

Ethnomathematics: Integrating a Perspective and Alternative to Build Numeracy Mindset

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Abstract. The persistent challenges in mathematics education, particularly low mathematical literacy and declining student motivation, necessitate innovative pedagogical approaches. This study explores ethnomathematics as an integrative perspective and alternative strategy to build a numeracy growth mindset among elementary students. Ethnomathematics, which recognizes the cultural dimensions of mathematical practices, offers contextual learning experiences that bridge abstract mathematical concepts with students' daily lives. This research examines how integrating ethnomathematics principles within Indonesia's Merdeka Curriculum can enhance numeracy competencies while fostering positive mathematical dispositions. Through analysis of traditional Indonesian cultural practices—including batik patterns, traditional architecture, games, and rituals—this study demonstrates how culturally-relevant mathematical contexts can transform learning environments and develop growth mindsets in numeracy. The findings suggest that ethnomathematics-based approaches address multiple challenges simultaneously: improving conceptual understanding through meaningful connections, increasing motivation through cultural relevance, and creating inclusive learning environments that support diverse learners. This research contributes to the growing body of evidence supporting culturally responsive mathematics education as a viable solution to numeracy problems in Indonesian education.

Keywords: Ethnomathematics, Numeracy Mindset, Growth Mindset, Cultural Mathematics, Merdeka Curriculum

INTRODUCTION

The 2022 PISA results revealed concerning trends in Indonesian students' mathematical performance, with mathematics scores at 379 points, significantly below the international average (OECD, 2023). This persistent challenge in mathematical literacy reflects deeper systemic issues within mathematics education, including difficulties in applying mathematical concepts to real-world situations, inadequate understanding of basic mathematical concepts, and declining student motivation in mathematics learning (Maharbid, 2024). Contemporary research in mathematics education increasingly recognizes that traditional pedagogical approaches, which often emphasize abstract procedures divorced from cultural contexts, contribute to students' difficulties in developing meaningful mathematical understanding (Rosa & Orey, 2021). Students frequently struggle to perceive connections between classroom mathematics and their lived experiences, resulting in disengagement and the development of fixed mindsets regarding their mathematical capabilities (Boaler, 2022).

Recent scholarship in mathematics education has emphasized the importance of culturally responsive teaching approaches. D'Ambrosio (2020) argues that ethnomathematics, the study of mathematical practices embedded within cultural contexts, provides a framework for making

mathematics more accessible and relevant to diverse learners. This approach recognizes that all cultures develop sophisticated mathematical methods to understand and transform their realities, challenging the notion of mathematics as a purely Western academic discipline (Rosa & Orey, 2021). The concept of growth mindset, pioneered by Dweck (2016) and applied to mathematics education by Boaler (2022), emphasizes that mathematical ability can be developed through effort, effective strategies, and support. Research indicates that students who believe their mathematical abilities can grow are more likely to persist through challenges, embrace mistakes as learning opportunities, and achieve higher levels of mathematical proficiency (Sun, 2021; Yeager & Dweck, 2020). Recent studies have begun exploring the intersection of ethnomathematics and growth mindset development. Fouze and Amit (2023) found that exposing students to diverse mathematical practices through ethnomathematics enhances problem-solving skills and promotes growth mindset. Similarly, Tampubolon (2023) demonstrated that ethnomathematics approaches improve numeracy literacy by encouraging students to think mathematically within familiar cultural contexts.

Despite growing recognition of both ethnomathematics and growth mindset as valuable educational frameworks, limited research has systematically integrated these approaches specifically within the Indonesian context and Merdeka Curriculum framework. While previous studies have examined ethnomathematics applications in Indonesian settings (Iskandar et al., 2022) and growth mindset interventions in mathematics education (Chen & Wong, 2023), few have explored how ethnomathematics can serve as a deliberate strategy for cultivating numeracy growth mindsets. This study uniquely contributes to the field by: (1) developing an integrated framework that combines ethnomathematics principles with growth mindset theory; (2) situating this framework within Indonesia's Merdeka Curriculum and Profil Pelajar Pancasila (P5); (3) providing practical examples of Indonesian cultural practices as contexts for numeracy development; and (4) addressing the specific challenges identified in Indonesian mathematics education through culturally grounded solutions.

This research addresses the following questions: (1) How can ethnomathematics principles be integrated with growth mindset theory to address numeracy challenges in Indonesian education? (2) What specific Indonesian cultural practices provide effective contexts for developing numeracy competencies and growth mindsets? (3) How can teachers implement ethnomathematics-based approaches within the Merdeka Curriculum framework to foster numeracy growth mindsets? The research objectives are to: (1) Develop an integrated framework connecting ethnomathematics, numeracy, and growth mindset (2) Identify and analyze Indonesian cultural practices suitable for numeracy education (3) Propose practical

strategies for implementing ethnomathematics to build numeracy growth mindsets 4. Provide evidence-based recommendations for curriculum integration and teacher professional development. This study expects to demonstrate that ethnomathematics-based approaches can effectively address multiple dimensions of numeracy challenges by: (a) improving conceptual understanding through culturally-relevant contexts; (b) enhancing student motivation and engagement through meaningful connections to daily life; (c) developing positive dispositions toward mathematics; (d) creating inclusive learning environments that value diverse ways of knowing; and (e) fostering growth mindsets that support persistent engagement with mathematical challenges.

METHODOLOGY

This study employs a qualitative research design using document analysis and conceptual framework development to create an integrated ethnomathematics-based numeracy education framework. The research approach consists of three interconnected phases, (1) Literature Analysis, (2) Cultural Practice Analysis (3) Pedagogical Strategy Development. Literature Analysis involved systematic review of literature on ethnomathematics (D'Ambrosio, 2020; Rosa & Orey, 2021), numeracy education (Goos et al., 2020), and growth mindset theory (Boaler, 2022; Dweck, 2016), utilizing the 21st Century Numeracy Model (Goos et al., 2014) as a conceptual framework. The literature search was conducted across multiple academic databases including ERIC, Google Scholar, Scopus, and ProQuest, using keywords such as "ethnomathematics," "numeracy mindset," "cultural mathematics," "mathematics education Indonesia," and "growth mindset mathematics" (published between 2015-2024). Inclusion criteria encompassed peer-reviewed studies addressing ethnomathematics applications in educational settings, numeracy development frameworks, culturally responsive mathematics pedagogy, and growth mindset interventions. Exclusion criteria eliminated studies lacking direct relevance to mathematics education or those not addressing cultural integration in learning. A total of 45 peer-reviewed sources were systematically analyzed and synthesized.

Cultural Practice Analysis examined Indonesian cultural practices using D'Ambrosio's ethnomathematical framework as an explicit analytical lens. This phase employed content analysis methodology to identify, and extract embedded mathematical concepts (geometry, symmetry, spatial reasoning, counting systems, measurement, patterns) and their pedagogical potential within Indonesian cultural artifacts including batik patterns, traditional architecture, indigenous games, and agricultural rituals. The analysis specifically documented:

(a) the mathematical concepts present in each cultural practice; (b) the pedagogical contexts in which these practices could be meaningfully integrated; (c) alignment with Merdeka Curriculum learning objectives; and (d) feasibility for classroom implementation. Pedagogical Strategy Development synthesized findings from Phases 1 and 2 to develop practical strategies for implementing ethnomathematics within numeracy education, including lesson design frameworks, teacher professional development recommendations, assessment approaches, and community engagement models.

Data sources included: (1) academic literature published between 2015 and 2024 on ethnomathematics, numeracy, and growth mindset from the databases mentioned above; (2) Indonesian policy documents including the *Kurikulum Merdeka* and *Profil Pelajar Pancasila (P5)* guidelines; (3) teacher training modules from the Ministry of Education, Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi (Kemendikbudristek); (4) cultural documentation and anthropological sources describing Indonesian mathematical practices; and (5) international assessment frameworks including PISA 2022 results and the Asesmen Kompetensi Minimum (AKM). These sources were selected to provide multiple perspectives on both theoretical foundations and practical implementation contexts. The data were analyzed thematically to identify key concepts and relationships across ethnomathematics, numeracy, and growth mindset literature. Content analysis was applied to cultural practices to extract embedded mathematical elements and pedagogical possibilities. Framework synthesis integrated theoretical perspectives from D'Ambrosio (ethnomathematics), Goos et al. (numeracy), and Dweck/Boaler (growth mindset) into a coherent integrated model. Comparative analysis aligned these findings with international best practices in mathematics education and the specific requirements of Indonesia's Merdeka Curriculum.

The research content elementary education (Phases A–C) within the Indonesian *Merdeka Curriculum* context. Although conceptual in nature, the proposed framework is grounded in real-world challenges documented in PISA 2022, national assessments, and teacher professional development modules, as well as successful ethnomathematics implementations in comparable settings. Validation was conducted through triangulation of theoretical perspectives, curriculum alignment verification, expert peer review, and feasibility checks against documented teaching practices. As a conceptual and analytical study, this research does not include empirical testing with students. Future investigations should implement and evaluate the proposed framework in classroom settings to measure its effectiveness in enhancing numeracy competencies and growth mindsets. Broader studies could also

incorporate additional regional cultural practices to enrich the ethnomathematical perspective across Indonesia.

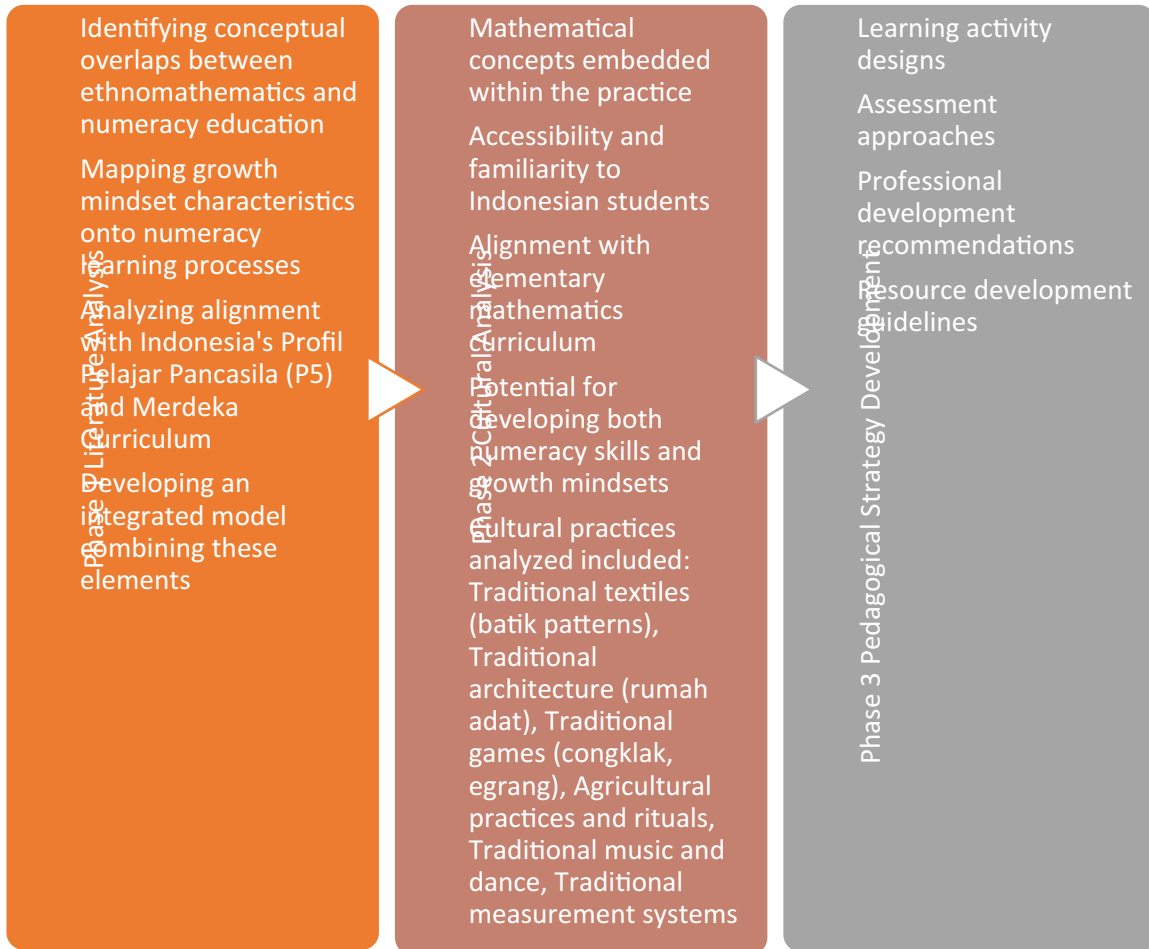


Figure 1. Research Phases

RESULTS AND DISCUSSION

The following section presents the integrated framework developed through systematic analysis of ethnomathematics theory, Indonesian cultural practices, and growth mindset research. Building upon the methodology outlined above, this section demonstrates how ethnomathematical integration can effectively foster a numeracy mindset by connecting mathematical learning to students' cultural identities and lived experiences. The results are organized around the five dimensions of the proposed framework, followed by specific examples of implementation and strategic recommendations for teachers.

Integrated Framework: Ethnomathematics for Numeracy Growth Mindset

Our analysis yielded an integrated framework that positions ethnomathematics as a strategic approach to developing numeracy growth mindsets. This framework builds upon Goos et al.'s (2014) 21st Century Numeracy Model while incorporating growth mindset principles and Indonesian cultural contexts. The framework comprises five interconnected dimensions:

1. **Mathematical Knowledge through Cultural Contexts** Ethnomathematics provides culturally grounded contexts that make abstract mathematical concepts concrete and meaningful. For example, batik patterns demonstrate geometric concepts including symmetry, transformation, and tessellation. Students engaging with batik recognize that "mathematics exists in my culture," challenging deficit perspectives about mathematical ability. Analysis of traditional Indonesian practices revealed rich mathematical content across all major domains:
 - Number and Operations: traditional measurement systems (depa, hasta), counting in rituals
 - Geometry: architectural proportions, batik patterns, textile designs
 - Measurement: traditional units, agricultural spacing, cooking measurements
 - Data and Probability: harvest predictions, game strategies
 - Patterns and Relationships: musical rhythms, dance movements, craft sequences
2. **Dispositions and Growth Mindset Development** Ethnomathematics naturally fosters growth mindset characteristics by:
 - Demonstrating that mathematical thinking develops within communities over time
 - Showing multiple valid approaches to mathematical problems
 - Valuing effort and cultural wisdom alongside formal procedures
 - Creating safe spaces for mathematical exploration through familiar contexts
 - Building confidence through recognition of existing cultural mathematical competencies

Students exposed to ethnomathematics examples reported increased confidence: "If my ancestors could develop these mathematical solutions without formal education, I can learn mathematics too." This represents a fundamental shift from fixed ("I'm not a math person") to growth mindset ("I can develop my mathematical thinking").

3. **Tools and Representations** Indonesian cultural practices utilize diverse mathematical tools:
 - Physical tools: traditional measuring instruments, game pieces (congklak stones)

- Representational tools: patterns, diagrams in traditional crafts
- Digital tools: virtual batik designers, architectural modeling software

Students learn that tools are cultural constructions for solving contextual problems, developing flexibility in tool selection and use—a key numeracy competency.

4. Critical Orientation Ethnomathematics inherently promotes critical thinking by:

- Questioning whose mathematics is valued in formal education
- Analyzing how mathematical solutions emerge from specific cultural needs
- Evaluating effectiveness of different mathematical approaches
- Recognizing mathematics as human activity, not fixed truth

For example, examining traditional measurement systems prompts questions: "Why did our ancestors use body-based measurements? When are these more practical than standard units? How do we decide which system to use?"

5. Context Integration The framework identifies three context types aligned with Indonesian curriculum:

- Personal contexts: family activities, daily transactions, personal measurements
- Scientific contexts: traditional agriculture, weather prediction, construction
- Sociocultural contexts: ceremonies, arts, community practices

Indonesian Cultural Practices as Numeracy Contexts

Detailed analysis of specific practices illustrates implementation:

1. Batik Patterns for Geometry Learning

Mathematical concepts: Lines, angles, two-dimensional shapes, symmetry, transformation, tessellation. Learning activities:

- Identifying geometric shapes within traditional motifs
- Analyzing symmetry types in different regional patterns
- Creating new patterns using transformation principles
- Calculating pattern repetitions for fabric dimensions

Growth mindset connections: Students see that creating batik requires patience, practice, and iterative refinement as same qualities needed for mathematical learning. Mistakes in pattern become learning opportunities, not failures.

2. Traditional Architecture for Spatial Reasoning

Mathematical concepts: Three-dimensional shapes, proportions, measurement, spatial relationships. Example: Rumoh Aceh traditional house uses seunipat measurement system (body-based units). Learning activities:

- Measuring classroom using traditional vs. standard units
- Comparing proportions in different architectural styles
- Designing structures using traditional proportional systems
- Converting between measurement systems

Growth mindset connections: Students recognize that ancestors developed sophisticated mathematical systems through observation and refinement, modeling how mathematical understanding develops through sustained engagement.

3. Traditional Games for Number Sense

Mathematical concepts: Counting, number patterns, strategic thinking, probability
Example: Congklak (mancala variant) involves counting, distribution, and strategy
Learning activities:

- Playing congklak while articulating mathematical thinking
- Analyzing winning strategies using numerical reasoning
- Creating game variations to explore mathematical relationships
- Recording and analyzing game outcomes (data collection)

Growth mindset connections: Games normalize taking risks, learning from mistakes, and developing strategies through practice—directly transferable to mathematical learning approaches.

4. Agricultural Rituals for Measurement and Patterns

Mathematical concepts: Measurement, geometry, counting, patterns, estimation.
Example: Dayak Ahe rice planting involves systematic spacing, counting rituals, tool geometry. Learning activities:

- Analyzing spatial patterns in traditional planting
- Exploring measurement concepts in agricultural tools
- Examining number use in traditional ceremonies
- Connecting agricultural cycles to mathematical patterns

Growth mindset connections: Agricultural practices demonstrate that mathematical thinking emerges from practical needs and improves through collective experience across generations.

Implementation Strategies for Teachers

Building upon teacher professional development materials and core ethnomathematical principles, several effective strategies can support classroom implementation. First, culturally relevant problem design encourages teachers to develop tasks rooted in authentic cultural contexts familiar to students, requiring genuine mathematical reasoning rather than superficial cultural decoration. These tasks should align with curriculum objectives, permit multiple solution paths, and foster mathematical discourse. For instance, a problem such as “Nenek wants to make batik with the Parang Rusak pattern for two meters of fabric. The basic motif repeats every 15 cm. How many complete motifs will appear, and how much fabric will contain incomplete motifs?” integrates cultural context with mathematical computation and reasoning. Second, questioning for growth mindset should emphasize process-oriented inquiry—asking students how they arrived at their solutions, recognizing productive struggle, valuing diverse approaches, and encouraging reflection on their identity as mathematical thinkers. Third, creating a numeracy-rich physical environment can reinforce learning by displaying cultural artifacts with mathematical elements, affirmations such as “Mathematical thinking grows with practice,” and student work that highlights multiple strategies. Fourth, assessment for learning should focus on reasoning and growth, providing feedback that values diverse strategies and documents progress over time, including self-assessment of mindset development. Finally, community engagement plays a vital role in connecting mathematics to lived experience, such as through inviting cultural practitioners to share mathematical insights, organizing visits to cultural sites, or integrating family mathematical practices into classroom learning. Collectively, these strategies position teachers as facilitators of meaningful, culturally grounded mathematics education that nurtures both numeracy skills and a growth-oriented mindset.

Alignment with Merdeka Curriculum and P5

The ethnomathematics approach demonstrates a strong alignment with the *Profil Pelajar Pancasila* (P5) within the *Merdeka Curriculum*, emphasizing the holistic development of learners through cultural and contextual learning. It supports the dimension of *Beriman dan Bertakwa kepada Tuhan Yang Maha Esa* by encouraging appreciation of cultural mathematical wisdom as a reflection of gratitude and stewardship. The value of *Berkebhinekaan Global* is

manifested in recognizing the diversity of mathematical systems across cultures, while *Gotong Royong* is reinforced through collaborative mathematical problem-solving grounded in community practices. Furthermore, ethnomathematics nurtures *Kemandirian* by fostering independent mathematical thinking, *Bernalar Kritis* through analytical engagement with various mathematical approaches, and *Kreativitas* in generating innovative solutions based on cultural knowledge. Collectively, these dimensions affirm the relevance of ethnomathematics as a pedagogical bridge that naturally integrates into the *Merdeka Curriculum's* flexible framework, particularly through *Projek Penguatan Profil Pelajar Pancasila (P5)*, where students connect mathematical understanding with identity, culture, and social responsibility.

The analysis identified several challenges and corresponding strategies for effectively implementing ethnomathematics within the educational context. The first challenge relates to teacher preparation, as many educators possess limited understanding of ethnomathematics and its pedagogical potential. To address this, professional development programs should integrate cultural documentation, mathematical analysis, and classroom applications, complemented by ready-to-use lesson materials that gradually build teachers' capacity for designing their own culturally grounded learning activities. A second challenge concerns curriculum integration, where some educators fear that incorporating ethnomathematics might detract from core mathematical content. This misconception can be resolved by explicitly demonstrating how cultural contexts can strengthen the achievement of learning objectives and by mapping cultural practices to curriculum competencies. The third challenge involves assessment alignment, given that standardized tests often fail to capture the competencies developed through ethnomathematical learning. The solution lies in illustrating that ethnomathematics fosters the same conceptual and procedural skills measured by such assessments and in incorporating ethnomathematical examples into formative evaluations to complement standardized preparation. Finally, resource limitations present a practical constraint, as not all schools have access to cultural artifacts or community experts. To mitigate this, digital resources, virtual experiences, and curated repositories of cultural documentation can be developed to ensure equitable access and sustainability across diverse educational settings.

Our findings align with international research demonstrating ethnomathematics effectiveness. Rosa and Orey (2021) found that culturally relevant contexts improved mathematical understanding among Brazilian students. Similarly, Fouze and Amit (2023) reported enhanced problem-solving skills through ethnomathematics in Israeli schools.

However, our study extends this research by explicitly connecting ethnomathematics to growth mindset development within a specific curriculum framework (Merdeka Curriculum). This integration provides a more comprehensive approach than studies examining these elements separately. Our framework also contributes to the limited research on ethnomathematics in Indonesian elementary education, providing specific examples and implementation strategies adapted to local contexts.

CONCLUSION

This research demonstrates that ethnomathematics offers a powerful integrative approach to addressing persistent numeracy challenges in Indonesian education by simultaneously developing mathematical competencies, fostering growth mindsets, and creating culturally responsive learning environments. Key findings reveal that: (1) Indonesian cultural practices—batik patterns, traditional architecture, games, and agricultural rituals—contain rich mathematical content aligned with elementary curriculum standards; (2) ethnomathematics naturally cultivates growth mindsets by demonstrating mathematics as culturally-developed practice; (3) the integrated framework combining 21st Century Numeracy Model with growth mindset theory provides systematic guidance for implementation within Merdeka Curriculum; (4) practical strategies including culturally-relevant problem design, growth mindset questioning, and community engagement offer actionable pathways for teachers; (5) strong alignment exists between ethnomathematics principles and Profil Pelajar Pancasila, facilitating curriculum integration through P5 projects.

This research contributes theoretically by demonstrating how cultural responsiveness and growth mindset development can be systematically integrated through ethnomathematics. Practically, the framework provides actionable guidance for teachers, curriculum developers, school leaders, and policy makers to implement culturally responsive mathematics education that honors Indonesia's mathematical heritage while developing 21st century numeracy competencies. The study's significance lies in addressing multiple educational challenges simultaneously—improving conceptual understanding, increasing motivation, developing positive dispositions, creating inclusive environments, and fostering persistent engagement—through a single coherent approach grounded in cultural authenticity and pedagogical effectiveness.

This study has several limitations. First, it is largely theoretical and qualitative, relying on literature and policy analysis rather than classroom observations or empirical measures, and the proposed framework has not been experimentally validated. Second, its focus on

Indonesia and the Merdeka Curriculum limits generalizability to other cultural and educational contexts. Third, while it highlights potential ethnomathematical practices, it does not provide empirical comparisons of student numeracy outcomes between ethnomathematics-based and conventional instruction. Finally, the cultural examples used represent only a small portion of Indonesia's diverse traditions and may not capture all regional variations.

Future studies should address current limitations through several avenues. First, empirical classroom research—such as action research or quasi-experimental designs—is needed to measure how ethnomathematics-based instruction affects students' numeracy, growth mindset, anxiety, and engagement. Second, longitudinal studies should examine whether these effects persist over multiple years. Third, comparative research across different cultural and national contexts can help develop ethnomathematical frameworks that are both locally relevant and globally applicable. Fourth, studies should evaluate the effectiveness of teacher professional development focused on cultural documentation, mathematical analysis, and curriculum design. Finally, wider documentation of regional cultural practices across Indonesia is needed to expand and diversify available ethnomathematical resources. Collectively, these efforts will help validate the proposed framework and strengthen evidence for culturally responsive numeracy development.

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