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Implementation of Problem-Based Learning with Ethnomathematics to Enhance Students' Mathematical Literacy: A Systematic Review and Bibliometric Analysis (2020-2025)

Siti Khalimatus Sakdiyah[1*], Sugiman[2], Zaenuri[3], Walid[4]

[1,2,3,4] Universitas Negeri Semarang, Indonesia
[*]Corresponding Author: *deyasakdiyah@students.unnes.ac.id*

Abstract : *Education in Indonesia continues to face various challenges, one of which is the low level of mathematical literacy. Mathematical literacy reflects the extent to which students are able to understand, formulate, and apply mathematical concepts appropriately to interpret information and solve problems in real-life contexts. One possible effort to overcome this issue is through the implementation of the Problem-Based Learning (PBL) model with an ethnomathematics approach, which integrates local cultural contexts into the process of mathematical problem solving. This study aims to analyze research trends and the implementation of the PBL model with an ethnomathematics approach toward students' mathematical literacy during the period of 2020-2025. The method used is a Systematic Literature Review (SLR) combined with bibliometric analysis using the VOSviewer software and a review of nine articles that met the inclusion and exclusion criteria. The results indicate that research on PBL-ethnomathematics has increased over the years, focusing on developing mathematical literacy through culture-based learning, and the implementation of the PBL model with an ethnomathematics approach has been proven effective in enhancing students' mathematical literacy.*
Keywords*: PBL; ethnomathematics; mathematical literacy*

Abstrak: Pendidikan di Indonesia masih menghadapi berbagai tantangan, salah satunya adalah rendahnya tingkat literasi matematis. Literasi matematis mencerminkan sejauh mana siswa mampu memahami, merumuskan, dan menerapkan konsep-konsep matematika secara tepat untuk menafsirkan informasi dan menyelesaikan masalah dalam konteks kehidupan nyata. Salah satu upaya yang dapat dilakukan untuk mengatasi permasalahan tersebut adalah melalui penerapan model *Problem-Based Learning* (PBL) dengan pendekatan etnomatematika, yang mengintegrasikan konteks budaya lokal ke dalam proses pemecahan masalah matematika. Penelitian ini bertujuan untuk menganalisis tren penelitian dan implementasi model PBL dengan pendekatan etnomatematika terhadap literasi matematis siswa selama periode 2020-2025. Metode yang digunakan adalah *Systematic Literature Review* (SLR) yang dipadukan dengan analisis bibliometrik menggunakan perangkat lunak VOSviewer serta telaah terhadap sembilan artikel yang memenuhi kriteria inklusi dan eksklusi. Hasil penelitian menunjukkan bahwa kajian mengenai PBL-etnomatematika mengalami peningkatan dari tahun ke tahun dengan fokus pada pengembangan literasi matematis melalui pembelajaran berbasis budaya, serta implementasi model PBL dengan pendekatan etnomatematika terbukti efektif dalam meningkatkan literasi matematis siswa.
Kata Kunci: PBL; etnomatematika; literasi matematis

INTRODUCTION

Education is one of the fundamental aspects of human life that plays a crucial role in responding to the dynamics and development of the modern era. Without education, individuals will find it difficult to adapt to changes that occur in various aspects of life. Furthermore, education is closely related to learning, which is a systematic process that functions to shape ways of thinking, develop reasoning abilities, and improve the overall quality of students. Mathematics is a fundamental subject that plays an important role in developing students' logical, analytical, and systematic thinking skills. Gauss even

referred to mathematics as “the queen of sciences” (Yadav & Kumar Yadav, 2017), emphasizing its position as the foundation for mastering science and technology.

Mathematics is one of the most essential subjects to be taught at every level of education because it provides numerous benefits and can be applied in various fields of life (Mahendra, 2017). One of the key competencies that students must possess in mathematics learning is mathematical literacy. Mathematical literacy is an important skill that helps students understand mathematical concepts and apply them in real-world contexts (Lestari & Waluya, 2020) .

Mathematical literacy is defined as an individual’s ability to formulate, apply, and interpret mathematics in various contexts, including the ability to reason mathematically and use concepts, procedures, and facts to describe, explain, or predict phenomena (OECD, 2023). It consists of seven components: (1) communicating; (2) mathematising; (3) representing; (4) reasoning and argument; (5) devising strategies for solving problems; (6) using symbolic, formal, and technical language and operations; and (7) using mathematical tools. However, the current level of mathematical literacy among Indonesian students remains low and is still far below the international average. The 2022 Programme for International Student Assessment (PISA) results showed that Indonesia scored 366 and ranked 68th out of 81 participating countries, with mathematics, reading, and science as the main focus areas. This score is significantly below the international average of 472, indicating the urgent need to improve students’ mathematical literacy.

The low level of mathematical literacy in Indonesia is partly due to students being more accustomed to solving routine problems given by teachers rather than non-routine problems such as those found in PISA assessments (Mutia et al., 2021). Several studies have also found that students often experience difficulties in formulating mathematical problems from real-life situations (Safitri & Khotimah, 2023). Therefore, mathematical literacy is a critical competence that should be further developed (Larasaty et al., 2018). Learning processes should thus facilitate students in enhancing their mathematical literacy, and mathematics instruction should provide opportunities to practice and develop this literacy as an integral part of improving learning outcomes (Pamungkas & Franita, 2019).

Given these challenges, it is necessary to consider alternative learning models that can support students in solving mathematical problems. Problem-Based Learning (PBL) has been widely discussed in mathematics education as a learning model that emphasizes active student engagement in real-world problem solving, encourages critical thinking, promotes collaboration, and integrates mathematical concepts into daily life (Huda & Khotimah, 2023; Wahyuni & Pratiwi, 2019). Several previous studies, such as those by Paloloang et al. (2019) and Pamungkas & Franita (2019) have examined the implementation of PBL in mathematics learning and reported various outcomes related to students’ mathematical literacy.

To optimize learning outcomes, an appropriate pedagogical approach is required so that the learning process becomes more meaningful and effective. One relevant approach is ethnomathematics. Ethnomathematics is a learning approach that connects

mathematical concepts with cultural, traditional, or local practices familiar to students. Integrating this approach into PBL provides students with culturally relevant contexts, making mathematical concepts easier to understand and increasing motivation to learn. Moreover, ethnomathematics not only supports academic achievement but also fosters cultural appreciation, pride in local traditions, and awareness of cultural diversity (Lubis et al., 2024).

The integration of PBL with an ethnomathematics approach can effectively enhance students' mathematical literacy. This finding aligns with studies by Qauliyah et al. (2022) and Prihatiningtyas & Buyung (2023), which reported significant differences in mathematical literacy improvement between experimental classes implementing PBL with an ethnomathematics approach and control classes using conventional PBL.

Research examining the implementation of Problem-Based Learning integrated with an ethnomathematics approach to enhance students' mathematical literacy has been widely conducted. However, the existing literature is still dominated by classroom-based experimental studies. Comprehensive studies that systematically synthesize research findings, identify publication trends, and map how the PBL-ethnomathematics approach has been implemented to support the enhancement of students' mathematical literacy across various educational contexts remain limited. In addition, bibliometric analyses that provide an overview of research development, collaboration patterns, and thematic focus related to PBL, ethnomathematics, and mathematical literacy are still relatively scarce, particularly for studies published between 2020-2025. This condition indicates a clear research gap, highlighting the need for a systematic literature review combined with bibliometric analysis to obtain a more holistic understanding of research trends and implementation patterns in this field.

Based on the above background, this study conducts a literature review on the implementation of the PBL model with an ethnomathematics approach toward students' mathematical literacy. The objectives of this study are: (1) identifying research trends on the implementation of PBL with an ethnomathematical approach in relation to students' mathematical literacy over the last six years (2020-2025), and (2) to analyze how the PBL model with an ethnomathematics approach is implemented to enhance students' mathematical literacy.

METHOD

This study employed the Systematic Literature Review (SLR) method. The stages of this method include identifying, reviewing, evaluating, and interpreting all relevant studies. The SLR was conducted through a systematic review and identification of articles, following established procedures at each stage (Triandini et al., 2019). In this study, the steps were adapted from the framework proposed by (Zawacki-Richter et al., 2020).

The design conceptual framework stage involved formulating the theoretical foundations underpinning this SLR. This framework mapped the relationships among the key constructs Problem-Based Learning (PBL), ethnomathematics, and mathematical

literacy by identifying how each concept interacts within the context of mathematics education. This conceptual mapping served as the basis for determining the search keywords, establishing the inclusion and exclusion criteria, defining the coding categories, and synthesizing the research findings. This stage ensured that the entire review process was systematically aligned with the central purpose of the study.

The develop research questions stage involved formulating clear and focused research questions aligned with the study objectives. The research questions were as follows:

(1) RQ1: What are the research trends regarding the implementation of PBL with an ethnomathematics approach in relation to students' mathematical literacy from 2020 to 2025?
(2) RQ2: How is the PBL model with an ethnomathematics approach implemented to enhance students' mathematical literacy?

The construct selection criteria stage aimed to define inclusion and exclusion criteria to ensure that only relevant and high-quality studies were included. The criteria used in this study are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	**Exclusion Criteria**
Research articles published between 2020-2025.	Research articles published before 2020.
Research articles published in national, international, or Scopus-indexed journals that are relevant to the research topic and title.	Articles published in national, international, or Scopus-indexed journals that are unrelated to the research topic and title.
Research articles focusing on the implementation of the PBL model with an ethnomathematical approach toward mathematical literacy.	Research articles unrelated to the implementation of the PBL model with an ethnomathematical approach toward mathematical literacy.
Research subjects are students.	Research subjects other than students.
Written in Indonesian or English.	Written in languages other than Indonesian or English.

The develop search strategy stage involved designing a systematic search process using Harzing's Publish or Perish application with the Google Scholar database. This application was chosen because it provides comprehensive and structured results based on selected keywords. The keywords used were "problem-based learning (PBL)", "ethnomathematics", and "students' mathematical literacy."

The select studies using selection criteria stage consisted of screening the collected articles based on the established criteria. The screening process began with reviewing the titles and abstracts to assess their relevance to the study topic, followed by a full-text evaluation. Articles were retained if they met the publication year (2020-2025), document type (journal or conference proceeding), indexing status (Sinta, Google Scholar, or Scopus), and alignment with the focus of the study. The detailed process of article selection is illustrated in the flowchart presented in Figure 1.

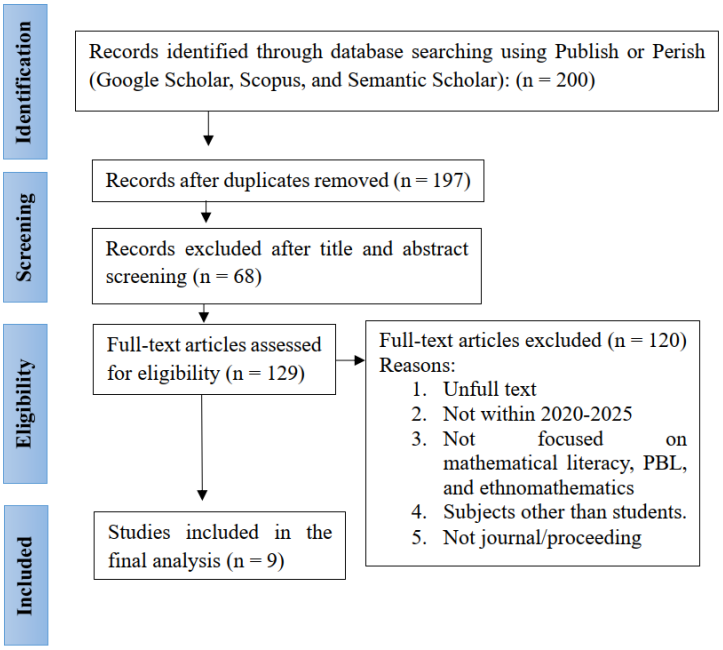

Figure 1. Flowchart of the article selection process

The coding studies stage involved categorizing the selected articles based on essential information, including author(s), publication year, journal or proceeding name, indexing status, research focus, methodology, and key findings. The coding process was conducted by extracting relevant information from each selected article and organizing it according to these categories to ensure consistency and accuracy. The results of the coding process are presented in the Results section, where the characteristics of the selected studies are summarized and analyzed. This coding stage facilitated the identification of research patterns, trends, and gaps within the reviewed literature.

The assess the quality of studies stage consisted of applying five Quality Assessment (QA) criteria to ensure that the selected articles met the required standards of relevance, credibility, and methodological appropriateness. These criteria were used to evaluate publication year, indexing status, topical alignment, research participants, and language accessibility. The complete QA criteria used in this SLR are presented in Table 2.

Table 2. Quality Assessment (QA) Criteria

Code	Quality Assessment Question	Expected Response	Purpose of the Criterion
QA1	Was the article published within the 2020–2025 timeframe?	Yes	Ensures recency and relevance to the defined review period.
QA2	Is the article a national or international research publication aligned with the study topic and indexed in Sinta, Google Scholar, or Scopus?	Yes	Confirms publication credibility and alignment with the research focus.
QA3	Does the article discuss the implementation of the PBL model with an ethnomathematical approach toward students' mathematical literacy?	Yes	Ensures topical relevance to the core concepts of the SLR.

QA4	Does the article involve students as the research participants?	Yes	Verifies suitability of the research population.
QA5	Is the article written in Indonesian or English?	Yes	Confirms accessibility of the article for analysis.

The synthesis of research questions and reporting of findings stages integrated the findings from all included studies. The synthesis described the participant characteristics, research contexts, and methodological approaches, while the reporting phase presented the results in narrative form supported by tables and graphs. These outputs provided a comprehensive overview of research distribution, dominant themes, and trends regarding the implementation of the PBL model with an ethnomathematical approach toward mathematical literacy, along with recommendations for future research.

The report findings stage presented the final results through narratives, tables, and graphs illustrating the distribution of articles, key findings, and emerging research patterns. These results served as the basis for answering the research questions and provided insights for identifying potential directions for future investigations.

RESULT AND DISCUSSION

The findings of this study consist of an analysis and synthesis of previously documented articles related to the implementation of the Problem-Based Learning (PBL) model with an ethnomathematical approach toward students' mathematical literacy. A total of 200 research articles published from 2020 to 2025 were identified using the Harzing's Publish or Perish application from the Google Scholar database. After a screening process based on inclusion and exclusion criteria and a quality assessment (QA), nine articles met the eligibility requirements for further analysis in the final synthesis stage. The data included in this literature review are presented in Table 3.

Table 3. Research Findings

Code	Author(s), Year	Jurnal/Prosiding	Indexing	Research Findings
A1	(Amidi et al., 2025)	Jurnal Pendidikan Progresif	Sinta 2	The study showed that the ethnomathematics-based PBL model was effective in improving students' mathematical literacy. A correlation was also found between mathematical literacy and learning independence. Students with high, moderate, and low learning independence demonstrated different levels of literacy. These findings highlight the importance of integrating PBL with local culture to enhance both cognitive and affective learning outcomes, emphasizing learning independence as an internal factor supporting mathematical literacy development.
A2	(Nagari et al., 2025)	Imajiner: Jurnal Matematika dan Pendidikan Matematika	Sinta 4	The study found significant differences in mathematical literacy between students taught using the ethnomathematics-based PBL model and those taught conventionally. The ethnomathematical PBL approach was more effective than conventional learning in

Code	Author(s), Year	Jurnal/Prosiding	Indexing	Research Findings
				enhancing students' mathematical literacy, with noticeable improvement after its implementation.
A3	(Meilina, 2025)	Ethnomathematics Journal	Sinta 4	The study revealed that applying the PBL model with the Taman Sari ethnomathematical approach significantly improved students' mathematical literacy. Marked progress was observed across all core literacy indicators formulate (problem formulation), employ (concept application), and interpret (interpretation and evaluation) with consistent gains from cycle I to cycle II.
A4	(Firdaus et al., 2023)	*Aksioma: Jurnal Program Studi Pendidikan Matematika*	Sinta 2	The implementation of ethnomathematics-oriented PBL positively affected students' mathematical literacy. Literacy levels varied according to students' self-confidence, with those having high self-confidence performing better than those with moderate or low confidence.
A5	(Prihatiningtyas & Buyung, 2023)	*Aksioma: Jurnal Program Studi Pendidikan Matematika*	Sinta 2	The ethnomathematics-based PBL model effectively improved students' mathematical literacy and learning motivation. This was evident from the N-gain scores, where the experimental class achieved a medium category and the control class a low category. Thus, the model proved more effective than conventional instruction.
A6	(Sigiro et al., 2023)	*Jurnal Pendidikan MIPA*	Sinta 2	The study conducted with 32 experimental class students showed that the implementation of ethnomathematics-based PBL was very successful (average score 4.50). The mean mathematical literacy score was 82.73, with 87.5% mastery. A correlation existed between learning independence and literacy, where students with higher independence exhibited higher literacy levels.
A7	(Qauliyah et al., 2022)	*Imajiner: Jurnal Matematika dan Pendidikan Matematika*	Sinta 4	Hasil penelitian menunjukkan bahwa model PBL berbasis etnomatematika efektif meningkatkan kemampuan literasi matematika peserta didik. Hal ini terlihat pada kelas eksperimen yang memperoleh pembelajaran PBL berbasis etnomatematika, di mana sebagian besar siswa mengalami peningkatan N-gain dengan kategori sedang hingga tinggi dan mencapai ketuntasan minimal. Sementara itu, kelas kontrol yang memperoleh PBL konvensional menunjukkan peningkatan yang lebih rendah.
A8	(Nuraini et al., 2022)	AIP Conference Proceedings	Scopus	The ethnomathematics-based PBL model effectively enhanced students' mathematical literacy. In the experimental class, most students achieved N-gain scores within the medium to high categories, meeting the minimum mastery criteria. Meanwhile, the

Code	Author(s), Year	Jurnal/Prosiding	Indexing	Research Findings
				control class, which received conventional PBL, showed lower improvement.
A9	(Zaenuri et al., 2020)	Journal of Physics: Conference Series (JPCS)	Scopus	The application of ethnomathematics-based PBL in the context of Acehnese culture improved students' mathematical literacy, higher-order thinking skills, learning independence, and self-confidence. Although student engagement was high, the study emphasized that mathematical concepts still need stronger connections to real-world contexts for more meaningful learning.

Table 3 presents a synthesis of nine selected studies that met the inclusion criteria and were analyzed to examine the implementation and impact of the Problem-Based Learning (PBL) model with an ethnomathematics approach on students' mathematical literacy. The table summarizes essential information, including authors, publication year, journal or proceeding sources, indexing status, and key research findings. Overall, the studies consistently report that ethnomathematics-based PBL has a positive effect on students' mathematical literacy across different educational levels, learning contexts, and cultural settings. The findings also highlight additional outcomes related to affective and learning autonomy aspects, such as self-confidence, learning motivation, and learning independence, as well as improvements in higher-order thinking skills and problem-solving abilities.

Based on the synthesis presented in Table 3, the results and discussion are organized to address the research questions of this review. The first discussion focuses on research trends related to the implementation of PBL with an ethnomathematics approach toward mathematical literacy, analyzed through bibliometric mapping. The second discussion elaborates on how is the PBL model with an ethnomathematics approach implemented to enhance students' mathematical literacy?, as evidenced by the empirical findings of the selected studies.

(RQ1) What are the research trends regarding the implementation of PBL with an ethnomathematics approach in relation to students' mathematical literacy from 2020 to 2025?

Research trends on the implementation of PBL with an ethnomathematical approach toward mathematical literacy from 2020 to 2025 were analyzed through a bibliometric approach using the VOSviewer software. This analysis was chosen because it allows the mapping of relationships between research topics, identification of dominant keywords, and visualization of the development of research focus over time. Three main types of visualizations were generated: Network Visualization, Overlay Visualization, and Density Visualization.

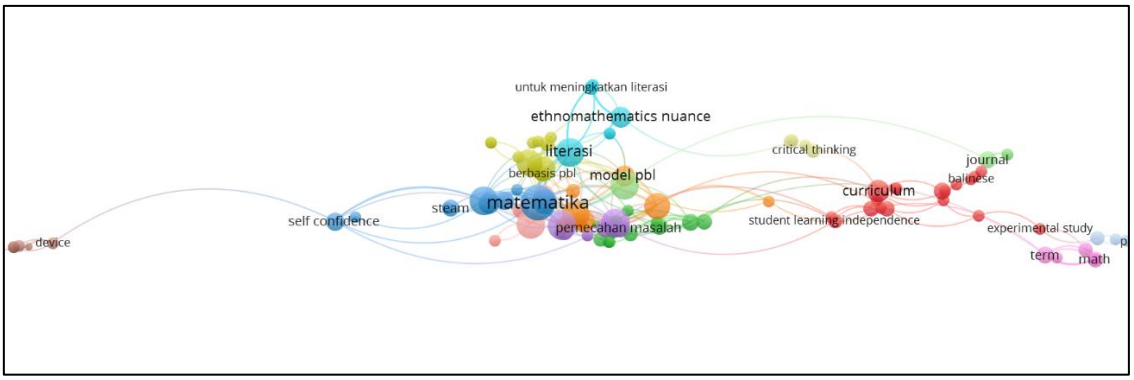

Figure 2. Network Visualization

Based on the Network Visualization, the analysis identified a structured network of keywords grouped into several interconnected clusters. The keywords with the largest node sizes *mathematics*, *literacy*, *PBL model*, *ethnomathematics nuance*, and *problem solving* formed the central cluster, indicating that research over the past six years has predominantly focused on implementing the PBL model within an ethnomathematical context to enhance students' mathematical literacy.

Additional supporting clusters included keywords such as *self-confidence*, *STEAM*, *curriculum*, and *critical thinking*, reflecting diversification toward affective domains, curriculum alignment, and technology-oriented learning innovations. The strong interconnections between the keywords *mathematics* and *PBL model* indicate that these terms function as central hubs within the research network. Overall, this visualization confirms that the integration of PBL and ethnomathematics for improving mathematical literacy represents a dominant and well-established research theme during the 2020-2025 period.

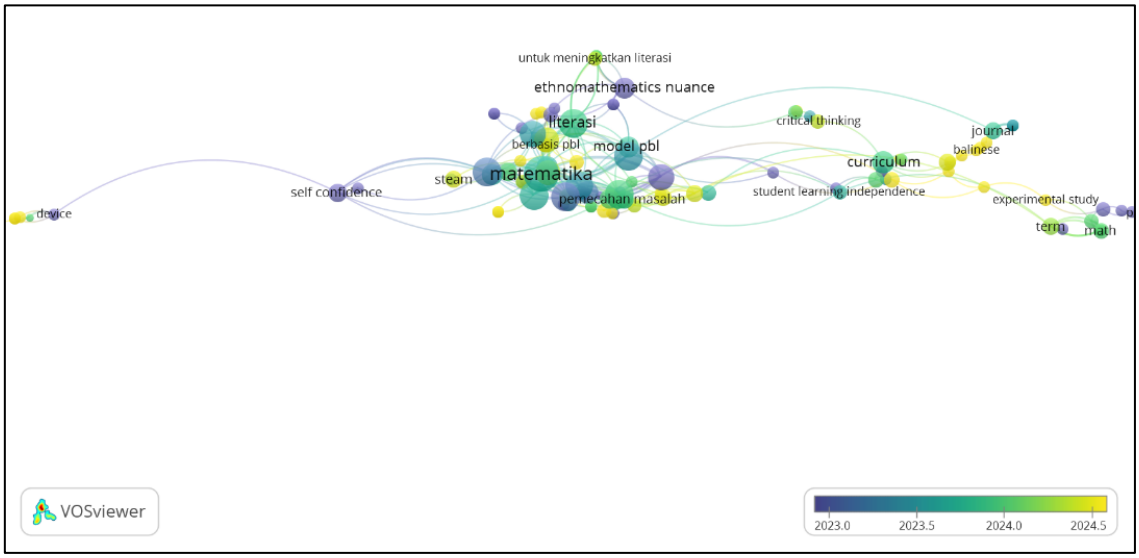

Figure 3. Overlay Visualization

The Overlay Visualization illustrates the temporal evolution of research topics related to the implementation of the PBL model with an ethnomathematical approach toward mathematical literacy from 2020 to 2025. The color gradient represents the year

of keyword occurrence, with blue-purple indicating earlier studies (2020-2022) and green-yellow representing more recent studies (2023-2025).

During the early phase (2020-2022), research primarily focused on foundational concepts such as *mathematics*, *literacy*, *PBL model*, and *ethnomathematics nuance*. These keywords reflect an emphasis on conceptual frameworks and initial applications of culture-based PBL in mathematics learning. Keywords related to *self-confidence* and *STEAM* also emerged, indicating early attention to affective factors and interdisciplinary learning.

In the later phase (2023-2025), the appearance of green-to-yellow nodes indicates a shift toward more applied and empirical research. Keywords such as *curriculum*, *critical thinking*, *student learning independence*, *experimental study*, and *journal* became more prominent. This shift suggests that recent studies have moved beyond conceptual exploration toward curriculum integration and experimental validation, emphasizing the development of 21st-century competencies alongside mathematical literacy.

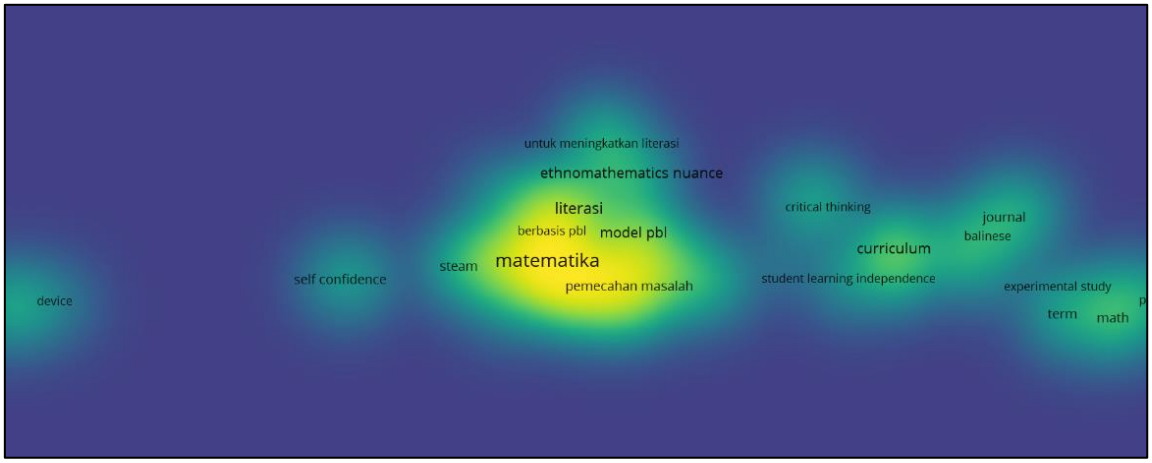

Figure 3. Density Visualization

The Density Visualization reveals varying concentrations of research focus within the field. High-density areas (yellow zones) are dominated by keywords such as *mathematics*, *literacy*, *PBL model*, *ethnomathematics*, and *problem solving*, indicating that these topics have been extensively studied and form the core of existing research.

Lower-density areas include keywords such as *self-confidence*, *critical thinking*, *curriculum*, and *student learning independence*. These findings indicate that affective dimensions, autonomous learning, curriculum design, and technology-supported ethnomathematical learning remain relatively underexplored. Limited representation of keywords related to digital learning environments and longitudinal research designs suggests clear opportunities for future studies.

Synthesis of Research Trends and Implications

The bibliometric findings demonstrate a consistent development of research on the implementation of PBL with an ethnomathematical approach toward mathematical literacy from 2020 to 2025. Early research emphasized conceptual and model-based

discussions, while more recent studies focused on empirical validation and curriculum integration. The identified gaps highlight the need for future research to explore technology-integrated PBL-ethnomathematics learning and longitudinal studies examining long-term impacts on students' mathematical literacy and related competencies.

(RQ2) How is the PBL model with an ethnomathematics approach implemented to enhance students' mathematical literacy?

The implementation of the PBL model with an ethnomathematical approach toward students' mathematical literacy was analyzed based on nine articles that met the inclusion and exclusion criteria. The findings consistently indicate that the application of ethnomathematics-based PBL positively influences the improvement of students' mathematical literacy at various educational levels. Integrating PBL with local cultural contexts bridges students' conceptual understanding and real-world experiences, making learning more contextual and meaningful. The combination of problem solving and cultural values encourages students to become more active, reflective, and capable of higher-order thinking.

Amidi et al. (2025) found that the ethnomathematics-based PBL model not only enhanced students' mathematical literacy but also strengthened learning independence. Students with higher levels of autonomy demonstrated better literacy skills than those with moderate or low autonomy. Similarly, Sigiro et al. (2023) reported that the implementation of ethnomathematical PBL was highly effective, with an average implementation score of 4.50 and an average mathematical literacy score of 82.73, achieving 87.5% mastery. These findings indicate that the success of the PBL-ethnomathematics model depends largely on students' independent engagement with culturally contextualized problem-solving activities.

Studies by Nagari et al. (2025) and Prihatiningtyas & Buyung (2023) confirmed significant differences between students taught using the PBL-ethnomathematics model and those taught using conventional methods. The N-gain scores for the experimental groups ranged from medium to high, while those for the control groups were low. This difference shows that combining local culture with problem-solving strategies enhances students' critical thinking and mathematical representation skills. Meilina (2025) also reported that the PBL model with the Taman Sari ethnomathematical approach improved mathematical literacy across the three key aspects of literacy namely formulate, employ, and interpret with consistent progress from cycle I to cycle II, confirming that the link between mathematics and culture supports holistic literacy development.

Further evidence from Firdaus et al. (2023) and Nuraini et al. (2022) highlighted the positive impact of ethnomathematical PBL on affective aspects such as motivation and self-confidence. Students became more confident in expressing ideas and were able to connect abstract mathematical concepts with real life situations in their cultural environments. Similarly, Zaenuri et al. (2020) reported a significant increase in the average post-test score of the experimental class from 38.02 to 72.11 with an N-gain of

0.56, indicating that culture-based learning effectively enhances not only cognitive skills but also mathematical communication, reasoning, and representational abilities.

The synthesis of the nine studies reveals a consistent pattern that the implementation of the PBL model with an ethnomathematical approach contributes to four key dimensions of students' mathematical literacy development. First, students' cognitive abilities improve through problem solving, reasoning, and contextual interpretation. Second, affective factors such as learning motivation, self-confidence, and independence increase significantly. Third, the integration of local cultural values makes learning more relevant, contextual, and meaningful. Fourth, learning outcomes show significant differences compared to conventional learning, both in test performance and in active engagement during the learning process.

These findings reinforce the view that the PBL model with an ethnomathematical approach is not only effective in enhancing mathematical literacy but also supports character formation and 21st-century skills. Students become capable of solving mathematical problems while interpreting, communicating, and connecting mathematical concepts with everyday life through cultural perspectives. This implementation represents a strategic innovation in mathematics education that is humanistic, contextual, and literacy-oriented for Indonesian students.

CONCLUSION AND SUGGESTION

Based on the bibliometric analysis and the synthesis of implementation findings, research on the application of the Problem-Based Learning (PBL) model with an ethnomathematics approach toward students' mathematical literacy from 2020-2025 demonstrates that the model effectively enhances both cognitive and affective aspects of learning. The nine selected studies consistently show improvements in students' ability to formulate problems, apply concepts, and interpret mathematical situations, alongside increases in motivation, self-confidence, and learning independence. The findings also highlight the importance of integrating local cultural contexts to make mathematics learning more relevant and meaningful. These results suggest that the PBL model with an ethnomathematics approach not only supports the development of mathematical literacy but also promotes higher-order thinking, autonomous learning, and culturally responsive pedagogy. Academically, the study underscores the potential of combining PBL with ethnomathematics to guide future research on culture-based and literacy-oriented mathematics education. Practically, educators are encouraged to adopt this model to foster active, reflective, and contextually grounded learning, while future studies could explore the integration of digital tools, broader cultural contexts, and longitudinal impacts to strengthen the sustained development of students' mathematical literacy.

This study has several limitations. The analysis is based on only nine classroom-based studies, which limits insight into long-term or real-world effects. Variations in reporting instructional strategies, teacher competencies, and cultural integration, as well as reliance on quantitative measures, may not fully capture the nuanced impact of PBL-ethnomathematics on students' cognitive, affective, and cultural development. Future

research should expand the scope, include longitudinal designs, and combine quantitative and qualitative methods for a more comprehensive understanding.

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