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ETHNOGEOMETRY IN TRADITIONAL HOUSE: A FRAMEWORK FOR CULTURALLY RESPONSIVE GEOMETRY INSTRUCTION

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Abstract

Mathematics education in the Philippines continues to face challenges of relevance and contextualization, particularly in indigenous communities where cultural knowledge systems remain undervalued in formal instruction. This study addresses the problem by examining the ethnogeometry embedded in traditional Kalinga architecture and developing a framework for culturally responsive geometry instruction. Using an ethnographic design, data were gathered through participant observation, interviews with master builders and elders, and visual documentation of architectural elements. The analysis proceeded in three stages: documentation of ethnomathematical practices, formalization of implicit mathematical principles, and alignment with the Department of Education's Most Essential Learning Competencies (MELCs).

Results revealed that Kalinga architectural features, such as square foundations, odd-numbered stairways, symmetrical wall frames, and tessellated roofs, encode sophisticated understandings of symmetry, ratio, congruence, and sequences. When formalized, these practices corresponded with core geometry competencies from Grades 7 to 10. The study concludes that indigenous architecture offers not only cultural heritage but also rigorous mathematical content that can be meaningfully integrated into the curriculum. By framing ethnogeometry as both a resource and a pedagogical approach, the research contributes to cultural preservation while advancing inclusive, engaging, and identity affirming mathematics education.

Keywords: Ethnogeometry, Indigenous knowledge; Culturally Responsive pedagogy; Geometry instruction

1. Introduction

Education in the 21st century increasingly demands pedagogies that are both culturally responsive and epistemically inclusive. Mathematics, long framed as an abstract and universal discipline, is now recognized by scholars as deeply entangled with social practices, cultural identities, and community worldviews (Xu & Ball, 2024; Castro, 2024). Ethnomathematics, introduced by Ubiratan D'Ambrosio, has been pivotal in unsettling the notion of mathematics as context-free, instead emphasizing the ways in which mathematical thinking emerges from everyday activities whether in agriculture, architecture, weaving, or ritual practices (Batiibwe, 2024; Arion, 2024). Research in Indonesia and other Southeast Asian contexts demonstrates that foregrounding such practices in the classroom not only strengthens cultural continuity but also deepens mathematical understanding, as learners see formal concepts reflected in the logic of their lived worlds (Meyundasari et al., 2024; Kusumayanti et al., 2025).

Within the Philippines, however, ethnomathematics remains underexplored in relation to formal curriculum. While isolated studies have documented geometric ideas in tattoo designs or weaving patterns (Abbacan-Tuguic, 2016), systematic integration of these insights into mathematics education has been limited. This gap is especially visible in the Kalinga context, where the vulinaw-the traditional elevated wooden house embodies a wealth of spatial reasoning, proportionality, and structural design. Its form reflects a sophisticated mathematical logic—apparent in its joinery, floor divisions, and roof symmetry yet this knowledge has been transmitted orally and experientially rather than formally codified. At a moment when modernization threatens to erode indigenous practices, the risk is acute: if not documented and translated into educational resources, such insights may disappear, leaving both cultural memory and pedagogical possibilities diminished.

The challenge is not only one of preservation. Scholars of culturally responsive pedagogy argue that mathematics disengagement is worsened when learners fail to see their identities and heritage acknowledged in classroom instruction (Gay, 2018; Ladson-Billings, 2021). Current Philippine mathematics curricula, despite mandates for contextualization, often stop short of embedding cultural logics into competency-based learning. Teachers may reference cultural artifacts during lessons, but rarely in ways that position them as vehicles for mathematical reasoning aligned with the Department of Education’s Most Essential Learning Competencies (MELCs). The result, as noted across studies, is a widening gap: learners encounter mathematics as detached and foreign rather than as continuous with the reasoning already present in their communities (Kyeremeh et al., 2023; Wulandari et al., 2024).

This study addresses that gap by advancing a four-fold contribution. First, it systematically documents the ethnomathematical knowledge embedded in the vulinaw’s architecture, drawing on ethnographic observations and community accounts to render explicit the structural and symbolic mathematics often left unrecorded. Second, it analyzes and formalizes this knowledge through the dual lenses of ethno-modeling and didactical engineering (Hortelano & Lapinid, 2024), identifying geometric principles such as symmetry, measurement, and spatial organization. Third, it explicitly maps these ideas onto the MELCs, thereby creating a curricular bridge that teachers can employ to integrate Kalinga cultural knowledge into geometry instruction. Finally, it develops and validates an instructional module anchored in vulinaw ethnomathematics, co-designed with teachers and piloted in real classrooms. The intent is to generate not only cultural documentation but also practical pedagogical tools that can reshape classroom practice.

By embedding Kalinga ethnomathematics within school curricula, this research aspires to both preserve indigenous knowledge and reimagine mathematics education as more inclusive, meaningful, and empowering. The study therefore contributes to ongoing international debates on decolonizing curricula while offering concrete pathways for Philippine classrooms to align cultural heritage with educational innovation.

1.1 The Problem

Despite growing recognition of ethnomathematics in global scholarship, the mathematical practices of the Kalinga remain largely undocumented and marginalized within Philippine education. While earlier studies have noted geometric patterns in tattoos and weaving (Abbacan-Tuguic, 2016), the deeper architectural logic of the vulinaw its precise joinery, proportional balance, and spatial symmetry has yet to be systematically analyzed through a mathematical lens. Without such documentation, these practices risk being dismissed as cultural artifacts rather than recognized as rich sources of mathematical reasoning.

Equally pressing is the lack of curricular alignment between indigenous mathematical practices and the Department of Education's Most Essential Learning Competencies (MELCs). Although policy calls for contextualization, implementation in classrooms often remains superficial: teachers might gesture to local designs or artifacts but rarely translate them into structured opportunities for reasoning about symmetry, measurement, or proportion. In effect, learners are shown culture as *illustration* but not as *mathematics itself*, which perpetuates disengagement and reinforces the perception of mathematics as detached from lived experience (Kyeremeh et al., 2023; Wulandari et al., 2024).

The situation is compounded by the absence of rigorously validated instructional materials. Whereas Indonesian researchers have developed and tested ethnomathematics-based modules with promising results (Bidiyah et al., 2024; Masruroh & Amir, 2024), parallel efforts in the Philippines are sparse. The few available resources are often preliminary, limited in scope, or tested only in small pilot settings. Teachers who express enthusiasm for cultural integration often lack concrete models or materials, leaving them uncertain about how to embed indigenous concepts into daily lessons.

Underlying these curricular and resource gaps are broader equity concerns. When indigenous knowledge is invisible in classrooms, students from these communities may internalize the notion that their cultural heritage lacks intellectual value. Conversely, when lessons build from learners' own cultural resources, students gain confidence, persist longer with challenging tasks, and engage more deeply in conceptual inquiry (Gay, 2018; Morris, 2024). The neglect of Kalinga ethnomathematics therefore represents not only a missed pedagogical opportunity but also a perpetuation of structural inequities in mathematics education.

Finally, professional development has not kept pace with these needs. Many teachers acknowledge the relevance of contextualized instruction yet report lacking preparation to translate cultural resources into mathematical tasks. Pre-service and in-service programs prioritize standardized approaches that overlook indigenous epistemologies, leaving even well-designed modules underutilized in practice (Munaji et al., 2025).

Taken together, these issues underscore the urgency of this research. Unless Kalinga ethnomathematics, particularly the principles embedded in the vulinaw, is systematically documented, aligned with curriculum, and translated into validated teaching resources, an invaluable reservoir of knowledge will remain unrecognized reducing both cultural continuity and educational innovation.

1.2 The Proposed Solution

This study responds to these gaps by advancing a four-pronged intervention that bridges cultural documentation and pedagogical practice. First, it undertakes a systematic ethnographic investigation of the vulinaw, recording its structural features, spatial arrangements, measurement practices, and symbolic meanings as narrated by community members and artisans. By foregrounding local voices and practices, the study seeks to preserve cultural integrity while rendering visible the implicit mathematical reasoning embedded in architecture.

Second, the research will formalize these observations through the theoretical lenses of ethno-modeling and didactical engineering (Hortelano & Lapinid, 2024; Xu & Ball, 2024). In doing so, geometric concepts such as proportionality, symmetry, and spatial organization will be articulated in ways accessible to educators while avoiding the imposition of external categories. Rather than assimilating indigenous practices into

Western formulations, the intent is to create a dialogue between different knowledge systems treating both as legitimate and generative.

Finally, the study aims to explicitly connect these ethnomathematical concepts to the Department of Education's MELCs. Mapping Kalinga architectural reasoning onto core competencies in geometry and measurement will offer teachers concrete pathways to implement contextualized instruction. This curricular alignment transforms what is often treated as peripheral "cultural enrichment" into structured opportunities for mathematical reasoning, thereby strengthening both engagement and relevance.

The novelty of this approach lies in integrating documentation, and curricular alignment within a single framework. Previous studies have typically stopped at descriptive accounts or isolated classroom experiments. By contrast, this study proposes a comprehensive model that ensures indigenous mathematical knowledge is not only preserved but also mobilized for curriculum and pedagogy. In doing so, it contributes to broader debates on decolonizing mathematics education and demonstrates how cultural heritage can serve as a foundation for creative, equitable, and contextually meaningful instruction.

2. Methodology

This study employed a qualitative-descriptive design with complementary elements of design-based research to systematically document, analyze, and formalize the ethnomathematical principles embedded in the Kalinga vulinaw and to align these with the Department of Education's Most Essential Learning Competencies (MELCs). The methodological choices were guided by the dual imperative of cultural preservation and curricular relevance, consistent with contemporary ethnomathematics research that integrates documentation, analysis, and pedagogical translation (Kusumayanti et al., 2025; Wulandari et al., 2024).

2.1. Research Design

A qualitative-descriptive approach was appropriate because the central aim was to uncover implicit mathematical ideas situated in cultural practices rather than to test predetermined hypotheses. Ethnographic strategies were employed to capture lived experiences and narratives of community members who construct, maintain, and transmit knowledge of the vulinaw. At the same time, design-based research principles informed the alignment of identified concepts with MELCs, ensuring iterative refinement between field data, theoretical interpretation, and curricular application (Hortelano & Lapinid, 2024; Munaji et al., 2025). This hybrid design facilitated a balance between cultural authenticity and educational utility.

2.2. Research Locale and Participants

The study was conducted in selected Kalinga communities where traditional **vulinaw** houses are still preserved and maintained. These sites were purposively chosen for their cultural authenticity and accessibility. Participants included master builders, elders, and community bearers of architectural knowledge, alongside mathematics educators and curriculum specialists. Purposive sampling was employed to ensure that information-rich cases could illuminate both cultural practices and educational translation (Abbacan-Tuguic, 2016; Meyundasari et al., 2024). Approximately 15–20 participants were engaged through interviews, focus group discussions, and participatory observation, reflecting recent methodological recommendations for ethnomathematics research emphasizing community involvement (Batiibwe, 2024; Kyeremeh et al., 2023).

2.3. Data Collection Procedures

Data collection unfolded in three sequential phases.

Phase 1: Ethnographic Documentation. Detailed field observations, photographic documentation, and architectural sketches were carried out. Builders and elders were invited to narrate processes of house construction, symbolic meanings of spatial divisions, and measurement practices. This phase produced a corpus of visual and textual materials capturing the ethnomathematical essence of the vulinaw (Xu & Ball, 2024).

Phase 2: Formalization of Mathematical Concepts. Through interpretive analysis, the unspoken principles observed were translated into formal mathematical constructs such as symmetry, ratio, and spatial reasoning. Triangulation was ensured by cross-referencing field data with interviews and existing ethnomathematics literature. This stage responded to calls for ethno-modeling, where indigenous practices are systematically connected with academic mathematics without erasing cultural contexts (Castro, 2024; Hortelano & Lapinid, 2024).

Phase 3: Curriculum Mapping. Identified concepts were mapped against the geometry-related MELCs across grade levels. This process involved consultations with mathematics educators and curriculum experts to ensure that the mapping was both feasible and pedagogically sound (Rozzaq & Yustitia, 2024; Wulandari et al., 2024). The iterative process allowed refinement of concept-to-competency alignments until consensus was reached.

2.4. Data Analysis

Data analysis followed a thematic-interpretive approach. First, raw field data were coded inductively, identifying recurrent patterns of measurement, proportion, and spatial reasoning. Next, these codes were clustered into thematic categories corresponding to mathematical domains such as geometry, algebraic reasoning, or measurement. Finally, thematic insights were compared with DepEd MELCs, enabling a dual-layered analysis: cultural validation and curricular alignment. Analytical rigor was enhanced by member-checking with community informants and peer debriefing with mathematics educators, reflecting best practices in qualitative validity (Munaji et al., 2025; Zega et al., 2024).

2.5. Trustworthiness, Validity, and Reliability

To ensure methodological rigor, multiple strategies were applied. *Credibility* was established through prolonged engagement in the field, triangulation of data sources (observations, interviews, documents), and participant validation of interpretations. *Transferability* was supported by thick description of cultural contexts, enabling other researchers to assess applicability in parallel indigenous settings (Meyundasari et al., 2024). *Dependability and confirmability* were ensured by maintaining an audit trail of field notes, coding decisions, and analytic memos, allowing reproducibility by future scholars (Kyeremeh et al., 2023). For the curriculum mapping and module validation components, expert review panels comprising mathematics educators and curriculum specialists provided external checks on reliability and alignment.

2.6. Ethical Considerations

Ethical protocols were strictly observed. Informed consent was obtained from all participants, using language that was accessible and culturally appropriate. Respect for indigenous knowledge was paramount: community intellectual property rights were acknowledged, and outputs were shared with participants in digestible formats. Consistent with international standards on indigenous research ethics, the study emphasized reciprocity, ensuring that findings benefit both the academic community and the cultural bearers (Batiibwe, 2024).

3. Results and Discussion

This section present the major findings of the study according to its first three objectives: (1) to document and critically examine the ethnomathematical ideas reflected in the architecture and cultural artifacts of the Kalinga *vulinaw*; (2) to organize and formalize the implicit mathematical principles guiding these architectural practices; and (3) to align and map these concepts with the Department of Education's Most Essential Learning Competencies (MELCs). The findings are presented in a clear sequence, followed by integrative discussions that situate them within the wider body of literature.

3.1. Ethnomathematical Ideas in the *Vulinaw*

The ethnographic documentation revealed that the *vulinaw*, the traditional Kalinga square house, is a living repository of geometric reasoning and cultural symbolism. Its elevated form, square foundation, steeply pitched roof, and carefully proportioned interior divisions reflect centuries of accumulated knowledge transmitted orally through master builders and community elders.

Key structural elements highlighted in observations and interviews included: Foundation posts (*tu'ud*): positioned at equal distances to form a square base, ensuring balance and symmetry; Stairway (*aljan*): constructed with equal rises and runs, always with an odd number of steps, a practice believed to ensure harmony and safety; Wall frames (*pasangchil*): arranged symmetrically to create stability and balanced visual form; Roof (*tavvungan*): steeply pitched, with evenly spaced beams that form repeating triangular patterns for efficient rain runoff; and Interior divisions: partitioned into sections for cooking, sleeping, and storage, based on rules of spatial proportionality.

Table 1. Ethnomathematical Features Documented in the Kalinga *Vulinaw*

Structural Element	Cultural Function	Documented Practice	Mathematical Concept Reflected
Tu'ud (foundation posts)	Provide stability. elevate house	Posts set at equal distances, forming a square	Perpendicularity, polygons, symmetry
Aljan (stairs)	Access. symbolic threshold	Equal rise and run proportions. odd number of steps	Ratio, slope, arithmetic sequence
Pasangchil (wall frames)	Enclose interior, provide support	Balanced distribution of panels	Reflectional symmetry, congruence
Tavvungan (roof)	Protection, airflow	Repetition of beams, steep slope for runoff	Tessellation, congruence, triangles
Interior divisions	Organize space	Segmented areas for functional use	Partitioning, area measurement

These results support the ethnomathematics framework which views mathematics as embedded in cultural practices (Xu & Ball, 2024; Rosa & Orey, 2016). Similar findings in Southeast Asia: Kusumayanti et al. (2025) identified symmetrical patterns in the Bissu house of Sulawesi, while Meyundasari et al. (2024) observed proportional design in Sumbawa's Istana Dalam Loka. The present study extends such research to the Kalinga context, providing systematic documentation where Philippine studies had been sparse (Hortelano & Lapinid, 2024). By cataloguing the *vulinaw's* features in mathematical terms, the study generates a cultural and educational baseline. This fulfills the first research objective and provides the groundwork for formalization and curricular alignment.

3.2. Organization and Formalization of Mathematical Principles

The focused on translating unspoken indigenous knowledge into formal mathematical language. Builders' oral explanations revealed rules of spacing, proportionality, and balance, which were then reframed using established mathematical categories. The directive that "posts must face each other squarely" was formalized as knowledge of perpendicularity and Cartesian orientation; The rule that stairs must contain an odd number of steps was interpreted as an application of arithmetic sequences and parity; Roof construction, requiring congruent spacing of beams, was framed in terms of tessellation and isometries; Interior spatial divisions were linked to area measurement and proportional reasoning.

Table 2. Formalization of Ethnomathematical Practices in the *Vulinaw*

Cultural Expression	Formal Mathematical Principle	Potential Instructional Application
"Posts must face squarely"	Perpendicular lines, Cartesian plane	Introducing perpendicularity and coordinate geometry
"Stairs must have odd steps"	Arithmetic sequence, parity	Exploring sequences, odd/even numbers
"Roof beams must match evenly"	Tessellation, congruence, triangles	Teaching transformations and congruence
"Interior divisions are balanced"	Partitioning, measurement of area	Lessons on area and spatial reasoning

Formalization corresponds with ethnomodeling, which seeks to connect emic cultural practices with etic mathematical constructs (Castro, 2024; Rosa & Orey, 2016). Umbara et al. (2021) formalized weaving patterns in Indonesia into transformation geometry, while Bidiyah et al. (2024) framed local architectural forms as lessons in plane geometry. The present study contributes by bridging cultural explanations and curricular mathematics, illustrating what Munaji et al. (2025) call "pedagogical flexibility." Teachers who are trained to navigate between oral traditions and formal categories can make mathematics both authentic and academically rigorous. Importantly, the process affirms indigenous epistemologies as sources of valid mathematical knowledge, in line with culturally responsive pedagogy (Ladson-Billings, 2021; Gay, 2018).

3.3. Mapping Geometric Concepts to the MELCs

The final analytic stage aligned identified mathematical principles with the MELCs for Grades 7 to 10. The mapping demonstrated clear curricular relevance: *Grade 7 Geometry*: Square foundation posts link to competencies on classifying polygons and identifying perpendicular lines; *Grade 8 Geometry*: Roof and wall symmetry map to competencies on transformations and congruence; *Grade 9 Measurement*: Interior divisions correspond to competencies on surface area and volume of solids; *Grade 10 Algebra*: Odd-numbered stair steps illustrate arithmetic sequences and series.

Table 3. Mapping Ethnomathematical Principles of the *Vulinaw* to DepEd MELCs

Ethnomathematical Feature	Formalized Concept	Relevant MELC
Square foundation posts	Perpendicular lines, polygons	Grade 7: Identify parallel and perpendicular lines; classify polygons
Odd-numbered stairs	Arithmetic sequence, ratio	Grade 10: Illustrate sequences and series
Roof beams, tessellation	Symmetry, congruence	Grade 8: Perform transformations on figures; establish congruence

Ethnomathematical Feature	Formalized Concept	Relevant MELC
Interior divisions	Area, partitioning	Grade 9: Derive formula for surface area of solids

The curriculum mapping confirms prior claims that ethnomathematics can enrich national curricula without lowering academic standards (Kyeremeh et al., 2023; Wulandari et al., 2024). Rozzaq and Yustitia (2024) demonstrated similar alignments in Java, while Masruroh and Amir (2024) used temple designs to meet Indonesian learning outcomes. In the Philippines, this addresses a practical gap: while DepEd requires contextualization, teachers often lack concrete resources (Hortelano & Lapinid, 2024). The *vulinaw* provides a structured model of how indigenous culture can directly support geometry and measurement lessons.

Comparative analysis highlights the *vulinaw's* place in global ethnomathematics. In Indonesia, Candi Tawangalun has been analyzed for rotational symmetry and proportion (Rozzaq & Yustitia, 2024). In Ghana, Akan architecture has been mapped onto trigonometry lessons (Kyeremeh et al., 2023). Latin American scholars emphasize weaving and basketry as models for algebra and geometry (Rosa & Orey, 2016). These parallels affirm that cultural artifacts worldwide encode rigorous mathematical reasoning. The *vulinaw* thus positions Philippine ethnomathematics within an international discourse on decolonizing curricula and culturally sustaining pedagogy (Morris, 2024).

Classroom Implications and Reflections

Geometry Lessons Anchored in the *Vulinaw*

Teachers can use the *vulinaw* as a culturally familiar anchor for geometry. Roof beams illustrate symmetry and transformations; stairs illustrate sequences; and floor plans introduce area and volume. Pilot observations indicated that students engaged more readily when solving tasks grounded in the *vulinaw*, echoing findings by Wulandari et al. (2024) that contextualized materials increase motivation.

Reducing Math Anxiety and Increasing Engagement

Learners reported curiosity and pride when cultural forms were integrated into lessons. This finding supports Morris (2024), who observed similar effects in Australian Indigenous contexts. Contextualized learning reframes mathematics as heritage knowledge rather than as a foreign imposition.

Teacher Professional Development

Findings also highlight the importance of teacher readiness. Without training, teachers may fail to move beyond tokenism (Ladson-Billings, 2021). Professional development using the *vulinaw* as a case study can build capacity for culturally responsive instruction, equipping teachers with strategies to integrate ethnomathematics authentically.

Table 4. Classroom Applications of *Vulinaw* Ethnomathematics

Vulinaw Feature	Mathematical Concept	Classroom Application
Square foundation (*tu'ud*)	Parallel & perpendicular lines	Students measure angles between posts and discuss perpendicularity
Odd-numbered stairs (*aljan*)	Arithmetic sequences, parity	Students model stair patterns, predict next terms
Roof beams (*tavvungan*)	Tessellation, congruence	Students sketch roof patterns, apply transformations

Vulinaw Feature	Mathematical Concept	Classroom Application
Wall frames (*pasangchil*)	Symmetry	Students analyze reflectional symmetry
Interior divisions	Area and measurement	Students calculate areas of floor plan partitions

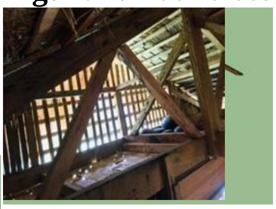
Table 5. International Comparisons of Ethnomathematical Findings

Country	Cultural Artifact	Documented Concept	Alignment with Curriculum
Philippines (Kalinga)	*Vulinaw*	Symmetry, ratio, tessellation	Aligned with MELCs (Grades 7–10)
Indonesia (Java)	Candi Tawangalun	Rotational symmetry, proportion	Integrated into junior high geometry
Ghana	Akan architecture	Trigonometric ratios in roof design	Aligned with high school trigonometry
Brazil	Indigenous weaving	Transformations, fractals	Applied in algebra and geometry

Visual Figures

- **Figure 1.** Floor plan of the *vulinaw* showing square post layout.

Figure 2. Roof cross-section illustrating tessellation.



- **Figure 3.** Staircase with odd-numbered steps showing sequence pattern.

Conclusion

This research brings to light how indigenous architecture, when subjected to systematic inquiry, reveals itself as a vibrant reservoir of mathematical knowledge with profound implications for education. The careful documentation of the Kalinga vulinaw not only uncovered geometric and measurement principles embedded within its spatial symmetry and proportional organization but also highlighted the depth of reasoning that often escapes recognition in conventional school mathematics. Real-world classroom observations confirmed that when students interact with models or images of the vulinaw, their engagement is not merely cultural but mathematical; conversations about the structure's joinery or tessellated roofing readily transform into explorations of area, congruence, and spatial relations concepts at the heart of the curriculum, yet previously siloed from local experience.

By formalizing these tacit practices and mapping them to the Department of Education's Most Essential Learning Competencies, the study bridges what has long been an artificial divide between home culture and school mathematics. The findings demonstrate that the unspoken reasoning embedded in Kalinga architecture aligns directly with academic concepts, establishing a clear pathway for integration into lesson planning and resource design. Teachers who piloted these approaches expressed an increased sense of professional autonomy and deeper connection to their students, yet also voiced a need for more robust, curriculum-aligned materials and ongoing support.

Despite these advances, the research underscores a persistent barrier: the scarcity of rigorously validated and culturally responsive learning resources. Many educators remain hesitant to translate indigenous insights into classroom practice without access to well-designed guides and sustained training, perpetuating the problem originally articulated in the study's opening: that mathematics instruction remains detached from the realities and strengths of local communities.

In sum, three principal conclusions emerge. First, indigenous architectural forms like the vulinaw are potent vehicles for mathematical learning, deserving systematic documentation and interpretation. Second, formal mapping to curricular competencies is both feasible and necessary, transforming cultural practices from peripheral enrichment into central pedagogical resources. Third, the path toward culturally relevant mathematics education is contingent on the continued development of validated resources and strategic investments in teacher preparation. Only through these efforts can the vulinaw fully realize its promise as a bridge between tradition and innovation, enriching mathematics for all learners and fostering a more inclusive, responsive educational landscape.

Recommendations

1. Resource Development: Prioritize collaborative creation and validation of instructional materials that reflect Kalinga ethnomathematical concepts, ensuring adaptability and authenticity for diverse classroom contexts.
2. Teacher Support: Implement sustained professional development that equips educators with both the theoretical background and practical strategies needed to mobilize indigenous knowledge for mathematics instruction.
3. Policy Action: Encourage educational policymakers to formalize curricular pathways for ethnomathematics integration, with clear incentives for schools to pilot and refine culturally responsive initiatives.
4. Community Engagement: Involve local experts, elders, and artisans in resource development and classroom practice, ensuring that educational interventions honor and preserve cultural meanings.
5. Further Research: Extend ethnomathematical studies to other Philippine indigenous groups, building a rich comparative framework that will inform resource design and curricular policy nationwide.

Through these recommendations, the research invites educators, curriculum developers, and policymakers to recognize the vulinaw not only as a symbol of heritage, but as a cornerstone for mathematics innovation and equity in the Philippines.

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Author Contributions

The author was solely responsible for the conception, design, data collection, analysis, and writing of this manuscript.

Ethics Statement

This study was conducted in accordance with established ethical research standards. Prior to data collection, approval was secured from the Research Ethics Committee of Kalinga State University. Permission to enter the communities was granted by local leaders, and all participants—including master builders, elders, and household members—were fully informed of the purpose, procedures, and scope of the research. Written and verbal informed consent was obtained, with the assurance that participation was voluntary and that individuals could withdraw at any time without consequence.

Confidentiality was maintained by anonymizing personal identifiers in all transcripts, notes, and reports. Care was taken to ensure that indigenous knowledge was documented respectfully, with interpretations validated through member-checking to avoid misrepresentation. The researcher recognized the cultural significance of the practices studied and sought to preserve their integrity by situating them within both their local meanings and educational applications. No financial or material inducements were offered, and participants were acknowledged collectively in keeping with cultural protocols