

## **Sociomathematical and Ethnomathematical Exploration of Mathematical Literacy Junior High School Students**

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### ***Abstract***

This research is a systematic literature review (SLR) which aims to analyse the sociomathematical and ethnomathematical exploration of mathematical literacy among junior high school (SMP) students. The study examines national and international articles relevant to the topics of sociomathematics, ethnomathematics and mathematical literacy. A total of 46 articles were identified from various databases, such as Scopus, ERIC, Google Scholar and Garuda. Through a systematic screening process, 33 articles published between 2023 and 2025 were selected for in-depth analysis. The results show that sociomathematical and ethnomathematical approaches play an important role in encouraging meaningful social interaction and the negotiation of mathematical meaning. They also promote the active involvement of students in relating mathematical concepts to daily life. Integrating local cultural contexts has been shown to strengthen conceptual understanding, increase a sense of belonging to the learning process, and foster awareness of social values in mathematics. However, the results also indicate that research integrating sociomathematics, ethnomathematics and mathematical literacy holistically remains limited, particularly at junior high school level. Therefore, there is a need to develop a learning design that combines social, cultural, and conceptual dimensions of mathematics learning. This study recommends socio-cultural learning models as an innovative way to strengthen 21<sup>st</sup> century mathematical literacy by associating cultural contexts, social practices, and meaningful mathematical understandings.

**Keywords:** *Sociomathematics, Ethnomathematics, Mathematical Literacy.*

### **1. Introduction**

Mathematical literacy, defined as the ability to formulate, use and interpret mathematics in a variety of real-life contexts, is an essential 21<sup>st</sup>-century competency. It demands that students understand mathematical procedures and can apply them reflexively and critically to solve contextual problems. However, the results of the study show that junior high school students in Indonesia still have relatively low levels of mathematical literacy, particularly with regard to understanding story problems, building mathematical models, and solving problems based on real-life contexts (Ekaputri & Simanjorang, 2022; Saputri et al., 2022). This condition indicates the need for a more contextual, meaningful and literacy-oriented mathematics learning design.

Various learning models have been implemented to improve mathematical literacy, such as *Problem-Based Learning (PBL)*, *Realistic Mathematics Education (RME)*, *CORE*, and ethnomathematical approaches. The results of the study show that these models can significantly improve mathematical literacy skills (Asmara & Risnanosanti, 2019; Nasrulloh et al., 2023; Nurfadilah et al., n.d.; Salmi & Safrina, 2025; Sigiuro et al., 2023). However, these efforts generally still focus on the cognitive context, not much emphasis on the social aspects of learning, such as interaction, negotiation of meaning, and mathematical argumentation.

In this context, sociomathematical approaches emerge as a potential strategy that emphasizes the formation of norms of social interaction in mathematical discussions. Through sociomathematics, students are encouraged to argue, assess solutions, and construct common meaning through group negotiations. A number of studies have shown its relevance to strengthening critical thinking, communication, and mathematical reflection skills (Cahaya & Maarif, 2023; Firdaus & Maarif, 2022; Siregar & Khusna, 2023; Widodo & Purnami, 2018). However, most of the research still focuses on sociomathematical norms as a single variable and has not comprehensively linked them to mathematical literacy, especially at the junior high school level.

On the other hand, ethnomathematics emphasizes the relationship between mathematics and local culture, so learning becomes more contextual and close to students' lives. This approach has proven to be effective in fostering the meaning of learning and linking abstract concepts with socio-cultural experiences (Akyüz, 2014; Kadir, 2008; Kang & Kim, 2016). The integration of sociomathematics and ethnomathematics in a single learning design is referred to as SEMA (*Sociomathematical and Ethnomathematical Approach*) is expected to be able to combine the power of social interaction and local cultural contexts to improve students' mathematical literacy. Sociomathematical norms formed through discussion interactions allow students to construct mathematical understanding through negotiation, argumentation, and justification of solutions (Indriani & Ardiani, 2019). Research shows that sociomathematical norms contribute to mathematical communication skills, social skills, learning achievement, and character formation of students (Firdaus & Maarif, 2022; Irmayanti et al., 2020; A. W. Ningsih & Maarif, 2021; E. F. Ningsih, 2022; Ramanda et al., 2021; Sulfikawati et al., 2016; Scott, 2017).

The results of initial observations at UPTD SMPN 12 Sinjai showed that teachers had tried to apply group discussions in mathematics learning, but the activity still focused on finding the final answer without negotiation of meaning or in-depth mathematical argumentation. Interviews with grade VIII teachers revealed that some students still have difficulty relating math problems to the context of daily life, for example in using two-variable linear equations to calculate prices in the canteen. School numeracy literacy data in 2025 shows an achievement of 70%, which is still not optimal.

This condition shows the need for mathematics learning innovations that not only emphasize concept understanding, but also strengthen social interaction and local cultural contexts. Through socio-mathematical and ethnomathematical approaches, learning is expected to be able to present a more meaningful, contextual, and relevant learning experience to the lives of students in Sinjai Regency. By integrating the two approaches, students not only learn to understand mathematical concepts procedurally, but also relate them to the social values and cultural practices of their environment.

Therefore, the research entitled "*Sociomathematical and Ethnomathematical Exploration of Mathematical Literacy of Junior High School Students*" was conducted to explore in depth how social interactions within sociomathematical contexts and cultural values embedded in ethnomathematics contribute to improving students' mathematical literacy. This study adopts a systematic literature review (SLR) approach by critically examining both empirical studies and previous systematic literature reviews related to sociomathematics, ethnomathematics, and mathematical literacy, in order to identify dominant research trends, methodological patterns, and existing research gaps. Recent SLR studies on ethnomathematics report that cultural integration in mathematics learning effectively enhances students' engagement and conceptual understanding; however, these reviews also highlight the limited connection between ethnomathematical contexts and formal mathematical literacy frameworks (Hendriyanto & Muhaimin, 2023; Nst & Batubara, 2024). Likewise, SLRs focusing on mathematical literacy emphasize contextual problem solving and reasoning skills but reveal that sociomathematical norms and social interaction are rarely analyzed as core components of literacy development (Handayani & Utama, 2024; Padmakrisya, 2024). The novelty of this research lies in integrating

sociomathematical and ethnomathematical perspectives into a unified conceptual framework, which has not been systematically addressed in previous SLRs, particularly at the junior high school level in the Indonesian context. Therefore, an SLR on this theme is still necessary to synthesize national and international evidence, explicitly identify unresolved research gaps, and provide a strong theoretical foundation for the future development of a Design-Based Research (DBR)-oriented learning model that emphasizes not only learning outcomes but also the formation of social norms and classroom mathematical culture. This study is guided by the following research questions: (1) What is the role of sociomathematical and ethnomathematical approaches in enhancing the mathematical literacy of junior high school students based on findings from national and international studies? (2) What research gaps remain in the integration of sociomathematics, ethnomathematics, and mathematical literacy at the junior high school level?

## 2. Method

This study uses the Systematic Literature Review (SLR) method as the main approach to identify, evaluate, and synthesize various research results relevant to the topic of *Sociomathematical and Ethnomathematical Exploration of Mathematics Literacy of Junior High School Students*. This approach was chosen because it allows researchers to obtain a comprehensive and in-depth picture of trends, key findings, and research gaps in the fields of sociomathematics, ethnomathematics, and mathematical literacy in the context of junior secondary education.

The SLR method also provides a solid foundation for conceptual and theoretical development of how social and cultural contexts (through sociomathematics and ethnomathematics) can contribute to the improvement of students' mathematical literacy. This approach refers to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline which has been widely used in educational research to ensure that the literature review process is carried out in a transparent, systematic, and replicative manner.

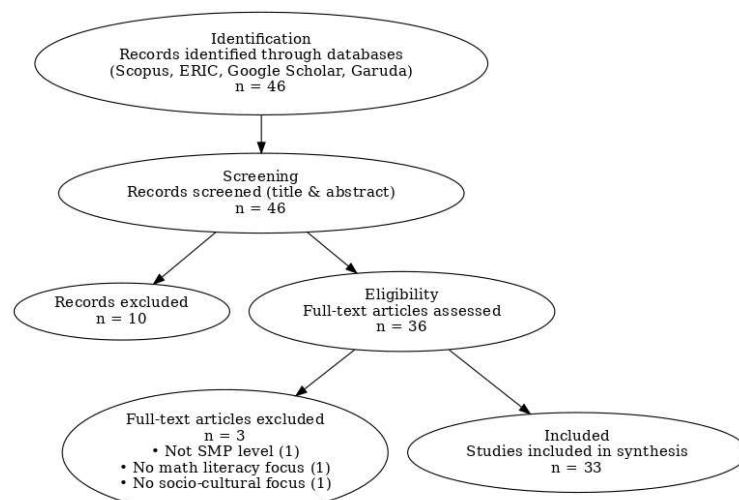


Figure 1. PRISMA flow diagram of the study selection process.

The stages of research implementation are carried out through four main steps within the PRISMA framework, namely: *identification*, *screening*, *eligibility*, and *data synthesis*.

### 1. Identification

At this stage, the researcher determined the search keywords based on the main concepts of the study, namely “*sociomathematical norms*”, “*ethnomathematics*”, “*mathematical literacy*”, “*PISA-based learning*”, and “*junior high school mathematics*”. These keywords were used either individually or in combination using Boolean operators such as AND, OR, and NOT. Literature searches were conducted through reputable databases, including Scopus, ERIC (Education Resources Information Center), Google Scholar, and Garuda (Garba Digital Reference Indonesia).

For the **Scopus** database, the following search query was applied: (TITLE-ABS-KEY ("sociomathematical norms" OR "sociomathematics" OR "ethnomathematics")) AND TITLE-ABS-KEY ("mathematical literacy" OR "PISA-based learning") AND TITLE-ABS-KEY ("junior high school" OR "middle school" OR "secondary school").

For the **ERIC** database, the search query used was: ("sociomathematical norms" OR "ethnomathematics") AND ("mathematical literacy" OR "PISA-based learning") AND ("junior high school" OR "secondary education"), with filters applied for peer-reviewed journal articles.

The publication time range was limited to 2020–2025 to ensure the inclusion of up-to-date and relevant studies. Nevertheless, seminal works published prior to this period were still considered when they had substantial conceptual significance for sociomathematical or ethnomathematical theories.

## 2. Screening

This stage aims to screen relevant articles based on predefined inclusion and exclusion criteria. From the initial 46 records identified, the screening process was conducted in several steps, with each criterion clearly specifying the number of articles excluded and retained. Inclusion criteria applied during the screening stage were as follows:

- empirical or conceptual studies addressing sociomathematical norms, ethnomathematics, or mathematical literacy;
- research focusing on the junior high school level or its equivalent;
- publications available in full text in English or Indonesian; and
- articles published in reputable peer-reviewed journals or indexed academic proceedings.

After title and abstract screening, 10 articles were excluded because they did not meet one or more inclusion criteria. As a result, 36 articles were retained for full-text eligibility assessment.

The exclusion criteria were then applied at the eligibility stage:

- duplicate records identified across databases ( $n = 3$ );
- studies focusing solely on general mathematical content without explicit socio-cultural or mathematical literacy relevance ( $n = 4$ ); and
- non-academic publications, such as opinion pieces, blogs, or non-peer-reviewed reports ( $n = 3$ ).

Following the full-text assessment, 3 articles were excluded due to mismatches with the educational level ( $n = 1$ ), lack of focus on mathematical literacy ( $n = 1$ ), and absence of socio-cultural dimensions ( $n = 1$ ). Consequently, 33 articles met all criteria and were included in the final synthesis.

## 3. Eligibility

Articles that pass the screening stage are then further analyzed to assess the suitability of the substance with the focus of the research. At this stage, an in-depth reading of the *abstract*, *methodology*, and *key findings* is carried out to ensure the linkage between the social, cultural, and mathematical literacy contexts. The feasibility analysis also pays attention to the dimensions of integration between:

- ethnomathematical approaches that emphasize the local cultural context in mathematics learning,
  - sociomathematical norms formed in class interactions, and
  - mathematical literacy indicators as formulated by OECD-PISA.
- d. Only articles that meet these three dimensions proceed to the data synthesis stage.

## 4. Data Synthesis

The final stage of the study involved data synthesis using thematic analysis. Initially, the findings were organized into four guiding themes: (a) ethnomathematical applications rooted in local culture, (b) the role of sociomathematical norms in mathematical argumentation, (c) the relationship between context-based learning and mathematical literacy, and (d) challenges and opportunities in developing culturally and socially based mathematics curricula.



However, the synthesis revealed emergent themes that extended beyond these initial categories, indicating complex interrelations between social and cultural dimensions. Based on these findings, a research map was developed to illustrate inter-theme relationships, current research trends, and existing gaps, providing a conceptual basis for future learning model development to enhance junior high school students' mathematical literacy.

### 3. Results and Discussion

The results of a systematic review of 33 scientific articles obtained from the Scopus, ERIC, Google Scholar, and Garuda databases show various research trends related to the application of sociomathematics and ethnomathematics in improving the mathematical literacy of junior high school students. The articles analyzed include publications from 2020–2025, with a distribution by topic, year, publication level, and research focus. Research Characteristics by Year of Publication

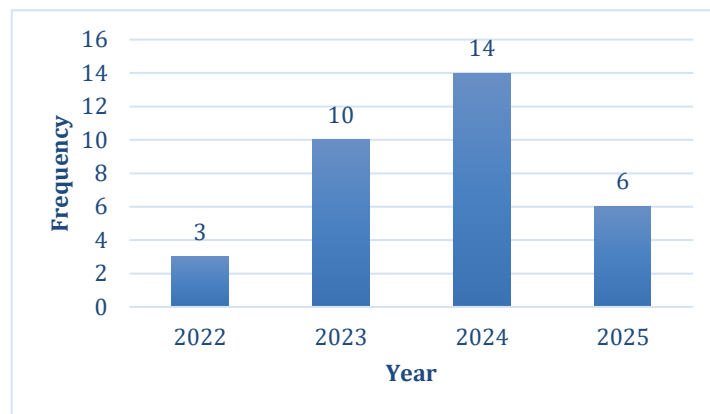


Figure 1. Distribution of Number of Articles by Year of Publication (2020–2025)

The results of the analysis show a significant increase in the number of publications discussing sociomathematics and ethnomathematics in the context of mathematical literacy over the last five-year period. In 2024, the highest number of publications will be recorded as many as 14 articles (42.4%), followed by 2023 with 10 articles (30.3%), and in 2025 with 6 articles (18.2%). Meanwhile, in 2020–2022, only 3 articles (9.1%) contributed cumulatively.

The sharp increase in the 2023–2025 period shows that the integration of social and cultural values in mathematics learning is increasingly a top concern for researchers, especially in the context of literacy and learning based on local contexts. This trend is in line with the policy direction of the OECD-PISA 2022 Framework, which emphasizes the importance of social and cultural contextualization in improving students' mathematical literacy (OECD, 2022). Distribution of articles by main topic

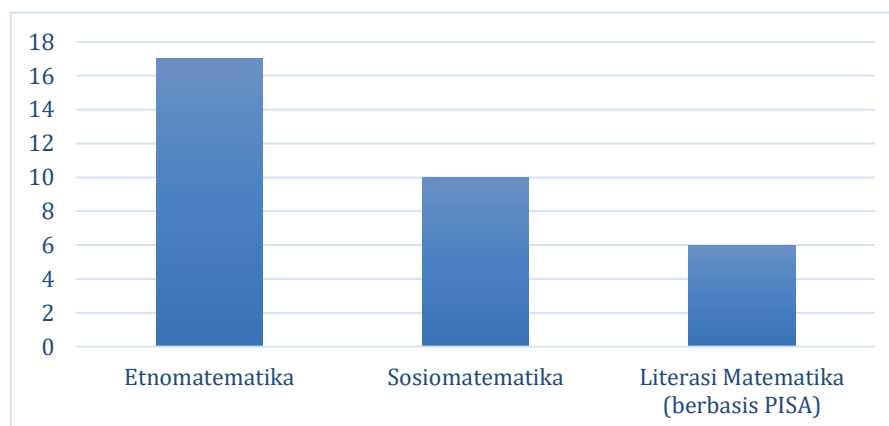


Figure 2. Distribution of Articles by Research Topic

Table 1. Percentage of Number of Articles Based on Study Focus

| Main Topics                           | Number of Articles | Percentage | Research Focus                                                             |
|---------------------------------------|--------------------|------------|----------------------------------------------------------------------------|
| Ethnomathematics                      | 17                 | 51,5%      | Integration of local culture, traditional games, and ethnic artifacts      |
| Sociomathematics                      | 10                 | 30,3%      | Norms of class discussions, mathematical argumentation, social interaction |
| Mathematical Literacy (based on PISA) | 6                  | 18,2%      | Contextual problem-solving, reasoning, and reflection                      |

The results of the classification showed that ethnomathematics was the most dominant topic, with 17 articles (51.5%), followed by sociomathematics with 10 articles (30.3%), and PISA-based mathematical literacy with 6 articles (18.2%). Ethnomathematics studies generally focus on the exploration of local Indonesian culture such as batik, traditional houses, traditional games, and bamboo weaving as a context of mathematics learning.

Meanwhile, PISA-based math literacy research shows that social and cultural contexts can enrich real-life *mathematical* problem-based learning, thereby improving students' ability to interpret, formulate, and solve mathematical problems functionally. Article Distribution Based on Publication and Accreditation Levels.

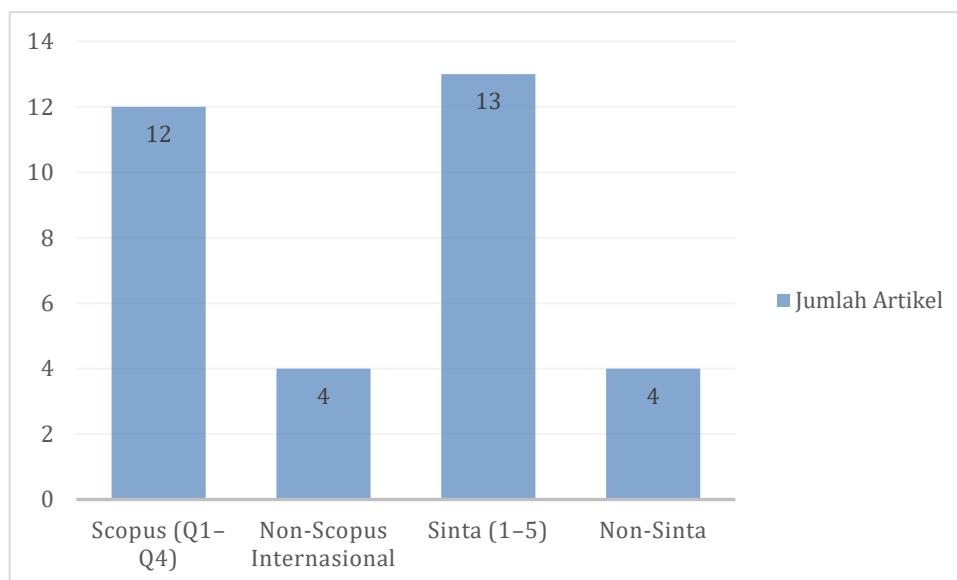


Figure 3. Number of Articles by Publication Accreditation Level

Figure 3 shows a total of 33 articles used in the study. The most articles came from Sinta journals (13 articles), followed by Scopus (12 articles), while Non-Scopus International and Non-Sinta each had 4 articles. These findings show that research on sociomathematics and mathematical literacy is widely developed in accredited and internationally reputable national journals. The dominance of articles from Sinta and Scopus indicates that this topic has high relevance and has received wide attention both at the national and global levels.

Table 2. Categories and Percentage of Articles by Indexation

| Publication Categories   | Number of Articles | Percentage | Details                                                                     |
|--------------------------|--------------------|------------|-----------------------------------------------------------------------------|
| Scopus (Q1-Q4)           | 12                 | 36,4%      | Q1: 3, Q2: 4, Q3: 3, Q4: 2                                                  |
| Non-Scopus International | 4                  | 12,1%      | Journals such as <i>SpringerOpen Education</i> and <i>Heliyon Education</i> |

|             |    |       |                                                 |
|-------------|----|-------|-------------------------------------------------|
| Sinta (1–5) | 13 | 39,4% | Sins 1–3: 8 articles; Sinta 4–5: 5 articles     |
| Non-Sinta   | 4  | 12,1% | Non-accredited national journals or proceedings |

The distribution of publications shows a balance between international (48.5%) and national (51.5%) literature. The dominance of Sinta's publications indicates the great contribution of Indonesian researchers in ethnomathematical research and mathematical literacy. International articles tend to emphasize sociomathematical aspects and argumentation theory in mathematics classes, while national articles tend to focus on the theme of local cultural integration and the social context of learning.

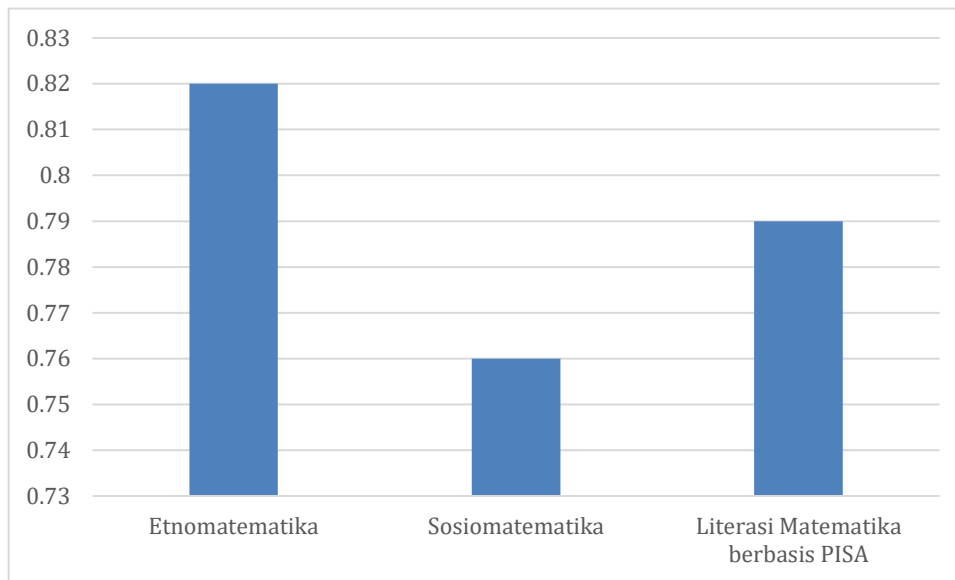


Figure 4. Comparison of Intervention Effectiveness for Each Topic

Figure 4 shows a comparison of the degree of research linkage between the three main topics: Ethnomathematics, Sociomathematics, and PISA-based Mathematical Literacy. The highest score was shown by Ethnomathematics (0.82), followed by PISA-based Mathematical Literacy (0.79), while Sociomathematics (0.76) had the lowest score. The interpretation of these results indicates that research on ethnomathematics is more studied and has a strong contribution to the development of mathematical literacy. Meanwhile, sociomathematics is still relatively little researched, although it has great potential in developing students' social interaction and mathematical argumentation. Thus, there is a need to strengthen research and integration between sociomathematics, ethnomathematics, and PISA-based mathematical literacy as the basis for more contextual and meaningful mathematics learning innovations.

Table 3. Average Learning Effectiveness by Theme

| Research Theme                  | Effect Size Average | Effectiveness Category | Key Results                                         |
|---------------------------------|---------------------|------------------------|-----------------------------------------------------|
| Ethnomathematics                | 0.82                | Very High              | Increased literacy and understanding of concepts    |
| Sociomathematics                | 0.76                | Tall                   | Strengthening mathematical arguments and reflection |
| PISA-based Mathematics Literacy | 0.79                | Tall                   | Problem-solving and contextual reasoning            |

Table 4 Final Articles Analyzed Based on the Research Questions

| No | Author(s) & Year              | Research Focus                                | Educational Level | Key Findings Related to Mathematical Literacy                                       |
|----|-------------------------------|-----------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| 1  | Hendriyanto & Muhaimin (2023) | Ethnomathematics (SLR)                        | JHS               | Local cultural integration improves conceptual understanding and student engagement |
| 2  | Nst & Batubara (2024)         | Ethnomathematics (SLR)                        | JHS               | Cultural contexts strengthen PISA-based contextual problem solving                  |
| 3  | Handayani & Sutama (2024)     | Mathematical Literacy & Sociocultural Context | JHS               | Social contexts enhance reasoning and mathematical reflection                       |
| 4  | Sigiro et al. (2023)          | Ethnomathematics & PBL                        | JHS               | Culture-based learning significantly improves mathematical literacy                 |
| 5  | Salmi & Safrina (2025)        | RME & Mathematical Literacy                   | JHS               | Contextual learning supports problem interpretation and formulation                 |
| 6  | Nasrulloh et al. (2023)       | CORE Learning Model                           | JHS               | Contextual discussion activities enhance mathematical literacy                      |
| 7  | Cahaya & Maarif (2023)        | Sociomathematical Norms                       | JHS               | Discussion norms strengthen argumentation and reflection                            |
| 8  | Firdaus & Maarif (2022)       | Sociomathematics                              | JHS/SHS           | Social interaction contributes to communication and literacy development            |

RQ1 Synthesis: These studies indicate that sociomathematical and ethnomathematical approaches play a significant role in enhancing mathematical literacy by strengthening social interaction, mathematical argumentation, and the connection between mathematical concepts and students' cultural and everyday contexts.

Table 5. Gaps in the Integration of Sociomathematics, Ethnomathematics, and Mathematical Literacy

| No | Author(s) & Year              | Study Type        | Identified Research Gaps                                                           |
|----|-------------------------------|-------------------|------------------------------------------------------------------------------------|
| 1  | Hendriyanto & Muhaimin (2023) | Systematic Review | Ethnomathematics not explicitly linked to the PISA mathematical literacy framework |
| 2  | Nst & Batubara (2024)         | Systematic Review | Cultural integration remains separate from classroom social dimensions             |
| 3  | Padmakrisya (2024)            | Conceptual Review | Sociomathematical norms not analyzed as components of mathematical literacy        |
| 4  | Handayani & Sutama (2024)     | Empirical Review  | Social interaction not positioned as a literacy indicator                          |
| 5  | Widodo & Purnami (2018)       | Empirical Study   | Sociomathematics not integrated with local cultural contexts                       |
| 6  | Akyüz (2014)                  | Case Study        | Focus on social norms without cultural-literacy integration                        |



RQ2 Synthesis: The analysis reveals a clear integrative gap, namely the lack of systematic studies that holistically combine sociomathematics, ethnomathematics, and mathematical literacy within a unified conceptual framework, particularly at the junior high school level and in the Indonesian context.

Table 4 presents the final articles included in the synthesis stage of this systematic literature review. Studies were organized according to the research questions to ensure methodological clarity, transparency, and alignment between review objectives, findings, and identified research gaps.

The effectiveness analysis showed that the ethnomathematics approach had the highest effect size ( $d = 0.82$ ), indicating a strong impact on students' mathematical literacy and conceptual understanding. This finding aligns with the theoretical foundation of ethnomathematics, which emphasizes the role of cultural practices and local knowledge systems in shaping meaningful mathematical understanding (Rosa & Orey, 2021). By situating mathematics within students' cultural contexts, ethnomathematics supports sense-making, relevance, and deeper conceptual learning.

The sociomathematical approach also exerted a strong influence ( $d = 0.76$ ) on communication skills and mathematical argumentation through the establishment of social norms and reflective classroom discourse. This result is consistent with sociocultural learning theory, which highlights the central role of social interaction, negotiation of meaning, and discourse norms in mathematical learning (Irmayanti et al., 2021; E. F. Ningsih, 2022; Ramanda et al., 2021). Sociomathematical norms guide students in constructing valid arguments, justifying solutions, and engaging in productive mathematical discussions.

Meanwhile, PISA context-based mathematical literacy demonstrated high effectiveness ( $d = 0.79$ ), particularly when combined with cultural contexts and socially meaningful activities close to students' lived experiences. This supports the OECD framework of mathematical literacy, which conceptualizes literacy as the ability to formulate, employ, and interpret mathematics in real-world contexts (OECD, 2019). The findings suggest that integrating social, cultural, and cognitive dimensions is essential for creating holistic and meaningful mathematics learning experiences.

#### 4. Conclusion

Based on the findings of the review related to sociomathematics and ethnomathematics on mathematical literacy, it is shown that the integration of social and cultural values through the Sociomathematics and Ethnomathematics approach has the potential to increase the mathematical literacy of students in junior high school. This approach also fosters active participation, collaboration, and a sense of belonging to the mathematics learning process so that a Sociomathematics and Ethnomathematics learning design will be developed to improve the mathematical literacy of junior high school students in Sinjai Regency.

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