mathematics lesson: A new perspective for raising the quality of teaching	12	Learning cross-cultural improve quality Teaching mathematics	Adopt lesson study As strategy Transnational reflective
8	[23]	Ethnomathematical Aspects Of Learning Geometry And Values Related To The Motifs Used By The Dayak Ngaju Tribe In Central Kalimantan	11	Motif containing transformation geometry and values culture	Usage motif Local in learning contextual

| 9 | (24) | Development of blended learning based on Google Classroom with osing culture theme in mathematics learning | 11 | Blended model learning culture-based valid, practical, and effective | Widely applied In other regions with cultural customization |
| 10 | (25) | The Effect of STEM Model Based on Bima's Local Cultural on Problem Solving Ability | 10 | STEM Model culture-based model improve Understanding geometry | Expand model Aspect creativity other aspects such as and motivation |

DISCUSSION

This bibliometric analysis provides a decade-long overview of how research on the integration of local culture into mathematics learning has developed within Scopus-indexed publications from 2015 to 2024. The findings indicate a consistent rise in scholarly attention, particularly after 2018, reflecting an increasing global recognition of cultural relevance as a key dimension of effective and equitable mathematics education. Three dominant thematic clusters were identified: (1) culturally responsive pedagogical approaches, (2) the strengthening of mathematical understanding through indigenous and context-based knowledge systems, and (3) technology enhanced innovations designed to preserve and apply cultural knowledge. Although global interest has expanded, contributions remain unevenly distributed, with Indonesia leading the field and limited representation from Africa and South America, highlighting persistent regional imbalances.

The interpretation of these findings aligns with international scholarship positioning mathematics as a culturally situated discipline shaped by community practices. Ethnomodelling research particularly the theoretical work of Rosa and Orey, helps explain these trends, showing how local cultural systems act as generative frameworks that reshape global mathematical ideas through glocalization processes.[26] This mechanism is reinforced by empirical studies demonstrating that cultural artifacts, crafts, and indigenous spatial reasoning encode sophisticated mathematical structures, as seen in Sasaknese cultural artifacts[27] and rattan craftsmanship.[28] Similarly, research consistently shows that culturally embedded instruction enhances students' identity formation, agency, and engagement, a pattern reflected in culturally grounded digital games developed in Brazil.[29]

A major trend revealed by this study is the emergence of digital ethnomathematics. The integration of local cultural values into mobile and visualization technologies such as Android-based applications embedding Bugis–Makassar cultural elements[30] and digital analyses of traditional architectural structures like the Joglo Pendopo Ageng[31] illustrates how technology can preserve, reinterpret, and mobilize cultural knowledge to support mathematical understanding. These developments explain the prominence of the third thematic cluster and indicate that digital tools are becoming essential mechanisms for modernizing and scaling culturally grounded mathematics instruction. This sentence was strengthened to explain the "mechanism" behind the results, as requested by reviewer. The dominance of Indonesian research within the dataset reflects national curriculum policies emphasizing contextualization and cultural heritage. In contrast, the underrepresentation of Africa, South America, and the Pacific likely reflects disparities in research infrastructure, database visibility, and institutional funding rather than a lack of cultural knowledge. This geographical imbalance limits the global applicability of current ethnomathematics models and underscores the need for broader cross-regional and comparative research efforts.

The broader implications of these findings are multifaceted. Theoretically, they reinforce mathematics as a sociocultural construct shaped by local epistemologies and community-based knowledge systems. Practically, they support the development of culturally responsive curricula, learning materials, and technology-enhanced environments aimed at improving conceptual understanding and learner engagement. At the policy level, these findings provide empirical justification for embedding cultural relevance within mathematics education frameworks.

Nevertheless, this study has limitations. Reliance on Scopus may exclude regionally published or non-indexed studies, potentially omitting culturally significant research from underserved regions. Bibliometric analysis also captures structural patterns but cannot measure pedagogical effectiveness or classroom-level impact. This section was expanded to meet the reviewer's request for a more honest and explicit limitations discussion. Future research should therefore combine bibliometric analysis with empirical, longitudinal, classroom-based, and cross-cultural studies. Expanding geographic coverage—especially to Africa, South America, and the Pacific— will improve global validity and promote equitable knowledge production.

CONCLUSIONS

This bibliometric analysis provides a comprehensive overview of the development of local culture integration in mathematics education across 122 Scopus-indexed publications from 2015 to 2024, revealing a significant rise in scholarly attention, particularly after 2018. The thematic structure identified three major areas culturally grounded pedagogical strategies, the reinforcement of mathematical understanding through indigenous

knowledge, and the growing incorporation of digital tools to support cultural preservation and learning aligning with international perspectives that position mathematical knowledge as culturally situated and dynamically constructed. Despite these promising developments, the field remains geographically imbalanced, with research heavily concentrated in Asia, especially Indonesia, while underrepresented regions contribute minimally, limiting global generalizability. Overall, the findings affirm local culture integration as a transformative pedagogical approach that strengthens conceptual understanding, learner identity, and engagement, while also providing an empirical foundation for future culturally responsive curriculum development, technological innovation, and more equitable global research participation.

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CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION
Conceptualization: Edwin Musdi.
Data curation: Devi Khairani.
Formal analysis: Edwin Musdi, Devi Khairani.

Research: Muth Mainnah Rangkuti,Nurul Syifa Riztavia.
Methodology: Edwin Musdi, Elita Jamaan.
Project management: Edwin Musdi.
Resources: Edwin Musdi, Devi Khairani, Daharnis, Elita Jamaan.
Software: Devi Khairani, Muth Mainnah Rangkuti.
Supervision: Edwin Musdi, Daharnis.
Validation: Daharnis, Elita Jamaan.
Display: Edwin Musdi.
Drafting - original draft: Edwin Musdi, Devi Khairani.
Writing - proofreading and editing: Devi Khairani, Elita Jamaan, Nurul Syifa Riztavia.