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Batak Toba Local Wisdom as a Conceptual Bridge in Primary Mathematics Instruction: A Systematic Literature Review

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ABSTRACT

Indonesian primary education continues to face significant challenges in numeracy, as evidenced by a persistent performance gap between formal mathematical abstractions and students' daily sociocultural contexts. This study explores the potential of Batak Toba local wisdom to serve as a conceptual bridge in elementary mathematics learning. Following the PRISMA protocol, a systematic review was conducted on seven empirical studies retrieved from SINTA-indexed journals published between 2015 and 2025. Inclusion was limited to studies that provided empirical evidence of classroom interventions. Findings reveal that Batak Toba cultural heritage—specifically the geometric symmetries of *Ulos* textiles, the structural proportions of *Rumah Bolon* architecture, and the functional designs of *Tandok*—provides a robust foundation for teaching geometry, measurement, and arithmetic. This integration operates through three primary pathways: the use of artifacts as visual anchors, the alignment of instructional materials with cultural identity, and the implementation of Realistic Mathematics Education (RME) within local settings. The synthesized evidence indicates that these culturally relevant approaches significantly enhance students' conceptual understanding and engagement in learning compared to conventional methods. The study concludes that while indigenous frameworks effectively foster mathematical literacy, further rigorous research is needed to evaluate their efficacy across broader socio-geographical contexts.

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1. INTRODUCTION

Primary education in Indonesia continues to face systemic challenges in mathematical literacy, specifically regarding students' foundational grasp of arithmetic and numeracy. Data from the Programme for International Student Assessment (PISA) over the last decade consistently highlights that Indonesian students' mathematical performance remains significantly below the OECD average. In the 2022 cycle, Indonesia recorded an

average score of 366, reflecting a substantial gap from the OECD mean of 472 [1], [2]. While low performance is a multifaceted issue, one significant factor is the persistent disconnect between formal, abstract mathematics and the informal mathematical reasoning used by students in their daily sociocultural contexts [3], [4].

From a developmental standpoint, primary school pupils are in the concrete operational stage, where cognitive acquisition is most effective when anchored in familiar, tangible experiences [5]. However, current instructional practices often remain procedural, relying heavily on standardized textbooks that seldom incorporate local cultural wisdom [6]. This approach, divorced from real-world circumstances, impedes students' ability to internalize mathematical logic [7].

As a theoretical response, ethnomathematics emerges as a vital cognitive bridge. D'Ambrosio posits that mathematics evolves through a dual trajectory: one institutionalized and the other rooted in community praxis [8], [9]. This aligns with sociocultural constructivism, which asserts that learning is a social process in which cognition flourishes within a familiar environment [10]. Furthermore, the Realistic Mathematics Education (RME) framework emphasizes that instruction should originate from "real-world" situations meaningful to the learner [11].

The Batak Toba culture in North Sumatra serves as a prominent example, rich with latent mathematical structures. Gorga engravings on traditional houses exhibit transformational symmetries, including translation, reflection, and rotation [12]. Artisans weave intricate numerical sequences into Ulos fabrics, while the Rumah Bolon (traditional house) manifests principles of volumetric proportion and precise measurement [13], [14]. These artifacts confirm that indigenous knowledge systems can function as powerful conduits for contextualized mathematical inquiry.

Despite growing interest, a significant research gap remains. Most previous studies focus on exploratory identification of concepts within individual artifacts in isolation [15], [16]. Furthermore, existing ethnomathematical research in Indonesia predominantly targets secondary education, leaving the primary sector under-researched [17]. There is a lack of a unified framework that synthesizes these fragmented discoveries into a cohesive pedagogical strategy for elementary schools.

This study aims to bridge these gaps through a Systematic Literature Review (SLR) following the PRISMA protocol [18]. The primary objective is to map Batak Toba cultural practices to the elementary curriculum and assess their efficacy as a "cultural bridge" for mastering formal concepts based on empirical evidence from existing studies.

2. METHOD

This study employs a Systematic Literature Review (SLR) to identify and synthesize existing research on integrating Batak Toba indigenous wisdom into elementary mathematics education. This strategy aims to provide a structured, reproducible overview of how ethnomathematical studies in this context have evolved over time [3]. The review process strictly adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines, encompassing the stages of identification, screening, eligibility, and inclusion [18]. Research questions were formulated using the PICOS

(Population, Intervention, Comparison, Outcome, and Study Design) framework to define investigation parameters and delineate pedagogical connections [19].

Table 1. PICOS Framework and Research Questions

Component	Description	Research Question (RQ)	Analytical Focus within Systematic Literature Reviews
P (Population)	Elementary school students in mathematics instruction.	RQ1: What forms of Batak Toba local wisdom practices incorporate mathematical concepts and have been implemented in mathematics instruction at the elementary school level?	Identification and mapping of Batak Toba cultural practices that embody mathematical concepts, and their pedagogical relevance to primary school education.
I (Intervention)	Integration of Toba Batak local wisdom into mathematics education	RQ2: How is Toba Batak local wisdom utilized as a conceptual bridge to integrate students' cultural experiences with formal mathematical concepts in primary school instruction?	Analyzing instructional strategies that integrate the Toba Batak culture to elucidate formal mathematical concepts.
C (Comparison)	Conventional mathematical instruction or pedagogy is devoid of cultural context.	RQ3: How does the Batak Toba local wisdom-based mathematics learning approach differ from conventional mathematics instruction in primary schools?	A comparative analysis of the characteristics of culture-based pedagogical approaches and conventional mathematics instruction.
O (Outcome)	Mathematical conceptual understanding, problem-solving ability, and mathematical connections.	RQ4: What is the impact of integrating Batak Toba local wisdom into mathematics instruction on the conceptual understanding and problem-solving abilities of primary school students?	Assessing the effectiveness of cultural integration in enhancing students' mathematical proficiency.
S (Study Design)	Ethnomathematical studies, educational experiments, quasi-experimental designs, design research, and qualitative investigations.	RQ5: What are the methodological trends identified in studies concerning the integration of Batak Toba local wisdom into elementary school mathematics instruction?	Identifying research design typologies, data collection methodologies, and the evolution of research trends within the subject area.

The primary demographic consists of elementary school children involved in formal mathematics, with the intervention defined as the integration of Batak Toba local wisdom. Comparisons assess these culture-centric techniques against conventional instructional models or baseline pedagogical practices described in the literature. Outcomes focus on mastering concepts, problem-solving proficiency, and mathematical connections, while the study design encompasses empirical research ranging from qualitative to quasi-experimental designs. The applied framework is detailed in Table 1.

Table 2. Inclusion and Exclusion Criteria

No	Criteria	Inclusion	Exclusion
1.	Publication Year Range	Articles published between 2015 and 2025.	Articles published prior to 2015.
2.	Database Sources	Articles were retrieved using the Publish or Perish software version 8, utilizing the Google Scholar database.	Articles that are unindexed or not retrieved through Publish or Perish searches.
3.	Publication Type	Scientific journal articles indexed in the Science and Technology Index (SINTA).	Books, conference proceedings, undergraduate theses, master's theses, doctoral dissertations, research reports, or articles not indexed in the Science and Technology Index (SINTA).
4.	Language of Publication	Manuscripts authored in either English or Indonesian.	Articles published in languages other than English and Indonesian.
5.	Research Topic	Research investigating Toba Batak indigenous wisdom, ethnomathematics, or the integration of Toba Batak cultural elements into mathematics education.	Research that does not pertain to Toba Batak culture or mathematics education.
6.	Research Subjects (Population)	Research involving elementary or primary education students.	Research conducted at secondary education levels, within higher education, or among the general public, devoid of a primary education context.
7.	Instructional Focus (Intervention)	Research investigating the integration of Batak Toba cultural elements or local wisdom into mathematics instruction.	Mathematical research that lacks integration with the cultural contexts or local wisdom of the Toba Batak.
8.	Research Design and Methodology	Empirical research, encompassing experimental and quasi-experimental designs, qualitative studies, design research, and mixed-methods approaches.	A purely conceptual article devoid of empirical research data.
9.	Article Access	The articles were available in full text, thereby facilitating a comprehensive and rigorous analysis.	Articles available only in abstract form or those for which the full text is inaccessible.

Selection factors delineated the literature boundaries to ensure methodological rigor. Strict inclusion and exclusion criteria were established to filter the search results. Eligible manuscripts had to be SINTA-indexed and published between 2015 and 2025. The decision to limit the timeframe to 2025 ensures the inclusion of complete publication cycles and avoids the uncertainty of unfinished metadata for 2026. This study focuses on Indonesian and English texts that examine Batak Toba ethnomathematics in primary education. Research designs must have empirical foundations—whether experimental, qualitative, or mixed-methods—and be accessible in full text. Purely conceptual articles devoid of empirical data were excluded to ensure that the synthesis is based on verified educational outcomes [20]. The specific criteria are categorized in Table 2.

The literature search was conducted on February 20, 2026, using the Publish or Perish 8 software to query the Google Scholar database. The topic's localized nature strategically justifies the choice of Google Scholar and SINTA-indexed journals; Batak Toba ethnomathematics is a regional cultural-educational subject predominantly documented in Indonesian national academic repositories. Boolean operations were strategically implemented to ensure data accuracy. The exact search strings utilized were: *"etnomatematika Batak Toba", "kearifan lokal Batak Toba" AND "pembelajaran matematika", "ethnomathematics AND Batak Toba", and "local wisdom AND mathematics learning AND Batak"*. This targeted approach effectively reduced noise and ensured a focused dataset [20].

To ensure methodological reliability, the screening and data extraction processes were performed by two independent reviewers. This multi-stage process included duplicate removal, title and abstract screening, and a comprehensive full-text assessment. Any disagreements regarding article eligibility or coding were resolved through a consensus-based discussion with a third senior researcher. Furthermore, a formal quality appraisal was conducted for all included studies. Each article was evaluated based on the clarity of its objectives, the appropriateness of the research design, the validity of its instruments, and the transparency of its data analysis. Only studies meeting a "Moderate" to "High" quality threshold were synthesized to ensure that the reported findings on student numeracy were derived from rigorous and reliable evidence. Findings were coded into thematic categories corresponding to the research questions. This analysis critically examines how Batak Toba traditions function as "conceptual bridges" between informal indigenous knowledge and formal primary school mathematics.

3. RESULTS AND DISCUSSION

3.1. Results

Using Publish or Perish 8 (Google Scholar) to extract bibliometric data gave us 475 potential entries. We got rid of 95 copies right away. This left us with 380 papers, which we then looked at the titles and abstracts of to narrow down the rest. Screening meant eliminating literature that was not useful. We threw away any text that did not combine Batak Toba local knowledge with basic math lessons. Accuracy was important. The remaining articles underwent a stringent full-text assessment, and only 7 research articles passed. These

last choices are the main part of the study's analysis. Figure 1 shows this filtration using a PRISMA Flow Diagram.

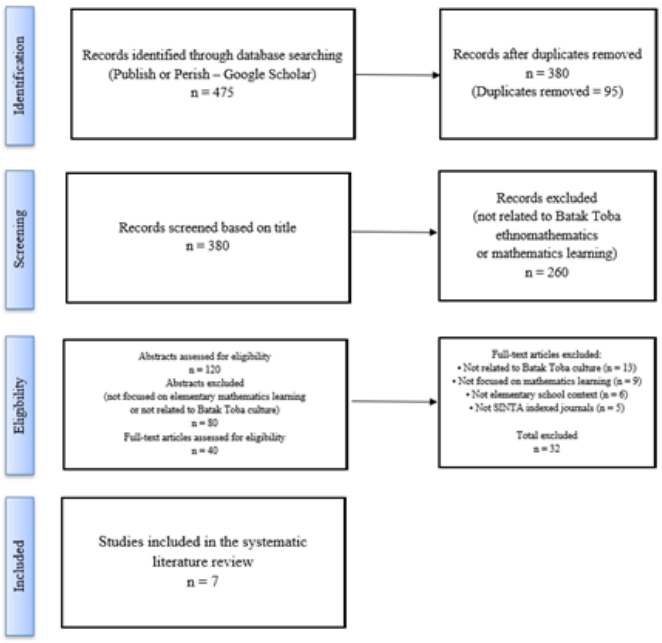

Figure 1. PRISMA Flow Diagram of the Article Selection Process.

Literature mapping from 2015 to 2026 shows that there is a lot of research on Batak Toba ethnomathematics. Most writers focus on high school students. This focus on junior and senior high school cohorts sidelines primary-level pedagogy; it is still uncommon to use local knowledge in elementary math. The data is sparse. This analysis examined precisely seven pertinent papers after using stringent inclusion criteria.

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Table 3 lists the characteristics of the publications that met the inclusion criteria so that you can see all of the research that was looked at. This table shows the authors, the years the studies were published, the research methods used, the specific elements of Toba Batak local wisdom examined, the mathematical principles investigated, and the key outcomes of each study.

Table 3. Characteristics of the Analyzed Articles

No	Author and Year	Research Methodology	Toba Batak Local Wisdom	Mathematical Concepts	Principal Findings
1.	Simorangkir et al. (2025) [21]	Research and Development (ADDIE Framework)	Ulos Motifs	Geometry	The development of instructional media utilizing the Desmos application based on Ulos ethnomathematics effectively enhances students' mathematical literacy, achieving a high N-Gain category.
2.	Landong et al. (2025) [22]	Research and Development (ADDIE Framework)	General Overview of Toba Culture	Numeracy literacy	The development of mathematics instructional materials based on Realistic Mathematics Education (RME) and Batak Toba ethnomathematics was evaluated as valid, practical, and effective in enhancing the numeracy literacy of elementary school students.
3.	Panjaitan & Sukmawarti, (2022) [23]	Research and Development	Toba Batak Vernacular Architecture	Geometry and measurement	Mathematics instructional materials integrated with Batak Toba traditional architecture are highly feasible and suitable for implementation in primary school mathematics education.
4.	Lubis et al. (2025) [24]	Quasi-Experimental Design	The Bolon House	Plane figure	Geometry instruction integrated with Batak traditional houses enhances students' numeracy skills more effectively than conventional pedagogical approaches.
5.	Landong et al. (2025) [25]	Mixed-methods research / Quasi-experimental design	Toba Batak Culture (Ulos and Numerical Concepts)	Mathematics instruction	The ethnomathematics-based Realistic Mathematics Education (RME) model significantly enhances students' interest in learning mathematics.
6.	Mailani et al. (2025) [26]	Qualitative	The Batak *Tandok*: A Traditional Woven Ceremonial Receptacle	Three-dimensional geometric solids	The integration of local wisdom into the instructional framework significantly enhances students' motivation to learn compared with conventional pedagogical approaches.
7.	Siregar et al. (2025) [27]	Classroom Action Research	The cultural medium of Bolon Café	The concept of the time value of money	Conceptual understanding and student engagement are significantly enhanced through the utilization of local culture-based media.

Mathematical Concepts Inherent in Toba Batak Local Wisdom Practices (RQ1)

An examination of seven publications meeting the inclusion requirements revealed that several Batak Toba indigenous wisdom practices incorporate mathematical principles relevant to elementary school mathematics education. Most of these activities use traditional

cultural objects, cultural symbols, and culture-based learning resources directly related to arithmetic subjects in the primary school curriculum.

The Ulos fabric motif is one of the most common cultural practices used to teach math. Research by [21] shows that *Ulos* motifs feature structured, repeating geometric patterns that can help primary school students understand geometric ideas. In that study, the Desmos application was used to show *Ulos* motifs as a way to help students better understand geometric principles. The findings indicated that the use of Ulos motifs in mathematics training substantially improved students' mathematical literacy.

The Batak Toba traditional house (Rumah Bolon) is another fantastic way to learn math, along with Ulos. A study by [23] produced math teaching materials for primary schools based on the Batak Toba traditional house to help kids learn how to measure flat shapes. There are many geometric shapes in the traditional house's structure, including triangles, rectangles, and three-dimensional figures. These shapes can be utilized to teach math. The results showed that the materials produced for teaching were very likely to work well in math lessons for kids in elementary school kids.

The integration of cultural symbols into mathematics instructional design also incorporates Batak Toba traditional practices. According to [24], teaching geometry using Batak traditional dwellings made kids far better at math than using traditional methods. This method uses geometric shapes in the traditional house structure as visual aids to help pupils better learn plane figure principles.

Many studies have employed Batak Toba cultural symbols, such as the Tandok Batak, to teach math alongside physical education. Using Tandok Batak symbols in the classroom can make students more interested in what they are learning and help them learn in a more helpful and meaningful way, according to [26].

The Batak Toba people's wisdom practices are also part of culture-based learning. A study by [27] created the "Bolon Café" learning medium, which uses Batak Toba economic practices in a new way. Students use this medium in buying-and-selling simulations to help them understand the value of money. The results showed that using media rooted in local culture helps kids learn more and become more involved in their education.

Moreover, numerous studies have used the Realistic Mathematics Education (RME) methodology grounded in Batak Toba ethnomathematics. The study by [22] shows that creating ethnomathematics-oriented mathematics educational materials using the RME methodology markedly enhances elementary school students' numeracy literacy skills.

The synthesis of the research suggests that Batak Toba local knowledge tactics applied in primary school mathematics instruction may be divided into three broad groups: traditional cultural objects, cultural symbols, and local culture-based educational tools. People often use cultural things like Ulos and the Batak Toba traditional house to teach kids how to measure and do geometry. To assist youngsters in relating math to activities they do every day, they use culture-based learning methods.

Table 4 summarizes these data to provide a more organized picture of how Toba Batak local wisdom practices and mathematical ideas are related in elementary school.

Table 4. Toba Batak Local Wisdom Practices and Mathematical Concepts in Primary School Education

No	The researcher	Toba Batak Local Wisdom	Mathematical Concepts	Mathematics Instructional Content for Primary Education	Implementation Modalities
1.	Simorangkir et al., (2025) [21]	The ornamental motifs of Ulos textiles	Geometric patterns and symmetries	Geometric	Visualization of Ulos motifs utilizing the Desmos application.
2.	Panjaitan & Sukmawarti (2022) [23]	The Toba Batak vernacular architecture	Geometric shapes and measurement	Plane figures	Development of mathematics instructional materials for primary schools based on traditional house architecture.
3.	Lubis et al. (2025) [24]	The *Rumah Bolon* vernacular architecture.	Two-dimensional geometric figures	Geometric	Culturally-based geometry instruction
4.	Mailani et al., (2025) [26]	The symbolic significance of the Batak *tandok*	Spatial structure	Three-dimensional geometric figures	The integration of cultural symbols in instructional design.
5.	Siregar et al. (2025) [27]	The Bolon Café Medium	Monetary value	Arithmetic	Simulation of transactional activities
6.	Landong, (2025) [25]	Ethnomathematics of the Toba Batak	Numerical literacy	Numeracy	Culture-based Realistic Mathematics Education (RME) instructional materials
7.	Landong al. (2025) [22]	Toba Batak Culture	Contextual mathematical concepts	Mathematics education	Ethnomathematics-based Realistic Mathematics Education (RME) instructional model

Toba Batak Local Wisdom as a Conceptual Bridge in Mathematics Instruction (RQ2)

The seven publications examined suggest that Toba Batak local wisdom can serve as a conceptual bridge between students' cultural experiences and formal mathematical principles in primary school. Several teaching methods help students understand math topics by connecting them to things that are very important to their daily lives.

Employing local knowledge as a conceptual bridge can be achieved through the instruction of geometry using Ulos patterns. Research indicates that Ulos motifs, including geometric patterns, can facilitate a deeper comprehension of geometric concepts among students by providing visual representations [21]. The study incorporated the Desmos application to demonstrate Ulos motifs, thereby improving students' understanding of symmetry patterns and geometric structures before they encountered formal geometric

theory. Consequently, this approach enables students to connect their existing knowledge of cultural patterns with their mathematical and geometric learning experiences.

Consequently, the design of the Toba Batak traditional dwelling, known as the Rumah Bolon, serves as a pedagogical tool, connecting students' cultural backgrounds with formal mathematical principles. Research by [23] suggests that the geometric shapes inherent in the construction of traditional Toba Batak houses can serve as an initial instructional approach before introducing plane figures and measurement concepts. When mathematics instruction includes culturally relevant artifacts, it becomes more meaningful, helping students better understand abstract ideas.

Similarly, the study by [24] used traditional Batak houses as a teaching tool in geometry. In said study, geometric shapes found in the roofs, walls, and pillars of traditional houses were used as concrete examples to illustrate the concept of plane figures. The results indicate that this culture-based instructional approach can enhance students' numeracy skills, as they can understand mathematical concepts through objects in their cultural environment.

Toba Batak local wisdom is also employed as a conceptual bridge through culture-based instructional media, such as the "Bolon Café" media. Research by [27] shows that this instructional medium utilizes simulations of buying and selling activities inspired by local culture to assist students in understanding the concept of currency value. Through these activities, students learn to connect daily life experiences with basic arithmetic concepts in a more contextual way.

Moreover, the Realistic Mathematics Education (RME) approach, based on Toba Batak ethnomathematics, is used to connect cultural experiences with formal mathematical concepts. Research by [22], [25] demonstrates that the use of ethnomathematics-based teaching materials enables students to initiate learning from a familiar culture before formally constructing mathematical concepts. This approach has been proven to improve students' numeracy literacy and render mathematics instruction more meaningful for primary school students.

The examination of key manuscripts indicates that Toba Batak local wisdom operates as a cultural connector, supported by three core principles: first, the conversion of tangible objects into visual depictions of ideas to aid in the assimilation of the material; second, the adaptation of teaching resources to resonate with students' cultural backgrounds, thereby fostering a more individualized learning experience; and third, the application of a structured ethnomathematical approach to bridge traditional practices with formal reasoning. Consequently, students' cultural heritage becomes the fundamental basis for mathematical comprehension, ensuring that the educational process transcends mere knowledge transfer and evolves into a significant and practical engagement.

Table 5 presents a synthesis of the findings derived from the seven articles chosen to investigate the integration of Toba Batak traditions with mathematical logic in educational settings. This table elucidates how conceptual bridging strategies connect Batak cultural identity with formal mathematical principles. The analysis reveals that Ulos motifs and traditional house symbols function as more than decorative elements; they actively contribute to the learning experience. Consequently, this pedagogical approach facilitates

students' ability to link their cultural backgrounds with the school curriculum, thereby rendering mathematics more relevant and meaningful.

Table 5. The Role of Toba Batak Local Wisdom as a Cultural Bridge in Mathematics Instruction

No	The researchers	Toba Batak Culture	Mathematical Concepts	Manifestations of the Cultural Bridge
1.	Simorangkir et al., (2025) [21]	Ulos Motifs	Geometri	Ulos patterns are visualized utilizing Desmos to elucidate geometric concepts.
2.	Panjaitan & Sukmawarti (2022) [23]	The traditional vernacular architecture of the Toba Batak.	Two-dimensional figures and measurement	The architectural structures of traditional houses are utilized as a pedagogical medium for geometry instruction.
3.	Lubis et al. (2025) [24]	The Bolon House	Two-dimensional geometric figures	The architectural forms of traditional houses are utilized as concrete representations of geometric concepts.
4.	Siregar et al. (2025) [27]	Bolon Café Media	Monetary value	Simulation of transactional activities to facilitate conceptual understanding of arithmetic.
5.	Landong et. al. (2025) [22]	The Toba Batak sociocultural framework	Numerical literacy	Ethnomathematics-based Realistic Mathematics Education (RME) instruction.
6.	Mailani et al., (2025) [26]	The Batak *tandok* (traditional ceremonial woven receptacle)	Three-dimensional geometric figures	Integration of cultural symbols within pedagogical environments.
7.	Landong et al. (2025) [25]	Toba Batak Culture	Mathematics instruction	Culturally-based learning model

Disparities Between Batak Toba Local Wisdom-Based Mathematics Instruction and Conventional Learning Approaches (RQ3)

Based on an analysis of seven articles that met the inclusion criteria, the Batak Toba local wisdom-based mathematics learning approach showed distinct differences from traditional mathematics instruction in elementary schools. These differences were mainly evident in the teaching methods, the way materials were presented, and how students participated in the learning process.

In traditional pedagogical practices, mathematical principles are typically presented through direct teacher-led explanations and practice problems, often without any connection to students' lived experiences. This method often portrays mathematics as an abstract discipline, separate from students' realities, which can impede the development of a deep conceptual grasp.

Conversely, mathematics instruction that incorporates Batak Toba local wisdom uses culture as its teaching foundation. This approach employs cultural elements, such as Ulos designs, Batak Toba traditional houses, and indigenous cultural symbols, as teaching tools to help students better understand mathematical concepts. For example, [24] found that geometry lessons incorporating Batak Toba traditional houses significantly improve students' numeracy skills compared to standard teaching methods.

The differing methodologies are further evident in the application of culture-based instructional media, which offers a more contextually relevant learning environment. Research conducted by [27] demonstrates that the use of "Bolon Café" instructional media, which incorporates economic practices from Batak Toba culture, aids students in understanding monetary value through simulated transactions. Consequently, this approach facilitates mathematical learning through experiences more closely aligned with students' everyday lives, rather than traditional methods that emphasize memorization.

Table 6. Comparison of Batak Toba Local Wisdom-Based Mathematics Instruction and Conventional Instruction

No	The researcher	Culture-Based Learning Approach	Conventional Instruction	Research Findings
1.`	Simorangkir et al., (2025) [21]	Utilizing Ulos motifs as a visual context in geometry instruction via the Desmos application.	Geometry instruction is facilitated through conceptual explanations and the implementation of problem-solving exercises.	Ethnomathematics-based instruction enhances students' mathematical literacy.
2.	Panjaitan & Sukmawarti (2022) [23]	Instructional materials based on the Toba Batak traditional house are utilized to elucidate the measurement concepts of planar figures.	Instructional delivery using textbooks without cultural contextualization.	Culture-based instruction facilitates a more concrete comprehension of geometric concepts among students.
3.	Lubis et al. (2025) [24]	Geometry instruction utilizing the Bolon house context as a learning object.	Conventional instruction is devoid of cultural context.	Students' numeracy proficiency is significantly higher in culture-based classrooms.
4.	Siregar et al. (2025) [27]	The "Bolon Café" instructional media is used to facilitate a comprehensive understanding of the concept of monetary value through simulations of buying and selling activities.	The concept of the time value of money was conveyed through structured problem-solving exercises.	Culturally-based learning enhances students' conceptual understanding.
5.	Landong et al. (2025) [22]	Realistic Mathematics Education (RME) learning model based on Toba Batak ethnomathematics.	Math instruction lacks cultural contextualization.	Students' numeracy literacy demonstrated a significant enhancement.
6.	Mailani et al., (2025) [26]	The integration of Batak *tandok* symbolism into mathematics instructional design.	The learning process was implemented in the absence of cultural integration.	Student learning motivation was enhanced.
7.	Landong et al. (2025) [25]	The integration of the Batak cultural context into mathematics instructional materials.	Textbook-based instruction	The learning process is rendered more contextual and meaningful.

Furthermore, several studies indicate that local wisdom-based instruction tends to employ contextual learning approaches and Realistic Mathematics Education (RME). This framework positions culture as the initial situational context that assists students in the gradual construction of mathematical concepts. Research by [22] demonstrates that Batak Toba ethnomathematics-based teaching materials integrated with the RME approach improve students' numeracy literacy more effectively than instructional approaches devoid of cultural context.

Essentially, the differences between mathematics instruction based on Batak Toba local wisdom and traditional methods can be categorized into three key areas: teaching methods, instructional strategies, and student participation. Teaching methods that use culture often provide a more relevant and understandable learning experience. This is because mathematical ideas are directly linked to cultural objects that students already know about. To provide a more systematic overview of the differences between these two approaches, a synthesis of the literature findings is presented in Table 6.

The Impact of Integrating Toba Batak Local Wisdom on Students' Conceptual Understanding and Problem-Solving Skills (RQ4)

Based on a review of the seven articles, incorporating Toba Batak local wisdom into math instruction appears to improve elementary students' math skills significantly. This is especially true for understanding concepts, basic math skills, motivation to learn, and overall student involvement.

A common finding in the research is that students' understanding of math concepts improves. For example, [21] found that using ethnomathematics-based teaching materials, including ulos patterns in geometry lessons, significantly improves students' math skills. The use of ulos patterns helps students understand abstract math ideas by providing concrete, understandable examples.

Furthermore, a study by [24] shows that teaching geometry using Toba Batak traditional houses improves numeracy skills more effectively than standard teaching methods. This research found that students developed a better understanding of two-dimensional geometric shapes by directly observing the structural features of these traditional homes.

Furthermore, the research showed positive effects on both student motivation and engagement. Research [26] suggests that using Toba Batak cultural symbols in education can boost student motivation. The reason for this is that it makes learning more relevant and connected to their cultural backgrounds.

Using teaching materials that reflect students' cultural backgrounds has been shown to improve their understanding of concepts. According to [27], the "Bolon Café" learning media, which simulates transactional activities in Toba Batak culture, helps students understand the concept of monetary value in a specific context.

This approach enables students to acquire knowledge through activities that mirror real-world situations. Moreover, the application of Toba Batak ethnomathematics-based teaching materials through the Realistic Mathematics Education (RME) framework has been shown to improve numeracy literacy. Research by [22] indicates that using culturally

relevant materials helps students connect math concepts with their everyday experiences, which in turn encourages a more meaningful learning process.

Existing research indicates that incorporating Toba Batak local wisdom in mathematics instruction not only helps students better understand concepts but also improves their numeracy skills, increases their motivation to learn, and encourages more active participation.

These observations imply that leveraging local cultural elements constitutes a beneficial approach to improving the standard of mathematics instruction in elementary schools. To provide a more structured assessment of the effects of integrating Toba Batak local wisdom on the mathematical proficiency of elementary students, the results from the seven examined articles are presented in Table 7.

Table 7. The Impact of Toba Batak Local Wisdom Integration on Students' Mathematical Ability

No	The researchers	Manifestations of cultural integration	Enhanced mathematical proficiency	Research Findings
1.	Simorangkir et al. (2025) [21]	Ulos motifs within the Desmos medium	Mathematical literacy	Enhancing students' conceptual understanding of geometry
2.	Panjaitan & Sukmawarti (2022) [23]	The Integration of Toba Batak Vernacular Architecture into Instructional Materials	Conceptual understanding	Facilitating students' conceptual understanding of geometry through concrete representation.
3.	Lubis et al. (2025) [24]	The Rumah Bolon as a Geometric Context	Numeracy skills	Students' numeracy proficiency improved significantly relative to the conventional instructional setting.
4.	Mailani et al., (2025) [26]	The Symbolic Significance of the Batak *Tandok*	Learning motivation	Students' motivation for mathematics learning showed a significant improvement.
5.	Siregar et al. (2025) [27]	Bolon Café Communication Media	Learning motivation	Students' motivation for mathematics learning showed a significant improvement.
6.	Landong et al. (2025) [22]	Ethnomathematics-based Realistic Mathematics Education (RME) instructional materials.	Numerical literacy	A significant enhancement in students' numeracy literacy was observed.
7.	Landong et al. (2025) [25]	Batak culture-based contextual learning	Student engagement	The learning process becomes increasingly meaningful and contextualized.

Research Methodological Trends in the Integration of Batak Toba Local Wisdom within Elementary School Mathematics Instruction (RQ5)

The analysis of the seven selected articles showed that research on the use of Batak Toba local wisdom in elementary school math education employs various methods. The studies examined employ diverse methodologies, including Research and Development (R&D) initiatives, quasi-experimental designs, mixed-methods approaches, classroom action research (CAR), and qualitative methodologies. The variety of methods used suggests that research on Batak Toba ethnomathematics is still developing. These studies involve examining cultural contexts, creating teaching resources, and evaluating how well culture-based teaching methods work.

The most frequently used research method in the reviewed literature is Research and Development (R&D). This method is used to create teaching materials, learning resources, and instructional designs for mathematics, based on Batak Toba ethnomathematics. Studies by [21] and [22] used the ADDIE development model to design mathematical learning media and teaching materials that incorporate Batak Toba culture into primary school mathematics lessons. The results of these studies show that the instructional tools created are valid, practical, and effective in improving students' mathematical literacy.

Several studies, in addition to developmental approaches, have used quasi-experimental methods to evaluate how well culture-based learning compares with traditional teaching methods. For example, research by [24] used a quasi-experimental design to compare the math skills of students taught in the context of Batak Toba traditional houses with those of students who received standard instruction. The results demonstrated that culture-based learning positively impacts students' numeracy skills.

Other methodological approaches mentioned in the literature include classroom action research (CAR) and qualitative research. Classroom action research is used to evaluate the direct use of culture-based learning media in the classroom. This is shown by [27] in their study of the "Bolon Café" learning media. At the same time, qualitative research is used to explore how Batak Toba cultural symbols are integrated into the mathematics learning environment, and how this affects student motivation.

In general, research methodology trends in the integration of Batak Toba local wisdom into elementary mathematics education indicate that the majority of studies remain focused on developing ethnomathematics-based instructional tools and testing the effectiveness of culture-based pedagogical approaches. The predominance of developmental approaches suggests that research on integrating Batak Toba culture into mathematics education is still in the preliminary stages of instrument development. The distribution of research methods employed in the analyzed studies is presented in Figure 2.

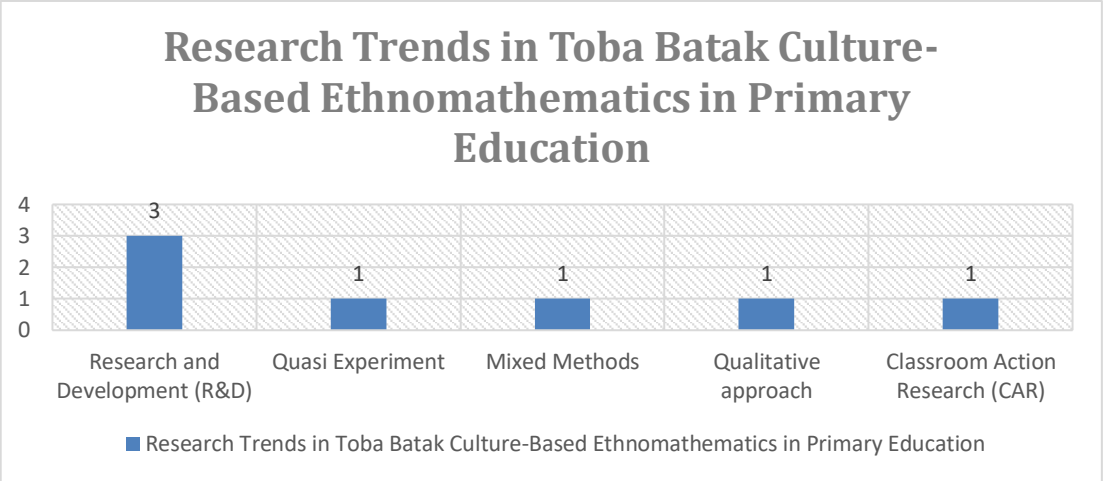

Figure 2. Distribution of Research Methodologies in Studies Concerning the Integration of Toba Batak Local Wisdom into Primary School Mathematics Instruction.

3.2. Discussion

The primary objective of this systematic review was to evaluate the integration of Batak Toba local wisdom as a conceptual bridge in elementary mathematics education. Based on the synthesis of the seven included studies, it is evident that Batak Toba cultural artifacts—specifically *Ulos* motifs, *Rumah Bolon* architecture, and *Tandok*—provide a robust "contextual entry point" for mathematical reasoning. These artifacts function as visual and cognitive anchors that help students in the concrete operational stage transition from their familiar surroundings to abstract mathematical concepts. For instance, the repeating geometric patterns and symmetries identified in *Ulos* textiles [15], [25] and the volumetric proportions found in the Rumah Bolon [17], [18] allow for the "mathematization" of cultural heritage into formal curriculum content, such as geometry and measurement. This finding directly supports Ubiratan D'Ambrosio's ethnomathematical paradigm, which posits that mathematical logic is inherently embedded within communal praxis and cultural identity [5], [6].

The effectiveness of this integration is further explained through the lens of sociocultural constructivism and the Realistic Mathematics Education (RME) framework. The evidence from the reviewed literature [16], [22] suggests that when mathematics is taught through a culturally resonant lens, it ceases to be perceived as a foreign or abstract discipline. By using local contexts such as the "Bolon Café" simulation [21] or Tandok spatial structures [20], educators align the learning process with students' social reality, thereby reducing cognitive load and increasing engagement. This theoretical alignment is a significant strength identified in the current research, as it demonstrates that Batak Toba ethnomathematics is not merely an additive cultural ornament but a fundamental pedagogical strategy that enhances conceptual understanding and numeracy skills while simultaneously promoting cultural preservation and identity [16], [27].

However, a critical appraisal of the synthesized evidence reveals a necessary distinction between "instructional potential" and "conclusive causal proof." While the reviewed studies report positive outcomes, the current body of research is heavily dominated

by Research and Development (R&D) frameworks, particularly the ADDIE model [15], [16], [17]. These studies primarily focus on the "feasibility" and "validity" of instructional instruments as judged by experts, rather than conducting large-scale longitudinal evaluations of student learning outcomes. Consequently, while the developed materials are proven to be "highly feasible" and "practical" for classroom use, their long-term efficacy in improving standardized national numeracy scores remains speculative. This dominance of developmental research suggests that the field of Batak Toba ethnomathematics for primary education is still in its nascent stages, prioritizing the design of tools over the rigorous testing of their academic impact.

Furthermore, the methodological diversity of the included studies is relatively narrow. Most empirical evidence is derived from small-scale interventions, such as Classroom Action Research (CAR) or mixed-methods studies with limited sample sizes [19], [21]. Although these studies provide deep insights into student motivation and initial interest, they lack the statistical power of large-scale experimental designs with rigorous control groups. This makes it difficult to establish a definitive causal link between Batak Toba cultural integration and broad mathematical achievement across diverse socio-geographical contexts. The review also highlights a significant gap in longitudinal data; there is currently no evidence to confirm whether the motivation and conceptual gains observed in these short-term interventions persist as students transition to higher levels of education.

In summary, while the integration of Batak Toba local wisdom offers a promising and theoretically sound pathway for primary mathematics education, the field requires a shift toward more diverse and rigorous methodologies. The current literature successfully establishes that Batak Toba artifacts can indeed function as "conceptual bridges" that make mathematics more meaningful and functional for students. However, to move from "promising potential" to "proven effectiveness," future research must transcend the design of instructional tools and focus on large-scale experimental validation and long-term impact studies. Addressing these methodological limitations will be crucial for transforming ethnomathematical insights into a robust, evidence-based pedagogical standard for Indonesian primary schools.

4. CONCLUSION

This systematic literature review underscores the promising instructional potential of Batak Toba local wisdom as a conceptual bridge in primary mathematics education. The synthesis of available evidence indicates that cultural artifacts—such as the geometric patterns of Ulos textiles, the structural proportions of Rumah Bolon architecture, and the functional design of the Tandok—can serve as effective cognitive anchors for students in the concrete operational stage. By integrating these elements through frameworks such as Realistic Mathematics Education (RME), mathematics instruction becomes more contextualized, helping students transition from informal cultural knowledge to formal mathematical reasoning. These findings suggest a dual benefit: the enhancement of students' conceptual understanding and numeracy skills, alongside the vital preservation of indigenous cultural identity within the formal school system.

However, the conclusions drawn from this review are subject to several research boundaries. With only seven studies meeting the inclusion criteria, the evidence base remains relatively narrow. Furthermore, the dominance of Research and Development (R&D) methodologies—focusing on the feasibility of instructional tools rather than large-scale impact—means that a definitive causal link between cultural integration and standardized achievement is yet to be fully established. Most existing studies are localized and small-scale, limiting the generalizability of their findings across broader, more diverse socio-geographical contexts.

For future research, it is recommended to expand the search parameters to broader international databases to capture a more global perspective on Indonesian ethnomathematics. There is also a critical need for comparative regional studies to evaluate how different indigenous contexts influence mathematical learning. Most importantly, subsequent research should prioritize stronger experimental evidence and longitudinal designs to determine the long-term efficacy of these cultural bridges on students' mathematical retention. Beyond its academic utility, this research contributes to the general public by providing educators and policymakers with a theoretically grounded reference for designing inclusive curricula. Ultimately, this approach empowers local communities by validating their cultural heritage as a sophisticated foundation for modern scientific reasoning.

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