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The Impact of Ethnomathematics Approach on Numeracy and Mathematical Reasoning Skills of Elementary School Students: A Systematic Literature Review

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ABSTRACT

This systematic literature review examines the effects of ethnomathematics-based approaches on numeracy and mathematical reasoning skills among elementary school students. The review analyzed 18 empirical studies and meta-analyses published between 2022 and 2025 to capture recent evidence aligned with contemporary educational contexts and pedagogical practices. Using PRISMA guidelines, quantitative and qualitative findings from quasi-experimental, mixed-method, and meta-analytic studies were synthesized. This review addresses a notable research gap, as recent literature has not comprehensively examined the combined impact of ethnomathematics on both numeracy and mathematical reasoning at the elementary level. The findings consistently demonstrate that ethnomathematics-based instruction significantly improves students' numeracy achievement and mathematical reasoning abilities. Meta-analytic results indicate strong to very strong effect sizes (ES = 1.22–1.42) on mathematical achievement. Culturally contextualized learning also enhances conceptual understanding, critical thinking, collaboration skills, and learning motivation. Positive effects are reported across grade levels and cultural contexts, with moderate to high improvements in numeracy outcomes. Various implementation modalities, including interactive digital media, traditional games, STEAM-oriented instruction, and culturally relevant learning modules, show high instructional validity and effectiveness. However, several studies exhibit methodological limitations, such as small sample sizes, limited use of control groups, and insufficient longitudinal analysis. Future research should prioritize large-scale and longitudinal studies, alongside systematic teacher professional development, to support the sustainable integration of ethnomathematics in elementary mathematics education.

Keywords**:** *elementary education, ethnomathematics, mathematical reasoning, numeracy skills, systematic literature review*

Dampak Pendekatan Etnomatematika terhadap Kemampuan Numerasi dan Penalaran Matematika Siswa Sekolah Dasar: Tinjauan Pustaka Sistematis

ABSTRAK

Kajian pustaka sistematis ini mengkaji pengaruh pendekatan etnomatematika terhadap kemampuan numerasi dan penalaran matematis siswa sekolah dasar. Sebanyak 18 studi empiris dan meta-analisis yang dipublikasikan pada periode 2022–2025 dianalisis untuk merepresentasikan temuan mutakhir yang relevan dengan konteks pendidikan dan praktik pembelajaran saat ini. Kajian ini menggunakan pedoman PRISMA dengan mensintesis temuan kuantitatif dan kualitatif dari studi kuasi-eksperimen, metode campuran, dan meta-analisis. Tinjauan ini mengisi celah penelitian karena belum terdapat sintesis komprehensif terkini yang secara simultan mengkaji dampak etnomatematika terhadap numerasi dan penalaran matematis pada jenjang sekolah dasar. Hasil kajian menunjukkan bahwa pembelajaran berbasis etnomatematika secara konsisten efektif dalam meningkatkan kemampuan numerasi dan penalaran matematis siswa. Bukti meta-analitik menunjukkan ukuran efek yang kuat hingga sangat kuat (ES = 1,22–1,42) terhadap capaian matematika. Pembelajaran yang terintegrasi dengan konteks budaya juga meningkatkan pemahaman konseptual, kemampuan berpikir kritis, kolaborasi, dan motivasi belajar. Dampak positif ditemukan pada berbagai jenjang kelas dan latar budaya, dengan peningkatan numerasi pada kategori sedang hingga tinggi. Implementasi melalui media interaktif, permainan tradisional, pendekatan STEAM, dan modul kontekstual budaya menunjukkan validitas dan efektivitas pembelajaran yang tinggi. Namun, keterbatasan metodologis masih ditemukan, terutama terkait ukuran sampel kecil, keterbatasan kelompok kontrol, dan minimnya studi longitudinal. Penelitian selanjutnya disarankan untuk menggunakan desain skala besar dan longitudinal serta memperkuat pelatihan guru guna mendukung keberlanjutan penerapan etnomatematika di sekolah dasar.

Kata kunci: *pendidikan dasar, etnomatematika, penalaran matematika, keterampilan berhitung, tinjauan literatur sistematis*

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1. Introduction

Mathematics education in elementary schools faces persistent challenges in developing students' numeracy and reasoning competencies, particularly in contexts where abstract mathematical concepts seem disconnected from students' daily experiences and cultural backgrounds. Contemporary mathematics pedagogy increasingly recognizes the importance of contextualizing mathematical learning within students' sociocultural environments to enhance meaningful understanding and engagement (Pratama & Yelken, 2024; Zuliana et al., 2025). The integration of cultural elements into mathematics instruction, known as ethnomathematics, has emerged as a promising pedagogical approach that bridges the gap between formal mathematical concepts and students' lived experiences (Hidayana & Lianingsih, 2025). Research demonstrates that culturally responsive mathematics teaching not only improves academic achievement but also fosters positive attitudes toward mathematics and strengthens cultural identity (Reyes, 2025).

Ethnomathematics, as conceptualized by D'Ambrosio (1985), represents the intersection of culture, history, and mathematics, acknowledging that mathematical practices are embedded in diverse cultural contexts and everyday activities. This approach recognizes mathematical

thinking inherent in traditional practices, artifacts, games, and cultural activities, making mathematics learning more accessible and relevant to students from various backgrounds (Nurhusain et al., 2025). By incorporating local cultural elements such as traditional games, architectural patterns, indigenous measurement systems, and cultural artifacts, ethnomathematics transforms abstract mathematical concepts into tangible, culturally meaningful learning experiences (Farabi et al., 2025; Hidayat et al., 2025; Muhakimah & Arfinanti, 2024). Studies have shown that this contextualization enhances students' conceptual understanding, reasoning, problem-solving abilities, and motivation to learn mathematics (Asmara et al., 2024; Putri et al., 2024).

Numeracy skills, defined as the ability to understand, use, and communicate mathematical information in various real-world contexts, constitute a fundamental competency for elementary students. Current assessment frameworks, including Indonesia's Minimum Competency Assessment (Asesmen Kompetensi Minimum/AKM), emphasize the importance of numeracy literacy beyond procedural calculation skills, focusing on mathematical reasoning, problem-solving, and the application of mathematical concepts in authentic contexts (Larasati et al., 2025; Ladyawati & Maftuh, 2025; Shodikin et al., 2024). However, conventional mathematics instruction often fails to develop these higher-order numeracy competencies, resulting in students who can perform algorithmic procedures but struggle with mathematical reasoning and contextual problem-solving. Research indicates that ethnomathematics-based instruction addresses this gap by situating numeracy development within meaningful cultural contexts that promote deeper understanding and application (Accra-Jaja et al., 2023; Iswara et al., 2022; Sunzuma & Umbara, 2025).

Mathematical reasoning, encompassing inductive, abductive and deductive thinking, pattern recognition, generalization, and justification abilities, represents a critical cognitive competency that underpins mathematical proficiency and problem-solving capability (Nabilah & Shodikin, 2025). Elementary school constitutes a crucial developmental period for establishing foundational reasoning skills that support advanced mathematical thinking in subsequent educational stages (Sulistyowati & Mawardi, 2023). Traditional mathematics pedagogy often emphasizes memorization and procedural fluency at the expense of reasoning development, resulting in students who lack the ability to think flexibly, analyze mathematical relationships, and construct logical arguments. Ethnomathematics approaches, by engaging students in exploring mathematical concepts through cultural activities and artifacts, naturally foster inquiry, pattern recognition, and reasoning as students discover and articulate mathematical relationships embedded in familiar cultural contexts (Mustika et al., 2025; Zainovi et al., 2025).

Recent meta-analytic evidence demonstrates the robust effectiveness of culturally-based mathematics instruction across diverse contexts and student populations. Multiple systematic reviews and meta-analyses have documented significant positive effects of ethnomathematics approaches on various mathematical competencies, with effect sizes indicating moderate to very strong impacts on student achievement (Pratama & Yelken, 2024; Sulistyowati & Mawardi, 2023; Zuliana et al., 2025). These studies reveal that ethnomathematics integration enhances not only procedural skills but also conceptual understanding, mathematical literacy, and problem-solving abilities. Furthermore, research shows that culturally responsive mathematics teaching enhances student motivation, reduces mathematics anxiety, and fosters more inclusive learning environments that value diverse cultural knowledge systems. The growing body of empirical evidence supports the scalability and sustainability of ethnomathematics approaches in elementary mathematics education (Reyes, 2025; Solihin et al., 2025).

Despite the promising findings, existing research on ethnomathematics reveals several gaps and limitations that necessitate comprehensive synthesis and analysis. Many studies employ

limited sample sizes, lack rigorous experimental designs with control groups, and focus on single cultural contexts or specific mathematical topics, limiting generalizability of findings (Zainovi et al., 2025). Moreover, most research examines short-term effects without assessing long-term retention and transfer of learning, and few studies systematically investigate the mechanisms through which ethnomathematics approaches enhance numeracy and reasoning skills. This study distinguishes itself from previous reviews by specifically focusing on the dual outcomes of numeracy skills and mathematical reasoning in elementary education, synthesizing both empirical studies and meta-analytic findings from 2022-2025, and employing rigorous PRISMA methodology to identify patterns across diverse cultural contexts and implementation modalities. A systematic literature review synthesizing recent empirical evidence on ethnomathematics' impact on numeracy and mathematical reasoning in elementary education is needed to identify patterns, effective practices, and directions for future research and educational policy.

2. Method

This systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, rigor, and replicability. The review process encompassed five primary stages: identification, screening, eligibility assessment, inclusion, and synthesis of relevant studies examining ethnomathematics approaches and their impact on numeracy skills and mathematical reasoning abilities of elementary school students (see Figure 1). The review protocol was designed to capture diverse research designs including experimental studies, quasi-experimental studies, meta-analyses, systematic reviews, and mixed-method research published between 2022 and 2025, focusing on recent empirical evidence and meta-analytic findings. This temporal scope of 2022-2025 (rather than a longer 10-year period) was deliberately selected to capture the most contemporary developments in ethnomathematics research following major curriculum reforms in several countries, ensure relevance to current educational contexts and assessment frameworks, and reflect recent technological innovations in culturally-integrated mathematics instruction. This focused timeframe allows for more meaningful synthesis of studies conducted under similar contemporary educational conditions and policy environments.

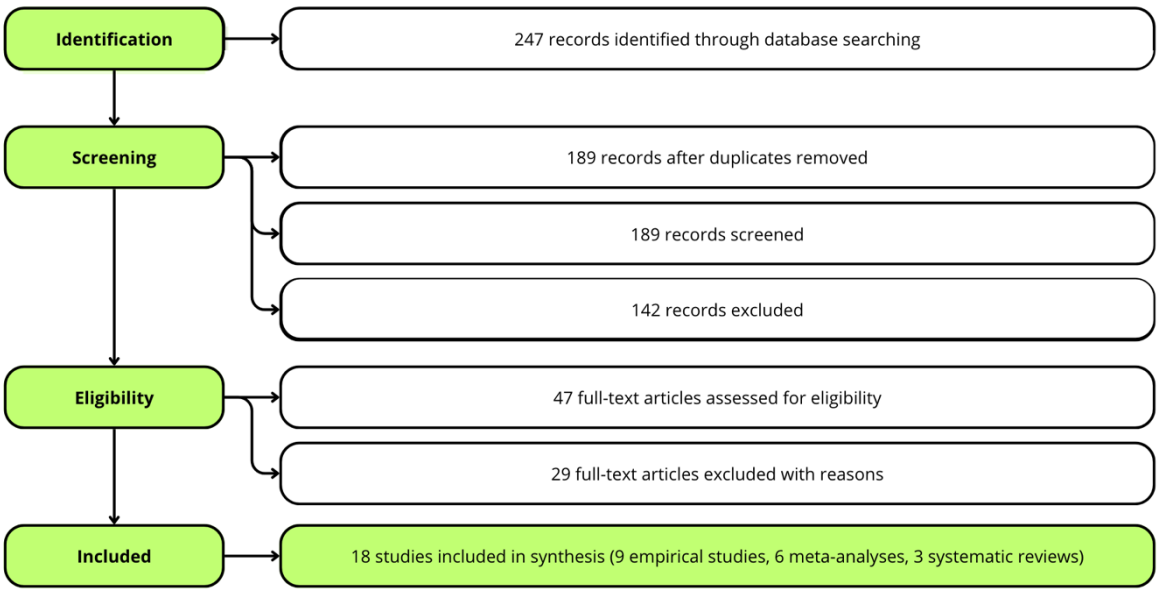

Figure 1. PRISMA Flow Diagram

The initial literature search identified 247 potentially relevant articles across all databases. Literature search strategies employed multiple academic databases and search engines including Google Scholar, ERIC, Scopus, and Consensus AI-powered research engine, utilizing systematic combinations of keywords in English and Indonesian languages. Primary search terms included "ethnomathematics," "cultural mathematics," "numeracy skills," "mathematical reasoning," "elementary school," "primary education," and variations thereof, combined using Boolean operators (AND, OR) to optimize search sensitivity and specificity. Inclusion criteria specified: (1) empirical studies or meta-analyses examining ethnomathematics interventions in elementary education contexts; (2) research measuring numeracy skills, mathematical reasoning, or related mathematical competencies as outcome variables; (3) peer-reviewed journal articles published between 2022-2025; (4) studies providing sufficient methodological details and statistical information for synthesis. Exclusion criteria eliminated: (1) studies focusing exclusively on secondary or higher education because the cognitive development and pedagogical approaches differ significantly from elementary contexts; (2) theoretical papers without empirical data as they cannot contribute to evidence synthesis regarding intervention effectiveness; (3) dissertations, conference proceedings, and grey literature due to concerns about peer review rigor and accessibility for replication; (4) studies not written in English or Indonesian due to resource limitations for translation and verification; (5) research lacking clear outcome measures for numeracy or reasoning skills as they cannot contribute to answering the research questions. The summary of inclusion and exclusion criteria can be seen in Table 1.

Table 1. Summary of Inclusion and Exclusion Criteria

Criteria Category	Inclusion Criteria	Exclusion Criteria
Study Design	Experimental, quasi-experimental, meta-analyses, systematic reviews, mixed-method studies	Theoretical papers, opinion pieces, commentary articles
Participants	Elementary school students (grades 1-6)	Secondary, tertiary education students, adult learners
Intervention	Ethnomathematics-based instruction, culturally-integrated mathematics pedagogy	Conventional instruction without cultural integration
Outcomes	Numeracy skills, mathematical reasoning, mathematical literacy, problem-solving	Studies without clear numeracy or reasoning outcomes
Publication Type	Peer-reviewed journal articles	Dissertations, theses, conference proceedings, grey literature
Language	English or Indonesian	Other languages without English or Indonesian translation
Time Period	2022-2025	Before 2022 (studies published prior to 2022 were excluded to maintain focus on contemporary research conducted under current curriculum frameworks and to ensure relevance to present-day educational contexts and assessment systems)
Data Availability	Sufficient methodological and statistical details	Insufficient data for synthesis and quality assessment

The screening and selection process yielded 18 studies meeting all inclusion criteria, comprising 9 empirical studies, 6 meta-analyses, and 3 systematic reviews that collectively examined ethnomathematics approaches across diverse cultural contexts and implementation modalities. The inclusion of both meta-analyses and systematic reviews alongside primary empirical studies provides multiple levels of evidence synthesis: primary studies offer detailed implementation insights and context-specific findings, meta-analyses provide quantitative

aggregation of effect sizes across multiple studies, and systematic reviews offer comprehensive thematic analysis of research trends and patterns. This multi-layered approach strengthens the robustness of conclusions by triangulating evidence from different methodological perspectives. Data extraction employed a standardized coding framework capturing study characteristics (author, year, research design, sample size, grade level), intervention features (type of cultural integration, duration, instructional approach), outcome measures (numeracy assessment tools, reasoning indicators, effect sizes), and key findings (statistical significance, practical implications, limitations). Quality assessment utilized appropriate critical appraisal tools adapted for different study designs: Cochrane Risk of Bias tool for experimental studies, AMSTAR-2 for systematic reviews, and modified Newcastle-Ottawa Scale for quasi-experimental designs. Each included study was independently evaluated by two reviewers for methodological rigor, with disagreements resolved through discussion and consensus. The synthesis approach combined narrative synthesis for qualitative findings and meta-analytic aggregation of effect sizes where appropriate, examining patterns across different types of ethnomathematics interventions, cultural contexts, and student populations to identify convergent evidence and contextual variations in effectiveness.

3. Result

The systematic review identified and analyzed 18 studies investigating the impact of ethnomathematics approaches on numeracy and mathematical reasoning skills in elementary education, representing a diverse range of research designs, cultural contexts, and implementation modalities. Among the included studies, 9 were primary empirical investigations employing experimental or quasi-experimental designs, 6 were meta-analytic studies synthesizing effect sizes across multiple primary studies, and 3 were systematic literature reviews providing comprehensive analyses of ethnomathematics research trends and patterns. The studies collectively examined interventions across various countries and cultural contexts, with predominant representation from Indonesia, reflecting the nation's rich cultural diversity and growing emphasis on culturally-responsive mathematics education aligned with the Merdeka Curriculum framework.

3.1 Characteristics of Included Studies

Primary empirical studies demonstrated considerable variation in sample sizes, ranging from 30 students in single-classroom interventions to multi-school implementations involving several hundred participants. Research designs included quasi-experimental pretest-posttest designs with control groups, one-group pretest-posttest studies, and mixed-method approaches combining quantitative outcome measures with qualitative data from interviews and observations. The duration of interventions varied from short-term implementations (2-4 weeks) to semester-long programs, with most studies conducting interventions over 6-12 weeks. Grade levels ranged from first to sixth grade, with particular concentration on grades 4 and 5, corresponding to the intermediate elementary level where both concrete and abstract mathematical thinking capabilities are developing.

Ethnomathematics interventions employed diverse cultural elements and implementation modalities, reflecting the multifaceted nature of culturally-integrated mathematics instruction. Traditional games emerged as a prominent vehicle for ethnomathematics integration, with studies examining congklak (traditional counting game), engklek (hopscotch variations), and pacu jalur lopek (traditional boat racing) as contexts for developing numeracy and reasoning skills (Asmara et al., 2024; Oktarisa et al., 2025; Tampubolon et al., 2023). Cultural artifacts and architectural elements provided another major category of intervention, including studies

on traditional textiles (Udeng Pacul Gowang), temple architecture (Candi Dermo), and indigenous measurement systems embedded in daily cultural practices (Susanti et al., 2025; Yustitia et al., 2025). Innovative digital media applications constituted a growing trend, with interactive videos, augmented reality applications, and multimedia modules integrating ethnomathematics content through technology-enhanced learning environments (Gustina et al., 2025; Yustitia et al., 2025). Additionally, several studies examined integrated pedagogical approaches combining ethnomathematics with contemporary instructional frameworks such as STEAM (Science, Technology, Engineering, Arts, Mathematics), Problem-Based Learning, and Deep Learning strategies (Aini et al., 2025; Dwiyani et al., 2025).

3.2 Impact on Numeracy Skills

Quantitative findings across primary empirical studies consistently demonstrated significant positive effects of ethnomathematics approaches on elementary students' numeracy skills, with improvements documented through various assessment instruments including standardized tests, researcher-developed numeracy assessments, and national competency frameworks. The most robust evidence comes from Larasati et al. (2025), whose quasi-experimental study examining ethnomathematics-based learning in the context of Indonesia's Minimum Competency Assessment (AKM) reported substantial numeracy score improvements from pretest mean of 27.83 to posttest mean of 56.17, representing a normalized gain (N-gain) of 0.37 in the moderate category with statistical significance ($p < 0.05$). Similarly, Aini et al. (2025) documented dramatic numeracy literacy improvements through STEAM-based ethnomathematics implementation, with scores increasing from 48 to 81, demonstrating statistically significant gains ($p < 0.01$) accompanied by enhanced Pancasila Student Profile character development.

Numeracy skill development manifested across multiple dimensions including computational fluency, conceptual understanding, and application of mathematical procedures in contextual problem-solving. Studies employing multi-level numeracy assessments revealed differential effects across cognitive complexity levels, with students demonstrating high performance on level 1 tasks (basic procedural skills) and moderate to high performance on levels 2-3 tasks requiring deeper conceptual understanding and mathematical reasoning (Iswara et al., 2022). Dwiyani et al. (2025) reported numeracy score increases of 24.3 points following implementation of ethnoliteracy-based numeracy learning combined with deep learning strategies, accompanied by enhanced positive attitudes toward mathematics and improved metacognitive awareness. The consistency of positive outcomes across diverse cultural contexts, grade levels, and implementation modalities provides strong convergent evidence for the effectiveness of ethnomathematics approaches in developing elementary students' numeracy competencies.

Digital and interactive media integrating ethnomathematics content demonstrated particularly high effectiveness and feasibility ratings from both validity assessments and practical implementation evaluations. Yustitia et al. (2025) reported that interactive video content featuring Candi Dermo temple architecture achieved very high validity ratings from expert validators and demonstrated high practical effectiveness in enhancing students' numeracy skills through culturally-contextualized geometric and measurement concepts. Similarly, Pohan & Wandini (2025) documented significant improvements in mathematical literacy ($p = 0.007$) following implementation of the "Bumi Bercerita" (Earth Tells Stories) ethnomathematics module, with students demonstrating enhanced abilities to formulate, apply, and evaluate mathematical solutions in authentic problem contexts. These findings suggest that

technologically-mediated ethnomathematics interventions effectively combine cultural relevance with engaging multimedia presentations to support numeracy development.

3.3 Impact on Mathematical Reasoning

Evidence regarding ethnomathematics approaches' impact on mathematical reasoning, while less extensively documented than numeracy outcomes, indicates significant positive effects on various reasoning competencies including pattern recognition, generalization, logical argumentation, and problem-solving strategies. Systematic reviews synthesizing multiple studies reported consistent findings that ethnomathematics integration enhances critical thinking, collaborative reasoning, and conceptual understanding alongside computational skills (Zainovi et al., 2025). The exploratory and inquiry-based nature of ethnomathematics learning, where students investigate mathematical concepts embedded in cultural artifacts and practices, naturally engages reasoning processes as students identify patterns, formulate conjectures, and justify their mathematical thinking through culturally-meaningful contexts.

Traditional games emerged as particularly effective vehicles for developing mathematical reasoning through playful, socially-interactive contexts that engage strategic thinking and pattern analysis. Tampubolon et al. (2023) found that students learning through ethnomathematics integration via congklak (traditional counting game) demonstrated superior understanding of numeracy concepts and reasoning processes compared to conventional instruction, with improved abilities to explain their mathematical thinking and apply strategic reasoning in game-based problem scenarios. Asmara et al. (2024) systematically reviewed 17 articles examining engklek (traditional hopscotch) integration and reported enhanced mathematical literacy and reasoning skills accompanied by reduced mathematics anxiety, suggesting that culturally-familiar game contexts provide psychologically safe environments for developing reasoning competencies without the intimidation often associated with formal mathematics instruction.

Problem-solving abilities, representing applied mathematical reasoning in authentic contexts, showed marked improvements following ethnomathematics interventions that situated mathematical challenges within culturally-relevant scenarios. Iswara et al. (2022) conducted in-depth qualitative analysis of students' numeracy literacy through ethnomathematics-based problem-solving, revealing that students successfully employed sophisticated reasoning strategies including problem representation, systematic analysis, and logical evaluation when mathematical problems were framed within familiar cultural contexts. The study identified problem comprehension and contextual interpretation as key factors influencing reasoning performance, with culturally-embedded problems providing meaningful anchors that supported students' reasoning processes. Integration of Problem-Based Learning with ethnomathematics demonstrated particularly strong effects, with meta-analytic evidence indicating very strong effect sizes (rRE = 1.42) on mathematical literacy, which encompasses both computational skills and reasoning competencies required for mathematical problem-solving (Sholihah, 2025, as cited in document).

3.4 Meta-Analytic Evidence and Effect Sizes

Meta-analytic studies provided robust quantitative evidence for the overall effectiveness of ethnomathematics and culturally-based mathematics instruction, synthesizing effect sizes across multiple primary studies to estimate population-level impacts. Zuliana et al. (2025) conducted a comprehensive meta-analysis of 25 studies yielding 45 effect sizes, examining culture-based mathematics learning instruction's impact on mathematical skills. The analysis

revealed significant and strong overall effects on mathematical achievement, with substantial heterogeneity explained by skill type, country context, and publication year, indicating that effectiveness varies across different mathematical competencies and cultural contexts but remains consistently positive across diverse implementations.

Sulistyowati & Mawardi (2023) meta-analyzed 13 effect sizes from ethnomathematics studies specifically in Indonesian elementary education contexts, finding high overall effectiveness on mathematical abilities with significant variation influenced by publication year but not by grade level or sample size. This suggests that ethnomathematics approaches are effective across different elementary grades and scale well beyond small pilot implementations. Pratama & Yelken (2024) meta-analyzed 16 studies examining ethnomathematics-based learning's impact on mathematical literacy, reporting strong effects moderated by demographic variables, instructional variables, and mathematical content areas. The study highlighted that effectiveness varies based on implementation specifics, with visual models and certain content domains showing particularly strong outcomes, suggesting that careful instructional design considerations can optimize ethnomathematics interventions' effectiveness.

Table 2 presents findings from primary empirical studies that directly implemented ethnomathematics interventions with students, providing detailed context-specific evidence of effectiveness across diverse cultural elements and grade levels.

Table 2. Summary of Primary Empirical Studies on Ethnomathematics Impact

Study	Design	Sample	Cultural Element	Intervention Duration	Numeracy/ Reasoning Outcome	Effect Size/ Significance
(Larasati et al., 2025)	Quasi-experimental	30 students, 1 school	Local cultural contexts	Not specified	Numeracy: 27.83→56.17	N-gain=0.37 (moderate effect size) p<0.05
(Aini et al., 2025)	Mixed-method	1 school	STEAM-ethnomathematics	Semester	Numeracy: 48→81	Significant, p<0.01
(Yustitia et al., 2025)	R&D validation	Elementary students	Candi Dermo temple	Media development	High validity & effectiveness	Expert validation ratings
(Iswara et al., 2022)	Qualitative analysis	Elementary students	Problem-solving contexts	Not specified	High literacy on level 1; moderate on levels 2-3	Qualitative findings
(Tampubolon et al., 2023)	Experimental	Elementary students	Congklak game	Not specified	Superior numeracy concept understanding	Comparative advantage
(Dwiyani et al., 2025)	Implementation study	3 schools	Ethnoliteracy approach	Not specified	Numeracy +24.3 points	Significant improvement
(Susanti et al., 2025)	Qualitative	Elementary students	Udeng Pacul Gowang textile	Not specified	Geometry identification, measurement application	Increased motivation
(Oktarisa et al., 2025)	R&D	Elementary students	Pacu jalur lopek tradition	Item development	22 valid items (Aiken V=0.91, reliability=0.79)	High validity
(Pohan & Wandini, 2025)	Control group design	Grade 5, 1 school	"Bumi Bercerita" module	Not specified	Mathematical literacy improvement	p=0.007 (statistically significant at α<0.01)

Reyes (2025) conducted meta-analysis comparing experimental and control groups in local wisdom-based learning models, documenting very strong effects (ES = 1.37) on learning outcomes with no evidence of publication bias, strengthening confidence in the validity of reported effects. Similarly, Hendri et al. (2025) reported strong average effects (ES = 1.22) of ethnomathematics on mathematical achievement across culturally diverse contexts, demonstrating effectiveness across different cultural implementations rather than being limited to specific cultural traditions. These converging meta-analytic findings provide compelling evidence that ethnomathematics approaches constitute an effective evidence-based practice for enhancing mathematical competencies in elementary education, with effect sizes substantially exceeding typical educational intervention impacts.

Table 3 presented synthesizes meta-analytic studies that aggregate effect sizes across multiple primary studies, offering population-level estimates of ethnomathematics effectiveness and identifying moderating factors that influence outcomes.

Table 3. Summary of Meta-Analyses on Ethnomathematics Effectiveness

Study	Number of Studies	Total Effect Sizes	Population Focus	Overall Effect Size	Key Moderators	Heterogeneity
(Zuliana et al., 2025)	25 studies	45 effect sizes	Mathematical skills	Significant & strong	Skill type, country, publication year	High
(Sulistyowati & Mawardi, 2023)	13 studies	13 effect sizes	Indonesian elementary math	High effectiveness	Publication year (not grade/ sample)	Moderate
(Pratama & Yelken, 2024)	16 studies	Not specified	Mathematical literacy	Strong effect	Demographics, variables, content	Moderate
(Reyes, 2025)	Meta-analysis	Not specified	Local wisdom learning	ES=1.37 (very strong)	Not specified	No publication bias
(Hendri et al., 2025)	11 studies	Not specified	Mathematical achievement	ES=1.22 (strong)	Context variations	High heterogeneity

5 Discussion

The synthesis of evidence from this systematic literature review provides compelling support for ethnomathematics approaches as effective pedagogical strategies for enhancing numeracy skills and mathematical reasoning abilities in elementary education contexts. The convergence of findings across diverse research designs, cultural contexts, and implementation modalities strengthens confidence in the robustness and generalizability of ethnomathematics' positive impacts. Meta-analytic evidence demonstrating strong to very strong effect sizes (ES = 1.22-1.42) positions ethnomathematics interventions among the most effective educational practices for elementary mathematics, with impacts substantially exceeding typical effect sizes for conventional instructional innovations (Hendri et al., 2025; Zuliana et al., 2025). The consistency of positive outcomes across different outcome measures from basic computational numeracy to complex mathematical reasoning suggests that culturally-integrated mathematics instruction benefits multiple dimensions of mathematical competency rather than merely enhancing specific procedural skills (Pratama & Yelken, 2024).

The mechanisms through which ethnomathematics approaches enhance mathematical learning appear multifaceted, operating through cognitive, affective, and sociocultural pathways that collectively support deeper engagement and understanding. Cognitively, situating mathematical concepts within familiar cultural contexts provides meaningful anchors that facilitate comprehension, retention, and transfer of learning by connecting abstract mathematical ideas to concrete, experientially-grounded cultural practices and artifacts (Nurhusain et al., 2025; Reyes, 2025). This cognitive bridging reduces the abstraction gap that often impedes elementary students' mathematical understanding, enabling them to construct conceptual schemas rooted in culturally-meaningful experiences before generalizing to formal mathematical representations. Affectively, ethnomathematics instruction enhances student motivation, reduces mathematics anxiety, and fosters positive mathematical identities by validating students' cultural backgrounds and demonstrating mathematics' relevance to their lived experiences (Asmara et al., 2024; Susanti et al., 2025). Socioculturally, ethnomathematics acknowledges and honors diverse ways of mathematical knowing, promoting inclusive learning environments where all students' cultural knowledge systems are recognized as legitimate foundations for mathematical development.

The particular effectiveness of traditional games as vehicles for ethnomathematics integration merits specific attention, as multiple studies documented enhanced numeracy and reasoning outcomes through game-based cultural learning. Games like congklak, engklek, and other traditional activities embed mathematical concepts in playful, socially-interactive contexts that naturally engage strategic thinking, pattern recognition, and numerical reasoning while maintaining high student interest and motivation (Asmara et al., 2024; Tampubolon et al., 2023). The game context provides repeated opportunities for mathematical practice without the tedium often associated with computational exercises, as students willingly engage in multiple iterations to improve their game performance, thereby consolidating mathematical skills through meaningful repetition. Furthermore, traditional games typically involve social interaction and collaboration, creating opportunities for peer explanation, mathematical discourse, and collective problem-solving that support reasoning development through social constructivist learning processes (Oktarisa et al., 2025).

Digital media integration with ethnomathematics content represents an emerging trend that demonstrates particular promise for scaling effective culturally-responsive mathematics instruction. Studies examining interactive videos, augmented reality applications, and multimedia modules reported high validity ratings, implementation feasibility, and effectiveness in enhancing numeracy skills, suggesting that technology-mediated ethnomathematics interventions can effectively combine cultural authenticity with engaging multimedia affordances (Gustina et al., 2025). Digital formats enable wide dissemination of culturally-rich mathematical content beyond geographic limitations, potentially making diverse cultural mathematical practices accessible to students across different regions and cultural backgrounds. However, digital implementations must carefully balance technological engagement with authentic cultural representation, ensuring that cultural elements are not merely superficial "decorations" but rather constitute genuine mathematical contexts that reflect the cultural communities' actual practices and epistemologies (Dwiyani et al., 2025; Hendri et al., 2025).

The integration of ethnomathematics with contemporary pedagogical frameworks such as STEAM, Problem-Based Learning, and Deep Learning strategies demonstrates productive synergies that enhance both cultural relevance and instructional effectiveness. Aini et al. (2025) documented that STEAM-based ethnomathematics implementation simultaneously developed numeracy literacy and Pancasila Student Profile character dimensions, illustrating how integrated approaches can address multiple educational objectives through coherent, culturally-

grounded learning experiences. Problem-Based Learning combined with ethnomathematics showed particularly strong effects on mathematical literacy and reasoning, as culturally-relevant problem contexts motivated sustained engagement with complex mathematical challenges while providing meaningful scenarios for applying mathematical reasoning (Sholihah, 2025, as referenced). These integrative approaches suggest that ethnomathematics should not be viewed as a standalone pedagogical method but rather as a cultural framing that can enhance various evidence-based instructional strategies by providing culturally-meaningful contexts and motivational relevance (Gustina et al., 2025; Nurhusain et al., 2025).

Systematic reviews examining ethnomathematics integration across different mathematical content domains reveal both consistent effectiveness patterns and domain-specific considerations. Zainovi et al. (2025) specifically examined ethnomathematics in geometry education, finding enhanced conceptual understanding, critical thinking, collaboration, and motivation through culturally-embedded geometric explorations of traditional patterns, architectural elements, and cultural designs. Geometry may be particularly amenable to ethnomathematics integration given the ubiquity of geometric patterns and spatial relationships in cultural artifacts, architectural traditions, and decorative arts across diverse cultures. However, evidence also supports ethnomathematics' effectiveness for numerical operations, measurement, data analysis, and other mathematical domains when appropriate cultural connections are identified and pedagogically leveraged (Hendri et al., 2025; Pratama & Yelken, 2024). This suggests that successful ethnomathematics implementation requires thoughtful curriculum analysis to identify authentic cultural connections across mathematical topics rather than forcing superficial cultural links where genuine connections do not exist.

Despite substantial evidence for ethnomathematics' effectiveness, several methodological limitations in the existing research base necessitate cautious interpretation and suggest priorities for future investigation. Many primary studies employed relatively small samples from single schools or limited geographic regions, raising questions about generalizability across diverse educational contexts and student populations (Aini et al., 2025; Puspadewi et al., 2025). A substantial proportion of studies utilized quasi-experimental designs without control groups or with non-equivalent comparison groups, limiting causal inference regarding ethnomathematics interventions' specific impacts versus other concurrent factors influencing student learning. Few studies examined long-term effects or retention of learning beyond immediate post-intervention assessments, leaving questions about the durability of ethnomathematics' benefits and whether enhanced numeracy and reasoning skills transfer to subsequent mathematics learning (Pratama & Yelken, 2024). Additionally, implementation fidelity and dosage varied considerably across studies, with insufficient documentation of intervention specifics to enable precise replication or to identify optimal implementation parameters. Future research should address these limitations through large-scale randomized controlled trials, longitudinal designs tracking long-term outcomes, and detailed implementation research examining mechanisms and contextual factors influencing ethnomathematics effectiveness (Nurhusain et al., 2025; Reyes, 2025).

Implications for educational practice and policy are substantial, suggesting multiple pathways for broader integration of ethnomathematics approaches into mainstream elementary mathematics education. Teacher preparation programs should incorporate ethnomathematics principles and provide prospective teachers with conceptual frameworks for identifying cultural mathematical connections and pedagogical strategies for culturally-responsive mathematics instruction (Hendri et al., 2025). Professional development for in-service teachers should support the development of locally-relevant ethnomathematics curricula that reflect their specific students' cultural backgrounds while maintaining mathematical rigor and alignment with learning standards. Curriculum developers and publishers should systematically integrate culturally-diverse mathematical contexts and examples throughout instructional materials

rather than treating cultural connections as supplementary enrichment activities. Educational policymakers should recognize ethnomathematics as an evidence-based practice warranting systemic support through curriculum frameworks, assessment policies, and resource allocation that enable widespread implementation (Sulistyowati & Mawardi, 2023). Furthermore, assessment systems should value and measure students' abilities to apply mathematical thinking in culturally-relevant contexts, moving beyond decontextualized procedural testing to authentic performance assessment that recognizes diverse ways of demonstrating mathematical competency.

Key findings from this systematic review include: (1) Strong empirical evidence (ES = 1.22-1.42) supporting ethnomathematics' effectiveness in enhancing both numeracy skills and mathematical reasoning across diverse cultural contexts; (2) Particular effectiveness of traditional games, digital media integration, and STEAM-based approaches as implementation modalities; (3) Multi-dimensional impact encompassing cognitive, affective, and sociocultural benefits beyond mere procedural skill development; (4) Consistency of positive outcomes across different grade levels, cultural contexts, and mathematical content domains. Implications for future research include: (1) Need for large-scale randomized controlled trials with adequate control groups; (2) Longitudinal studies examining long-term retention and transfer effects; (3) Cross-cultural comparative research identifying universal versus context-specific effectiveness factors; (4) Detailed implementation research documenting fidelity, dosage, and mechanisms of impact; (5) Investigation of optimal teacher preparation and professional development models for supporting ethnomathematics integration.

5 Conclusion

This systematic literature review provides substantial evidence supporting ethnomathematics approaches as highly effective pedagogical strategies for enhancing elementary students' numeracy skills and mathematical reasoning abilities. Analysis of 18 studies encompassing primary empirical investigations, meta-analyses, and systematic reviews demonstrates consistent positive impacts across diverse cultural contexts, implementation modalities, and student populations. Meta-analytic findings reveal strong to very strong effect sizes exceeding typical educational intervention impacts, positioning culturally-integrated mathematics instruction among the most effective practices for elementary mathematics education. Primary studies document significant improvements in numeracy scores, enhanced mathematical reasoning capabilities, increased student motivation, reduced mathematics anxiety, and strengthened cultural identity through learning experiences that connect formal mathematical concepts with students' lived cultural experiences.

The evidence base, while compelling, reveals important methodological limitations including small sample sizes in many primary studies, limited use of rigorous experimental designs with control groups, insufficient examination of long-term outcomes, and concentration of research in specific geographic and cultural contexts limiting generalizability. Future research priorities include large-scale randomized controlled trials, longitudinal investigations of sustained effects, cross-cultural comparative studies, detailed implementation research examining mechanisms and contextual factors, and systematic investigation of teacher preparation and professional development models for supporting ethnomathematics integration. Educational practice and policy implications emphasize the need for comprehensive teacher preparation in culturally-responsive mathematics pedagogy, systematic curriculum integration of diverse cultural mathematical contexts, assessment reforms valuing culturally-situated mathematical competencies, and policy frameworks supporting widespread implementation of evidence-based ethnomathematics approaches in elementary education systems.

5 References

Accra-Jaja, F. S., Adolphus, T., & Omeodu, D. M. (2023). Effect of Ethnomathematics-Based Instructional Approach on Academic Performance in Plane Geometry among Senior Secondary School Students in Rivers State. *International Journal of Innovative Social & Science Education Research*, *11*(3), 43–51. https://www.seahipublications.org/wp-content/uploads/2024/06/IJISSER-S-5-2023.pdf

Aini, K., Wahab, A., Ar, M. M., & Asmoni, A. (2025). Numeracy Literacy Skills and Pancasila Student Profiles through the Implementation of Ethnomathematics-Based STEAM. *Al-Ishlah: Jurnal Pendidikan, 17*(1), 535-545. https://doi.org/10.35445/alishlah.v17i1.6048

Asmara, A., Andrini, V., Juwanto, Y. A., Asfar, A., Jumri, R., & T, A. Y. (2024). Engklek: Ethnomathematics-Based Traditional Games in The Development of Teaching Materials to Build Mathematical Literacy Skills. *Journal of Pedagogi, 1*(6), 98-115. https://doi.org/10.62872/rg2kny19

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics*, *5*(1), 44–48. https://www.jstor.org/stable/40247876

Dwiyani, E., Nursalim, M., & Puspita, A. M. I. (2025). Transformation of Numeracy Learning through Ethnoliteration Approach and Deep Learning Strategies in the Society 5.0 Era. *Journal of Innovation and Research in Primary Education, 4*(3), 664–672. https://doi.org/10.56916/jirpe.v4i3.1417

Farabi, M. A., Masamah, U., & Rofiki, I. (2025). Development of Visual-Spatial Thinking Ability Test Instrument Based on Pattern Batik Ceplok-Ceplok Jatipelem Jombang. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika*, *8*(2), 151–166. https://doi.org/10.26740/jrpipm.v8n2.p151-166

Gustina, D. M., Mariana, N., & Wiryanto, W. (2025). Augmented Reality-Based Ethnomathematics Learning Media to Enhance Spatial Ability in 3D Geometry for Fifth Grade Elementary Students. *Journal of Innovation and Research in Primary Education*, *4*(2), 273–280. https://doi.org/10.56916/jirpe.v4i2.1229

Hendri, S., Sa'dijah, C., & Muksar, M. (2025). Integration of Multicultural Discovery Learning and Computational Thinking in Elementary Mathematics Education: A Systematic Literature Review. *Journal of Ecohumanism, 4*(2), 1233–1247. https://doi.org/10.62754/joe.v4i2.6223

Hidayana, R. A., & Lianingsih, N. (2025). Contextual Learning as a Means to Improve Elementary School Students' Mathematical Literacy Skills. *International Journal of Ethno-Sciences and Education Research*, *5*(2), 46–50. https://doi.org/10.46336/ijeer.v5i2.935

Hidayat, A. R., Shodikin, A., & Hamiydah, S. H. (2025). Ethnomathematical Insights into Student Errors: Javanese Calendar and Pigeonhole Principle. (2025). *Journal of Current Studies in SDGs*, *1*(3), 58. https://doi.org/10.63230/jocsis.1.3.58

Iswara, H. S., Ahmadi, F., & Ary, D. Da. (2022). Numeracy Literacy Skills of Elementary School Students through Ethnomathematics-Based Problem Solving. *Interdisciplinary Social Studies*, *2*(2), 1604–1616. https://doi.org/10.55324/iss.v2i2.316

Larasati, I., Pramasdyahsari, A. S., & Harun, L. (2025). Enhancing elementary student's numeracy skills through ethnomathematics-based learning: An analysis of minimum competency assessment results. *Journal of Honai Math*, *8*(1), 71–88. https://doi.org/10.30862/jhm.v8i1.861

Ladyawati, E., & Maftuh, M. S. (2025). Mathematical Numeracy Literacy Ability of High School Students in Solving Math Problems. *Jurnal Riset Pendidikan Dan Inovasi*

Pembelajaran Matematika, *8*(2), 141–150. https://doi.org/10.26740/jrpipm.v8n2.p141-150

Muhakimah, I., & Arfinanti, N. (2024). Ethnomathematics: Cultural Exploration of Bangkalan Madura Regency in Mathematics Learning for Phase D. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika,* *8*(1), 46–59. https://doi.org/10.26740/jrpipm.v8n1.p46-59

Mustika, A. S., Riyadi, R., & Kurniawan, S. B. (2025). The effectiveness numeracy learning strategies for early grade students in elementary school: a systematic review. *Jurnal JPSD (Jurnal Pendidikan Sekolah Dasar)*, *12*(1), 57–66. https://doi.org/10.26555/jpsd.v12i1.a30854

Nabilah, I., & Shodikin, A. (2025). Students' Abductive Reasoning in Solving Quadratic Pattern Generalization Problem Based on the Initial Mathematical Ability. *Journal of Mathematical Pedagogy (JoMP)*, *6*(2), 72-93. https://doi.org/10.26740/jomp.v6n2.p72-93

Nurhusain, M., Upu, H., & Djadir. (2025). Ethnomathematics-Based Learning & the Merdeka Curriculum in the Society 5.0 Era: Indonesian Educational Innovation. *International Journal of Integrative Sciences, 4*(4), 743–766. https://doi.org/10.55927/ijis.v4i4.203

Oktarisa, L., Putra, Z., Erlisnawati, E., & Fendrik, M. (2025). Development of Ethnomathematics-based Numeracy Literacy Tasks using pacu Jalur Lopek Tradition Context for Elementary Students. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 14*(1), 246 – 261. https://doi.org/10.24127/ajpm.v14i1.10139

Pohan, R. I., & Wandini, R. R. (2025). The Influence of the 'Earth Tells' Module Based on Ethnomathematics on the Mathematical Literacy Skills of Fifth Grade Elementary School Students. *Attadrib: Jurnal Pendidikan Guru Madrasah Ibtidaiyah,* *8*(2), 452–463. https://doi.org/10.54069/attadrib.v8i2.955

Pratama, R. A., & Yelken, T. (2024). Effectiveness of Ethnomathematics-Based Learning on Students' Mathematical Literacy: a Meta-Analysis Study. *Discover Education, 3,* 202. https://doi.org/10.1007/s44217-024-00309-1

Puspadewi, K. R., Atmaja, I., & Noviyanti, P. L. (2025). Balinese Ethnomathematics in Numeracy Education: Culturally-Inspired Questions for Middle School Students. *Jurnal Pedagogi dan Pembelajaran, 8*(1), 100–107. https://doi.org/10.23887/jp2.v8i1.89054

Putri, K. D., Ekawati, R., & Shodikin, A. (2024). Students' Reasoning in Mathematics Learning: How to Solve Problem of Ethnomathematics Based on Personality. *Journal of the Indonesian Mathematics Education Society*, *2*(2), 70–79. https://doi.org/10.26740/jimes.v2n2.p70-79

Reyes, K. (2025). A Systematic Review of Culturally Relevant Pedagogy in Mathematics Teacher Education: Methods, Successes, and Room for Improvement. *International Educational Review*, *3*(1), 21–40. https://doi.org/10.58693/ier.312

Shodikin, A., Kohar, A. W., & Sumarno, W. K. (2024). Improving student bilingual numeracy: Developing teaching modules with a project-based learning approach. *AIP Conference Proceedings*, *3116*(1), 060043. https://doi.org/10.1063/5.0210433

Solihin, A., Mariana, N., Wiryanto, W., Rahmawati, I., & Suryanti, S. (2025). Integrating Ethnomathematics of Zero Waste Culture Based ESD to Enhance Students' Creative Thinking and Sustainability Consciousness. *Journal of Innovation and Research in Primary Education*, *4*(2), 136–147. https://doi.org/10.56916/jirpe.v4i2.1221

Sulistyowati, E., & Mawardi, D. N. (2023). The Effectiveness of Ethnomatematics Based Learning on Mathematics Ability of Elementary School Students: a Meta-Analyis Study. *Al-Bidayah : Jurnal Pendidikan Dasar Islam*, *15*(1), 1–26. https://doi.org/10.14421/albidayah.v15i1.879

Sunzuma, G., & Umbara, U. (2025). Ethnomathematics-based technology in Indonesia: A

systematic review. *Asian Journal for Mathematics Education*, *4*(1), 129–153. https://doi.org/10.1177/27527263241305812

Susanti, R. M., Gunansyah, G., & Nasution, N. (2025). Integrating Local Culture into Mathematics Learning: Ethnomathematics Approach Using Udeng Pacul Gowang in Elementary Schools. *Journal of Innovation and Research in Primary Education, 4*(3), 947–957. https://doi.org/10.56916/jirpe.v4i3.1472

Tampubolon, T., Sibarani, S., Zuhri, Zakiah, N., Zaini, H., Kunci, K., Congklak, E. P., & Pembelajaran, S. (2023). Ethnomathematics Learning to Improve Students' Understanding for Numeracy Concepts. *JPI (Jurnal Pendidikan Indonesia), 12*(2), 358-366. https://doi.org/10.23887/jpiundiksha.v12i2.60716

Yustitia, V., Wijayanti, S., Faridah, L., Emilia, N. P., & Kusmaharti, D. (2025). Ethnomathematics-Based Interactive Video of Dermo Temple to Enhance Numeracy Skills of Elementary School Students. *KnE Social Sciences*, *10*(9), 189–206. https://doi.org/10.18502/kss.v10i9.18490

Zainovi, P. S., Mariana, N., Istiq'faroh, N., Wiryanto, W., & Muhimmah, H. A. (2025). Integrating Ethnomathematics in Geometry Learning to Enhance Primary Students' Numeracy Skills: A Systematic Literature Review. *Journal of Innovation and Research in Primary Education*, *4*(3), 1044–1053. https://doi.org/10.56916/jirpe.v4i3.1467

Zuliana, E., Dwiningrum, S., Wijaya, A., & Hukom, J. (2025). The effect of culture-based mathematics learning instruction on mathematical skills: a meta-analytic study. *Journal of Education and Learning (EduLearn), 19*(1), 191-201. https://doi.org/10.11591/edulearn.v19i1.21172