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Trends in STEM-Based Ethnomathematics Research in Mathematics Education in Indonesia: A Systematic Literature Review

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Abstract: Ethnomathematics and STEM represent an innovative approach to mathematics education by integrating local culture with STEM (Science, Technology, Engineering, and Mathematics), creating a more contextual and meaningful learning experience. This study aims to analyze trends in the development of ethnomathematics and STEM research in mathematics education from 2017 to 2026 using the SLR method with the PRISMA approach. The number of publications increased significantly in 2024 to 7 articles and peaked in 2026 at 8 articles, indicating growing researcher interest in ethnomathematics studies using a STEM approach in mathematics education. The research is dominated by R&D and Quantitative methods focused on developing learning media and improving mathematical skills such as conceptual understanding, problem solving, critical thinking, and mathematical reasoning. The findings suggest that integrating local culture with STEM can support mathematics education, including local cultures such as Sulawesi, Kalimantan, and Java. This study highlights the potential of integrating STEM with a cultural elements approach to create more engaging and meaningful learning experiences. This approach offers innovative ways to enhance students' mathematical understanding.

Keywords: ethnomathematics, STEM, mathematics learning, systematic literature review.

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INTRODUCTION

Mathematics is a discipline that plays a crucial role in developing logical, analytical, and complex problem-solving skills. In schools, mathematics is a core subject that requires students to cultivate critical thinking abilities. (Auliya et al., 2024). Cevikbas et al. (2024) found that research in mathematics education continues to grow globally, with a primary focus on competency development, instructional technology, and improving student learning outcomes. Therefore, mathematics instruction should emphasize not only mastery of concepts but also the cultivation of higher-order thinking skills relevant to 21st-century demands.

Ethnomathematics offers a new perspective in education, referring to the relationship between culture and mathematics. Over time, it has developed into an instructional approach that connects mathematics with social and cultural contexts and helps enhance the quality of mathematics education (D'Ambrosio, 2020; Mulyadi & Putra, 2025; Nasrum et al., 2025). Ethnomathematics emphasizes that mathematical concepts are inseparable from the cultural activities of daily life, making learning more meaningful and contextual. As such, ethnomathematics can bridge abstract mathematical concepts and students' real-life experiences, helping them understand these concepts more deeply and contextually. This aligns with Payadnya et al. (2024), who argue that ethnomathematics connects mathematics instruction with students' culture and experiences, creating more meaningful and relevant learning. Such contextual learning enables students to relate

the concepts being studied to real-world situations, making learning more meaningful and encouraging students to apply the concepts, which in turn fosters the development of critical thinking and problem-solving abilities (Abu-rasheed et al., 2023; Hasanpour-dehkordi, 2021)

Ethnomathematics not only helps students understand mathematical concepts through local culture but can also be developed through integrated instructional approaches. One such approach is STEM (Science, Technology, Engineering, and Mathematics), which integrates various disciplines to address contextual problems comprehensively. This characteristic aligns with ethnomathematics, which shares similar phenomena and issues closely related to students' everyday lives. Therefore, integrating STEM and ethnomathematics can create more meaningful learning experiences while also supporting the development of 21st-century skills. STEM-based instruction emphasizes the interconnectedness of scientific, technological, engineering, and mathematical concepts, making learning more contextual and relevant to 21st-century needs (Han et al., 2021; Margot & Kettler, 2019). The STEM approach has been widely developed in education because it supports the cultivation of 21st-century skills, such as critical thinking, creativity, communication, and collaboration (AlAli, 2024; Ilma et al., 2023; Lafifa et al., 2023). Research on STEM in mathematics education has shown significant growth across various educational levels, from elementary schools to higher education. STEM studies often focus on developing instructional media, teaching materials, learning models, and integrating digital technology in mathematics education (Li et al., 2020; Wahono et al., 2020).

STEM and ethnomathematics share a common emphasis on contextual learning rooted in real-world phenomena relevant to students' lives. Ethnomathematics connects mathematical concepts to culture and everyday experiences, while STEM encourages solving real-world problems through an interdisciplinary approach. These similarities suggest that integrating STEM and ethnomathematics can create more meaningful and relevant learning experiences for students. This view is supported by Suprapto et al. (2024), who emphasized that understanding of the role and application of mathematics can be enhanced through cultural, interdisciplinary, and real-world analysis. Similarly, Supriyadi et al. (2024) found that this approach significantly benefits students' understanding of mathematics. Therefore, integrating STEM and ethnomathematics can support contextual and meaningful 21st-century mathematics learning.

Ethnomathematics and STEM complement each other; each has contributed significantly to mathematics education independently. Ethnomathematics connects students to cultural contexts in mathematics learning, illustrating mathematical concepts in ways that are meaningful and relevant to students' daily experiences (Iriandre et al., 2025; Yanti, 2025). STEM, on the other hand, emphasizes the integration of science, technology, engineering, and math through learning that is oriented toward focused on solving authentic and contextual problems, gives students a chance to develop critical thinking, problem-solving, creativity, and collaborative skills when issues that are relevant to real life(English, 2023; HIgde & Aktamýs, 2022; Tytler et al., 2023).

The integration of ethnomathematics and STEM has the potential to create learning experiences that are both culturally relevant and supportive of the development of students' critical thinking, creativity, and problem-solving abilities(Ariyatun, 2021; Risnanosanti et al., 2024; Sumarni et al., 2025). The shared characteristics of both approaches, which emphasize contextual and problem-based learning, present promising opportunities for integration in mathematics education. Integrating ethnomathematics and STEM not only allows students to understand mathematical concepts through cultural

perspectives but also helps them develop 21st-century skills.

Recent educational reforms have increasingly promoted integrating local culture into mathematics instruction through culturally responsive and contextual approaches. In line with this trend, ethnomathematics has garnered increasing attention from researchers, and recent studies have begun integrating it with STEM to create more meaningful and authentic mathematics learning experiences. Previous systematic reviews have also consistently shown that ethnomathematics positively contributes to students' mathematical understanding, critical thinking skills, mathematical literacy, and cultural awareness.

However, although the body of empirical evidence continues to grow, most existing reviews still focus on testing the effectiveness of learning, specific mathematical topics, or particular teaching approaches; consequently, our understanding of how STEM-based ethnomathematics research is evolving in terms of publication trends, methodological characteristics, educational contexts, and cultural representations remains limited. Consequently, it remains unclear whether the integration of ethnomathematics and STEM has evolved into a comprehensive pedagogical approach or has primarily been examined through standalone effectiveness studies. How has STEM-based ethnomathematics research in mathematics education in Indonesia evolved in terms of publication trends, educational levels, mathematical topics, and research methodologies? How has Indonesia's rich cultural diversity been represented in STEM-based ethnomathematics research, and are certain geographical regions still underrepresented in the existing literature?

METHOD

This study aims to analyze research trends in ethnomathematics with a STEAM approach in mathematics education in Indonesia. The method utilized in this research is a Systematic Literature Review (SLR), which is a research method designed to systematically collect, evaluate, and synthesize research findings from various relevant scientific sources. This approach enables researchers to identify patterns, developments, and directions of STEAM-based ethnomathematics research within a specified period. The literature used in this study was drawn from scholarly articles obtained through Publish or Perish (PoP) using the Google Scholar academic database.

Article searches used several keywords related to the research topic: STEM AND (Ethnomathematics OR Etnomatematika) AND (Mathematics OR Matematika). The articles obtained were then selected based on predetermined inclusion and exclusion criteria. The inclusion criteria in this study were: (1) research articles related to ethnomathematics and STEM, (2) articles published in national journals indexed by SINTA 1 to SINTA 6, (3) articles employing quantitative, qualitative, or mixed research methods, (4) articles available in full-text format, and (5) articles published between 2017 and 2026. The exclusion criteria consisted of: (1) articles not relevant to the context of mathematics education, (2) articles not available in full, and (3) articles containing duplicate data.

To ensure that article selection was systematic, transparent, and replicable, the review process followed PRISMA 2020 (Page et al.,2021). In the identification stage, articles were identified from databases using keywords. In the screening stage, articles were selected based on titles and abstracts to determine their topic relevance. Relevant Articles were analyzed in the eligibility stage. Eligible articles were included for further analysis. The article selection process flow in this study is illustrated in the PRISMA diagram below.

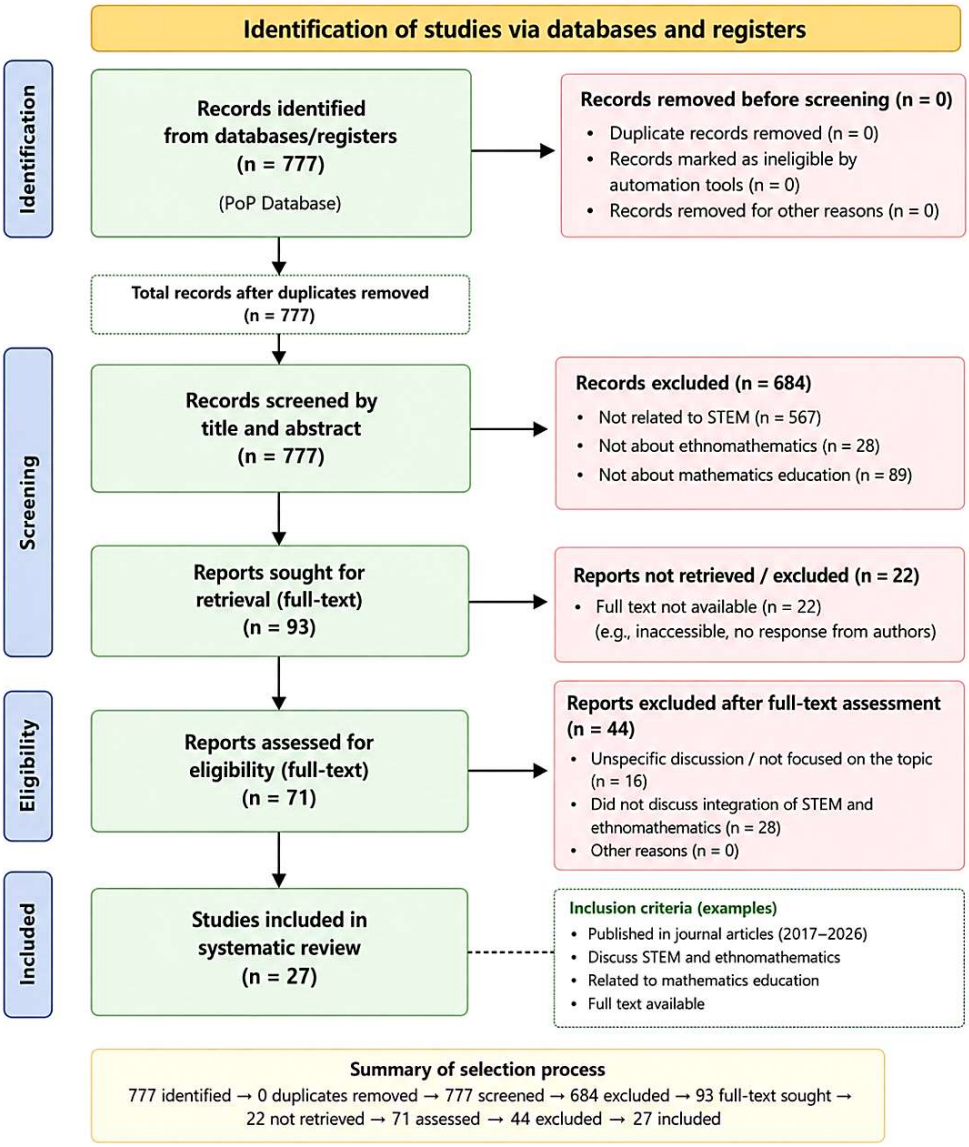

Figure 1. PRISMA flowchart

Identification stage

In this stage, Publish or Perish (PoP) was utilized to search for journal articles published between 2017 and 2026 in CSV format; the result was 777 articles. The CSV files were converted into .xlsx format for processing in Microsoft Excel. The journal data were processed and filtered according to the analytical needs.

Screening stage

At this stage, titles, abstracts, keywords, and publication years were screened. Articles were eliminated if they did not discuss mathematics education, were unrelated to ethnomathematics or STEM, or were published before 2017 or after 2026. This stage ensured that only articles relevant to the research topic remained.

Eligibility stage

Relevant articles proceeded to the eligibility stage for comprehensive full-text article review. Articles were analyzed based on the relevance of the research object, methodology,

implementation of ethnomathematics and STEM, and results. Articles that were not eligible, such as articles with less relevant discussions, incomplete research data, or unavailable full texts. This stage ensured that the included articles aligned with the focus of the systematic literature review.

Inclusion stage

In this stage, the selected articles were included as the final data source for the systematic literature review. These articles were analyzed to identify research trends in ethnomathematics and STEM in mathematics education during 2017–2026, including year of publication, research methods, educational levels, mathematical abilities, cultural origin, and SINTA classification.

Inclusion and Exclusion Criteria

The selection of articles in a systematic review is guided by inclusion and exclusion criteria to ensure relevance, consistency, and methodological rigor. Figure 2 presents the inclusion and exclusion criteria. The selection process resulted in 27 articles meeting the inclusion criteria.

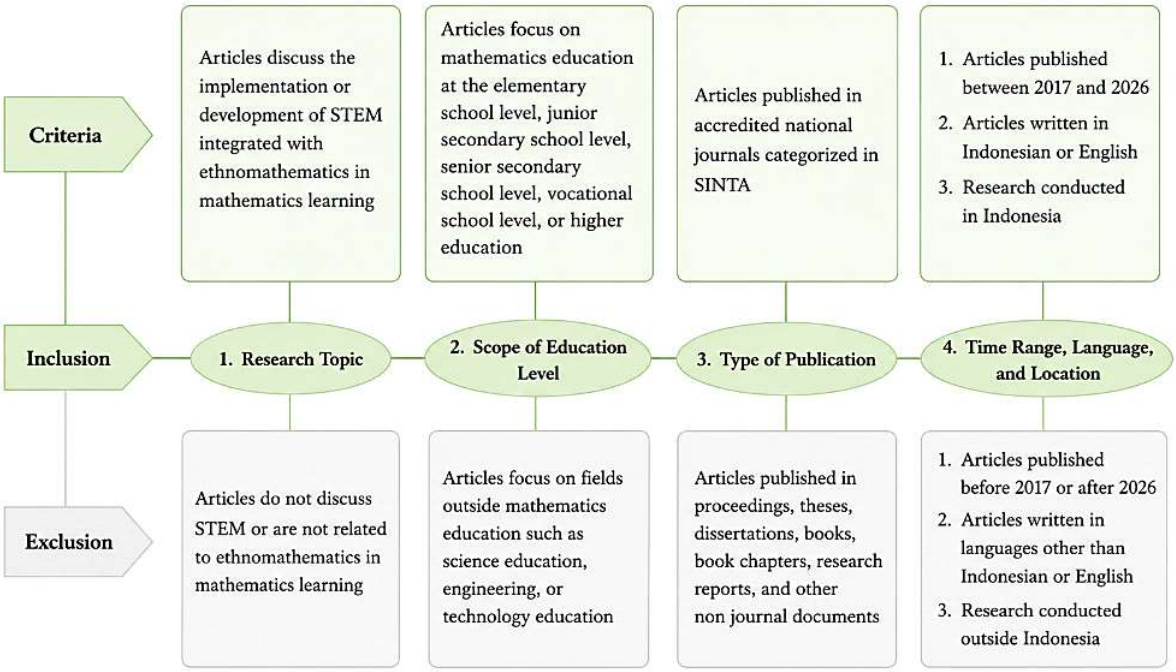

Figure 2. Criteria for inclusion and exclusion

Data Extraction

Data extraction was performed to ensure that the information gathered from each article is relevant and consistent. The coding framework is based on the research objectives and the focus of the research questions so that all information needed for the synthesis process can be systematically identified. The extracted data include bibliographic information such as the author's name, year of publication, and journal index (SINTA), as well as research characteristics like education level, research location, research methods, and research focus. The research focus is coded based on the main theme discussed in each article, such as Higher Order Thinking Skills (HOTS), 21st-century skills (4C Skills), affective aspects, and Conceptual Understanding. During coding, a single article may be assigned to more than one category if it reports on multiple capabilities.

Consequently, the total frequency of categories may exceed the number of articles analyzed. The coding framework is used to organize and synthesize data in order to identify characteristics, patterns, and trends in ethnomathematics-based STEM research. All extracted data were then reviewed again to ensure data consistency before entering the synthesis stage. To ensure a systematic and transparent data extraction process, a thematic matrix codebook was developed based on the research questions presented in Table 1.

Table 1. Thematic data extraction codebook

Research Question	Analytical Theme	Code	Extracted Data
RQ1	Publication Trends	PT	Publication Year
	Publication Quality	PQ	SINTA Index
	Educational Levels	EL	Elementary, Junior High, Senior High, Higher Education
	Mathematical Competencies	MC	Critical thinking, problem-solving, mathematical literacy, creative thinking, mathematical communication, mathematical reasoning, HOTS, numeracy
	Research Methodologies	RM	Quantitative, Qualitative, Mixed Methods, R&D, SLR
RQ2	Cultural Representation	CR	Cultural objects, Traditions, Local Wisdom
	Geographical Distribution	GD	Province or Island

Data Synthesis

Data synthesis was conducted in two stages. The first stage involved descriptive analysis to summarize publication trends by year. The second stage employed thematic synthesis of the 27 selected articles to extract and categorize information relevant to the research questions, including educational level, mathematical topics, research methods,

STEM integration, cultural objects, and geographical regions. The extracted themes were then synthesized descriptively using frequency distributions, tables, figures, and a concept map to identify research trends, characterize the existing body of literature, and reveal research gaps in STEM-based ethnomathematics in mathematics education.

Data Analysis

The synthesis data were analyzed descriptively. The analysis counted the frequency of each coding category, then interpreted the resulting patterns and trends. The results are presented in charts and narrative descriptions to provide an overview of research development trends, research characteristics, and the focus of research on implementing ethnomathematics-based STEM in math learning in Indonesia.

■ RESULT AND DISCUSSION

Articles in this study were searched using the Google Scholar database. The keywords were "ethnomathematics" and "STEM," with searches published between 2017 and 2026; a total of 777 articles were identified using the Publish or Perish (PoP) tool. After screening against the inclusion and exclusion criteria, 27 articles were selected as the final sample for analysis. A total of 27 articles were identified for further analysis; the results show an increase in the number of articles published on STEM-based ethnomathematics since 2017. This trend is

closely related to the implementation of curricula emphasizing challenge-based learning and connections to everyday life. The results presented include the year of publication, research methods, educational levels, mathematical abilities, cultural origin, and SINTA classification.

Research Trends and Characteristics of STEM-Based Ethnomathematics Research

The number of published articles varied from year to year during the period 2017-2026. According to the identified articles, no publications were found from 2017 to 2019. In 2020 and 2021, there were three articles each on ethnomathematics and STEM in mathematics education, followed by a decrease to two articles in 2022. No relevant articles were identified in 2023. The number of publications increased significantly in 2024, with seven articles, followed by six articles in 2025, and the highest in 2026 with eight articles. These findings research on STEM-based ethnomathematics in mathematics education has grown considerably in recent years. This trend suggests that research articles on ethnomathematics and STEM approaches in mathematics education have attracted increasing attention from researchers, especially to support 21st-century learning and the implementation of the Merdeka Curriculum.

In addition to the publication trends, research characteristics can also be examined based on the SINTA ranking of the journals in

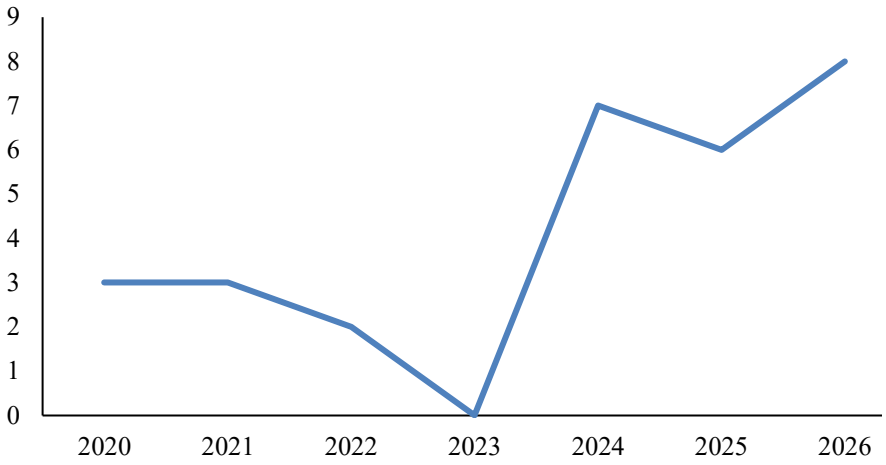

Figure 3. Trend of the number of research articles in mathematics education in indonesia

which the articles were published. This classification aims to determine the quality and distribution of publications

on ethnomathematics and STEM research in mathematics education within nationally accredited journals. The SINTA ranking classification results are presented in Table 2 below.

Most ethnomathematics research employing a STEM approach in mathematics

Table 2. Classification of the SINTA

Year	SINTA Journal Ranking						Total
	S1	S2	S3	S4	S5	S6	
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0
2020	0	0	0	1	1	0	2
2021	1	0	0	0	0	0	1
2022	0	0	2	0	0	0	2

2023	0	0	0	0	0	0	0
2024	0	3	2	1	1	0	7
2025	0	2	4	1	0	0	7
2026	0	2	3	2	1	8	8
	1	7	11	5	3	0	27

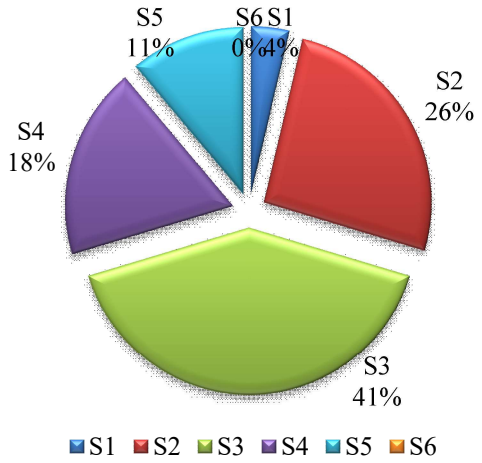

Figure 4. SINTA quartile distribution chart (2017-2026)

education has been conducted at the junior secondary school level, with 10 articles. Most ethnomathematics research employing a STEM approach in mathematics education has been conducted at the junior secondary school level, with 10 articles. One possible explanation is that junior high school mathematics includes several topics, particularly geometry, that can be readily contextualized through local cultural practices. Many Indonesian cultural artifacts, such as traditional houses, carvings, weaving patterns, and batik motifs, inherently embody geometric concepts, making them suitable contexts for integrating ethnomathematics with STEM learning. Consequently, researchers may have preferred junior high school settings because these topics enable the development of contextual learning media and authentic STEM-based activities. This interpretation is consistent with previous studies that implemented local culture and STEM learning using geometry-related cultural contexts in junior high school mathematics (Günay & Takunyac, 2023; Hoffmeester et al., 2025; Sudarsono et al., 2026).

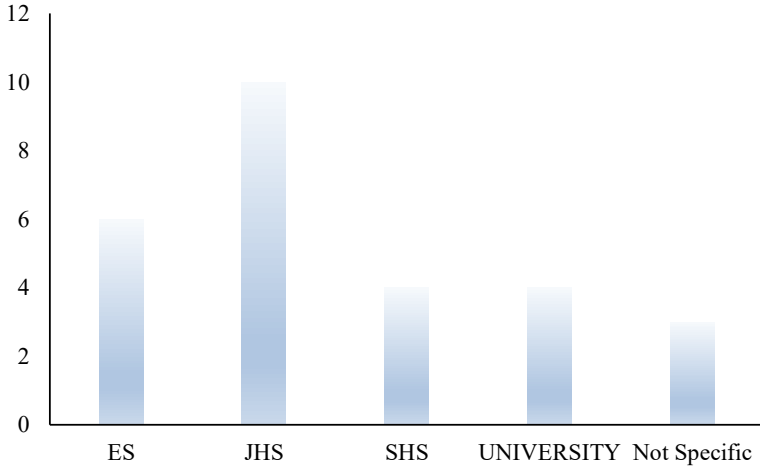

Figure 5. Trend of research by educational level

The differences in educational levels are subsequently linked to the abilities that form the focus of the research. In this study, the findings were grouped into four categories: (1) conceptual understanding, included students' understanding of mathematical concepts; (2) higher-order thinking skills (HOTS), encompasses critical thinking, problem-solving, creative thinking, mathematical reasoning, computational thinking, visual-spatial thinking, and critical understanding; (3) 21st-century skills (4C skills), covers communication and collaboration abilities; and (4) and affective aspects, includes learning interest and motivation. This classification aims to group and analysis the reviewed articles.

As shown in Figure 8, most studies focused on higher-order thinking skills (HOTS) and conceptual understanding. The implementation of

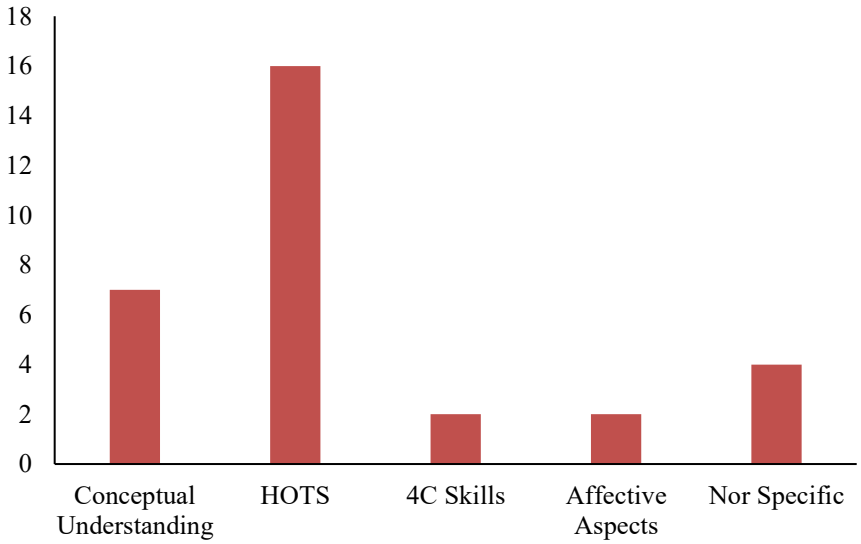

Figure 6. Frequency of ability categories

ethnomathematics and STEM was predominantly directed toward developing students' cognitive abilities. This finding indicates that integrating local culture into mathematics instruction is used not only to facilitate students' understanding of mathematical concepts but also to foster more complex thinking skills, such as critical thinking, problem-solving, and creative thinking. In contrast, 21st-century skills (4C skills) and affective aspects were addressed less frequently. This suggests that research on ethnomathematics and STEM has been more focused on cognitive abilities than on students' social or affective skills.

In addition to the capabilities that are the focus of the research, the characteristics of the research can also be observed through the type of research employed. This categorization aims to identify research types related to ethnomathematics and STEM in mathematics education. The analysis revealed that the research methods employed include qualitative, quantitative, mixed-methods, research and development (R&D), and systematic literature review (SLR) approaches.

Based on the analysis, 11 articles were categorized as research and development (R&D) studies, followed by 8 quantitative studies. In addition, 4 qualitative studies and 3 systematic literature reviews (SLR) were identified, while classroom action research (CAR) was the least used, with only 1 article. The analysis indicates that R&D studies were the most dominant, with 11 articles primarily focusing on developing instructional products such as e-modules, student worksheets (LKPD), digital media, and teaching materials incorporating ethnomathematics and STEM. The 8 quantitative studies mostly

examined the influence and effectiveness of ethnomathematics and STEM instruction on students' mathematical abilities, including conceptual understanding, critical thinking, and problem-solving. The results also show that qualitative studies remain relatively limited compared to research oriented toward outcome measurement and product development. The distribution of these research types is presented in Figure 7.

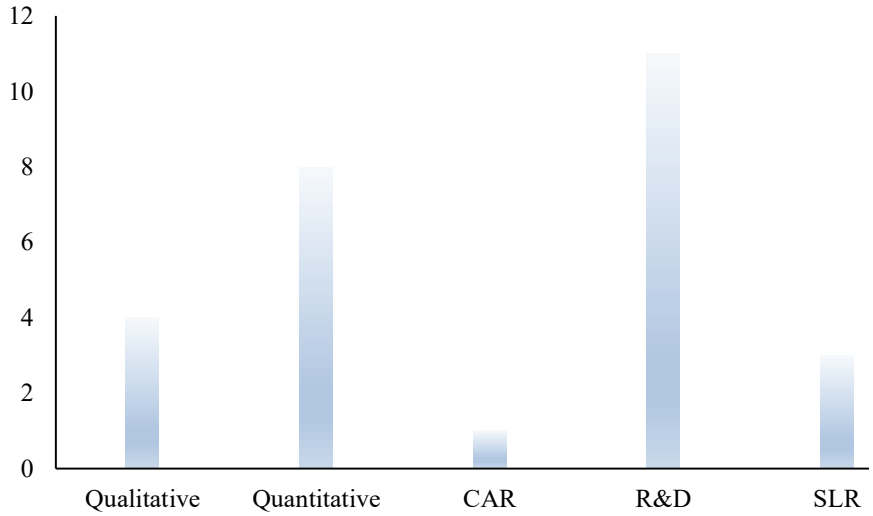

Figure 7. The distribution of research based on types of research

Cultural Representation and Geographical Distribution

By region, most studies originated from Java Island, followed by Nusa Tenggara. The use of local culture as context in mathematics learning is still dominated in western and central Indonesia. Research from Bali and Maluku is relatively underexplored, while research from Kalimantan, Sulawesi, Papua, and Sumatra is limited. The local cultures include Dayak, Banjar, Toraja, Songket Lombok, Perahu Arumbae, and Rumah Kaki Seribu. Several articles do not specifically discuss cultural regions because these articles are systematic literature reviews (SLRs). These findings reveal that the integration of local culture in STEM and ethnomathematics research is unequally distributed across Indonesia. The context of ethnomathematics and STEM research received limites attention.

Overall, the results of the systematic literature review indicate that research on ethnomathematics and STEM in mathematics

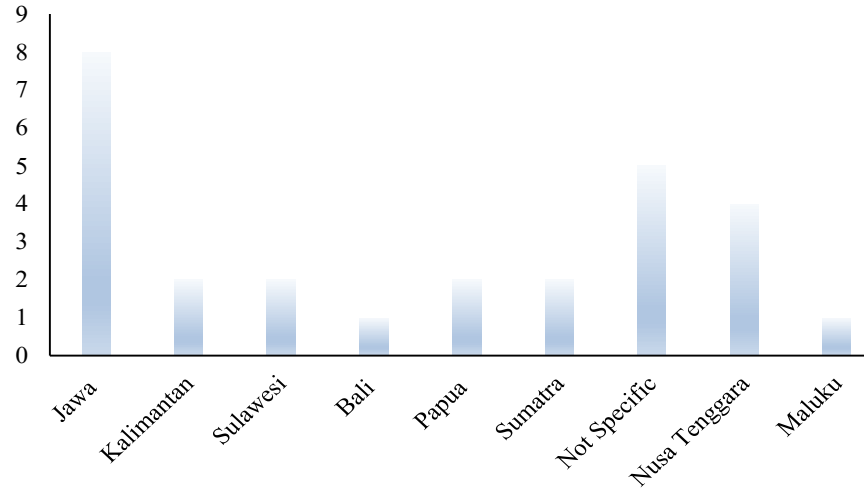

Figure 8. The distribution of research based on demographic

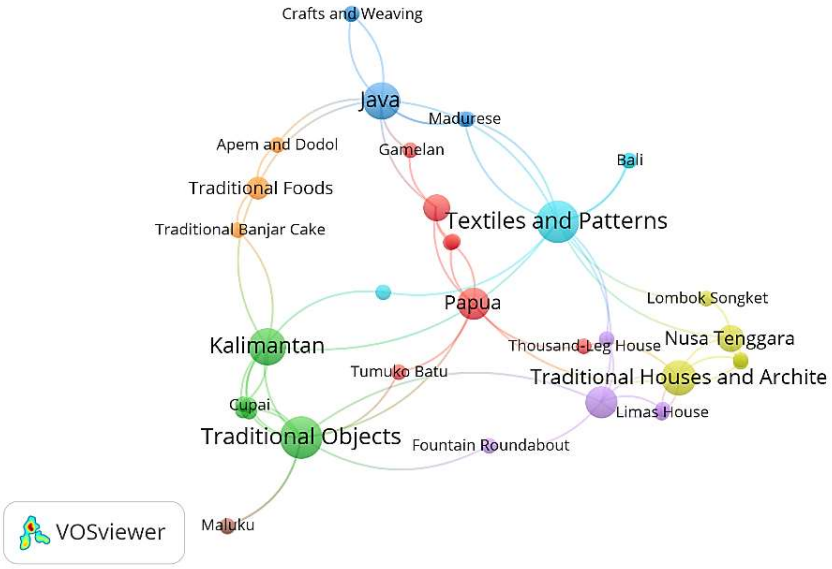

Figure 9. Concept map of cultural demographics

education has grown significantly in recent years. The research is predominantly characterized by quantitative methods and research and development (R&D) approaches, with a primary focus on developing instructional media and enhancing students' mathematical abilities, such as conceptual understanding, problem-solving, and critical thinking. Furthermore, implementing local cultures from various regions in Indonesia shows that ethnomathematics and the STEM approach can make mathematics learning more contextual and meaningful for students. These findings are consistent with Ma'rufi et al. (2021), which state that integrating ethnomathematics and STEM can enhance students' understanding of mathematical concepts by incorporating cultural elements into mathematics instruction. Batiibwe (2024) emphasized that ethnomathematics has increasingly been implemented to connect mathematical concepts with local cultural knowledge, thereby promoting culturally responsive mathematics learning. Similarly, Xu and Ball (2024) reported that international ethnomathematics research has shifted from merely identifying mathematical ideas embedded in cultural practices toward exploring diverse forms of mathematical knowledge across different cultural contexts. In line with these trends, the present review found a substantial increase in STEM-based ethnomathematics research in Indonesia, particularly after 2020.

However, unlike the broader international literature, which encompasses diverse educational contexts and theoretical perspectives, Indonesian studies remain predominantly focused on junior high school education, geometry topics, and the development of instructional media through quantitative and research and development (R&D) approaches. Furthermore, the meta-analysis conducted by Pratama and Yelken (2024) demonstrated the positive contribution of ethnomathematics-based learning to students' mathematical literacy. Nevertheless, the present review indicates that research in Indonesia has primarily emphasized instructional product development and short-term effectiveness evaluation, suggesting the need for more diverse methodological approaches, including mixed-methods, longitudinal, and large-scale experimental studies.

■ CONCLUSION

This review indicates that STEM-based ethnomathematics research in mathematics education has developed significantly, particularly since 2020. The publication landscape is

dominated by SINTA 3 journals. In terms of research characteristics, most studies were conducted at the junior high school (SMP) level using quantitative research approaches and Research and Development (R&D) methodologies. The reviewed literature primarily focuses on developing students' mathematical competencies, particularly conceptual understanding, problem-solving skills, critical thinking, and mathematical literacy. Furthermore, while these studies represent diverse cultural contexts in Indonesia, the research remains concentrated in a few regions, particularly Java, indicating that many local cultures and other geographic regions are still underrepresented in the existing literature. This review also reveals that the methodological profile of the research remains relatively homogeneous, with a predominance of quantitative approaches and Research and Development (R&D). The review also revealed that much of the research concentrated on improving students' mathematical abilities, particularly conceptual understanding, problem-solving, critical thinking, and mathematical reasoning. Local cultures such as Java, Toraja, and Songket Lombok served as the primary contexts for implementing STEM-based ethnomathematics, making the learning experience more meaningful. Recommendations for future research include using qualitative or mixed-method approaches, exploring other local cultures in Indonesia, and developing more innovative digital learning media to enhance the context of mathematics education; current research has primarily focused on developing instructional media and effectiveness studies.

■ DISCLOSURE OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES

During the writing of this manuscript, the authors used ChatGPT and Grammarly to assist with language refinement and proofreading. The authors reviewed and edited all generated content and take full responsibility for the final version of the manuscript.

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