Mathematics Education Journals
Vol. 9 No. 2 August 2025

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.ph

Geometric Transformations in Banjar Baanjung Woodcarvings: Reflection, Translation, Rotation

Azis Muslim[1], Rolina Amriyanti Ferita[*2], Williza Yanti[3], Arifin Riadi[4]

[1,2,3]Department of Mathematics Education, Faculty of Teacher Training and Education, Nahdlatul Ulama University of South Kalimantan, South Kalimantan, Indonesia

[4]Department of Mathematics Education, Faculty of Humanities and Social Sciences, PGRI University of Kalimantan, South Kalimantan, Indonesia

Email: rolina.amriyanti@unukase.ac.id

Corresponding author:

Rolina Amriyanti Ferita
rolina.amriyanti@unukase.ac.id

Keywords:
Ethnomathematics; Banjar; Baanjung house; woodcarving; geometric transformation

Abstract

This field-based ethnomathematical study examines how three geometric transformations—reflection, translation, and rotation—are embedded in the woodcarvings of the Banjar Baanjung house. The research involved in-situ exploration at a Baanjung house in Teluk Selong (Martapura) and close collaboration with a traditional carver in Kuin Cerucuk (West Banjarmasin) in August 2025. Data were gathered through on-plane scale referencing, motif tracing, semi-structured interviews, and think-aloud carving demonstrations. Using open and axial coding, we mapped motifs—including bilateral friezes, tampuk manggis rosettes, gigi haruan zigzags, and paired carvings—onto transformation types and derived classroom-ready parameters. The findings show: (1) reflections appear in paired panels and are quantifiable through local axes of symmetry; (2) translational friezes such as daun jaruju exhibit consistent period lengths supported by artisans' spacing templates; and (3) rotational symmetry emerges from tampuk manggis rosettes arranged using a radial layout technique. The study contributes a field-verified cultural dataset that connects transformation geometry with authentic Banjar carving practices. This contribution advances ethnomathematics scholarship by offering a clearly documented mapping from cultural artifacts to formal geometric structures and provides a sequence of ready-to-use instructional tasks for secondary classrooms.

Muslim, A., Ferita, R. A., Yanti, W., & Riadi, A. (2025). Geometric transformations in Banjar Baanjung woodcarvings: Reflection, translation, rotation.Mathematics Education Journal, 9(2), 176-185. DOI: 10.22219/mej.v9i2.42875

INTRODUCTION

Ethnomathematics views mathematical ideas, representations, and practices as inseparable from cultural activity (D'Ambrosio, 2006; Rosa & Orey, 2016). In the Indonesian (Nusantara) context, traditional houses concentrate forms, patterns, and work procedures that are not only aesthetically compelling but also rich in mathematical structure (Shaffee, Zakaria, Abdullah, & Taib, 2013; Silah, 2021).

The Banjar Baanjung house in South Kalimantan is one such example (Marwoto, 2016; Zulfa, Dewi, & Subiyantoro, 2025). Its woodcarvings on panels, moldings, and posts are not merely decorative. They are produced through layout rules, measuring aids, and consistent work sequences. The carver's discipline maintains motif repetition and balance. Meanwhile, the traces of hand-work introduce small deviations that create opportunities to discuss accuracy, tolerance, and approximation in mathematics.

Prior research has often highlighted vernacular architecture as a fertile arena for teaching symmetry and pattern. However, studies that focus specifically on the woodcarvings of the Banjar Baanjung house—and that link carving procedures to geometric transformation concepts (reflection, translation, rotation)—remain relatively scarce (Riadi, Turmudi, & Juandi, 2023). This gap becomes more evident in classroom settings, where teachers need measurable parameters that can be directly translated into tasks. Such parameters include reflection axes that students can identify on paired panels, translation vectors and periodic lengths that can be estimated on moldings, and rotation centers and orders that can be determined on rosettes. These measurable features are essential because they allow students to verify transformations numerically rather than only visually, strengthening conceptual accuracy and classroom applicability. Moreover, many culture-based teaching materials still rely on curated photographs or document reviews, leaving the relationship between production practice and mathematical concepts underexplored empirically in the field.

This study addresses that gap through a field-based ethnographic approach: the research team conducted in-situ exploration at a Baanjung house in Teluk Selong, Martapura, and engaged directly with a traditional carver in Kuin Cerucuk, West Banjarmasin. Rather than reading only the finished artefact, we examined the process: how a midline is drawn before carving mirrored sides; how a spacing template is used to maintain unit-to-unit consistency; and how a radial grid is prepared to guide the petals of rosettes. This process–product perspective matters because transformation concepts are not only visible in the final form but also operationalized within the carver’s workflow. Substantively, we delimit the study to three core transformations—reflection, translation, and rotation—because these appear most frequently and most clearly in Baanjung carving motifs and provide structurally consistent patterns suitable for classroom parameterization. These motifs are also the most empirically traceable through field observation. Accordingly, we focus on reflection on paired panels (e.g., on *tawing halat* and over-door panels), translation on *daun jeruju* moldings (straight and slanted variants), and rotation on *tampuk manggis* rosettes at multiple scales. This focus enables deeper parameterization: local reflection axes together with symmetry deviations, translation vectors and peak-to-peak periods, and rotation centers and orders n with base angle 360°/n. These parameters were planned from the outset to feed into didactics compiled into ready-to-use classroom teaching materials.

Pedagogically, the Baanjung carving context offers three advantages. First, it directs students’ attention to measurable imperfections—small deviations and spacing variation—that help them distinguish between ideal mathematical objects and material reality, a distinction highlighted in embodied cognition research showing how learners navigate tensions between empirical appearances and logical necessity (Nemirovsky & Ferrara, 2009). Second, it clarifies the meaning of transformation operations through procedural traces: the midline as a reflection axis, the spacing template as the implementation of a translation vector, and radial lines as the realization of angular partition. Third, it strengthens cultural relevance by situating transformation learning within valued local artefacts rather than within an abstract vacuum, aligning with perspectives that emphasize the material entanglements of mathematical activity (de Freitas & Sinclair, 2014).

Accordingly, the objectives are: to identify and classify occurrences of reflection, translation, and rotation in Baanjung woodcarvings; to derive measurable parameters that represent these transformations from scaled photographs and motif tracing; and to design a sequence of learning activities that leverages those parameters for middle/secondary classrooms. The contribution is twofold: empirical—providing field evidence that links carving practice with geometric transformations; and didactic—offering teaching materials (Reflection–Translation–Rotation) complete with analytic scoring rubrics that have been validated and refined through a focused group discussion involving Baanjung homeowners and mathematics teachers, whose feedback directly informed the revisions for classroom applicability and cultural accuracy.

METHODS

This qualitative–descriptive study adopts an ethnographic stance with a strong emphasis on in-situ observation of Baanjung house woodcarvings. Rather than relying on archives or secondary documentation, carving practices and finished products were treated as primary data. This approach allowed relationships between technique and mathematical concepts to be captured within a living cultural context. Fieldwork covered two complementary sites: a Baanjung house in Teluk Selong, Martapura, which retains active carved elements on both the façade and interior, and a traditional carver's workshop in Kuin Cerucuk, West Banjarmasin. The participating carver had at least ten years of experience and is identified only by initials or aliases to preserve confidentiality. Data collection took place in August 2025 after receiving permission from the homeowner and informed consent from all participants for interviews, audio–video documentation, and publication of images. All personal identifiers were anonymized and stored securely.

Visual data were obtained using a phone camera together with on-plane scale references that enabled centimeter-per-pixel calibration. For each object, multiple shots were taken with the camera positioned as orthogonally as possible to minimize distortion. During the same sessions, contour tracing was carried out on template sheets to record construction lines, peak and valley points, and any implied axes suggested by the carver's layout. Alongside the visual documentation, we interacted with the carver through semi-structured interviews and think-aloud demonstrations to capture motif meanings, layout rules, tool sequences, and acceptable hand-work tolerances. Observations were logged on structured sheets with synchronized time codes.

Pixel measurements were converted to centimeters using the on-plane ruler placed on the same carving plane. From the calibrated images, we derived three families of geometric parameters. First, local reflection axes on paired panels (tawing halat) were represented as lines in image coordinates and tested with six to ten correspondence pairs to the left and right of the axis; hand-work asymmetries were quantified as symmetry deviation, defined as the mean $\frac{|d_{left} - d_{right}|}{d_{ref}} \times 100\%$. Second, on daun jeruju moldings, the minimal translation vector and the period (repeat distance) were estimated through repeated peak-to-peak measurements of motif units along the molding. Third, for tampuk manggis rosettes, the rotation center and order n were determined by tracing the carver's radial guides and computing the base angle 360°/n.

Interview transcripts, think-aloud narration, fieldnotes, and annotated photographs underwent open coding to generate data-proximal labels, which were then organized through axial coding into practice–parameter categories: Local Reflection (panel), Translational Frieze (*daun jeruju*), Rosette Rotation (*tampuk manggis*), and Composition R→T (*gigi haruan*). Each category was split into practice (what the carver does) and parameter (what is measured), enabling a tight mapping from production steps to measurable geometric constructs. Credibility was strengthened through triangulation of sources (photos, carver explanations, demonstrations) and methods (observation, interview, tracing), followed by member checking in which annotated images were returned to the carver for correction of axis placement, period estimates, or rotation centers. We also conducted peer debriefing with mathematics-education colleagues to review operational definitions and measurement consistency, and a light inter-coder check in which 10–20% of the data were re-coded by a second reviewer. Discrepancies were addressed through a short reconciliation meeting in which both coders compared interpretations, clarified category boundaries, and revised the shared codebook until consensus was reached.

All raw photos (RAW/JPG), audio recordings, transcripts, and measurement sheets were organized in a folder structure by site–date–motif, backed up on encrypted media, and only consented image excerpts were used in publication. The validated parameters were subsequently distilled into teaching materials with practice problems aligned to reflection, translation, and rotation, ensuring a direct pathway from field observation to classroom use. Due to privacy agreements with the homeowner and the carver, several types of field data could not be shared publicly: (1) photographs containing the faces of the homeowner and the carver, (2) interior parts of the house that the homeowner explicitly restricted from dissemination, and (3) carving designs for which the carver had not granted permission for publication. These restrictions limit which raw materials can be openly distributed but do not affect the analytic procedures or the geometric parameters derived in the study.

To guide the field-based inquiry and link carving practice with measurable geometric structure, this study addresses the following questions:

RQ1. Where do reflection, translation, and rotation occur in Baanjung woodcarvings, and how are these transformations operationalized by the carver's procedures (e.g., midline drawing, spacing templates, radial grids)?

RQ2. Which measurable parameters—reflection axis with symmetry deviation, translation vector and period, and rotation center and order—support the design of robust, classroom-ready teaching materials based on these carvings?

RESULT AND DISCUSSION

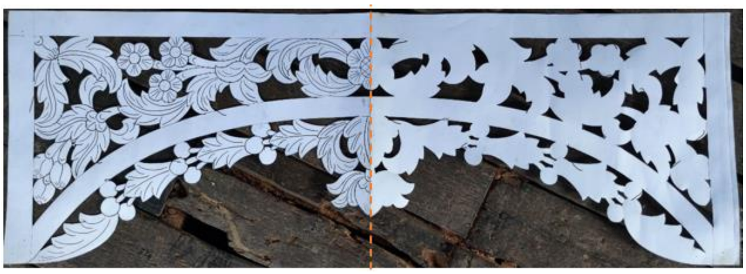
We report detailed, figure-anchored findings consistent with the paper's field-based aims. To maintain coherence with the now-stated research questions, the sub-sections below explicitly answer RQ1 (occurrences and craft processes) and RQ2 (measurable parameters for teaching materials), while keeping the narrative flowing without bullet points.

1. Reflection on paired panels (*tawing halat*) and over-door panels (RQ1→RQ2)

The mid-floor partition panel (*tawing halat*) presents two perpendicular reflection axes—vertical and horizontal—visible in the full-panel capture (Picture 1). In interviews and a think-aloud demonstration, the carver described the routine of "draw the midline first," followed by balanced removal on left–right sides and then top–bottom passes, a sequence that reflects craft conventions documented in process-tracing research (Ericsson & Simon, 1993). Architectural descriptions of Banjar houses also note the central role of *tawing halat* as a partition element (Marwoto, 2016), which culturally motivates bilateral layout.

Picture 1. Mid-floor partition (*tawing halat*)

To parameterize the reflection observed in Picture 1, we represented each axis as a line in image coordinates and sampled 8–10 correspondence pairs (e.g., mirrored leaf tips) to compute symmetry deviation—mean $\frac{|d_{left} - d_{right}|}{d_{ref}} \times 100\%$. On the over-door panel (Picture 2), which compositionally favors vertical growth, we found a single vertical axis and applied the same procedure; deviations were larger near spiral tendrils, consistent with hand-tool control rather than conceptual asymmetry. The fence module template (Picture 3) shows a locally drawn midline used to craft a symmetrized unit that is subsequently translated along the fence, an instance of reflection feeding into translation frequently analyzed in cultural pattern studies (Washburn & Crowe, 1988). These quantified axes and deviations feed RQ2 by supplying assessable targets (axis placement error; deviation percentage) for Teaching Material—Reflection.

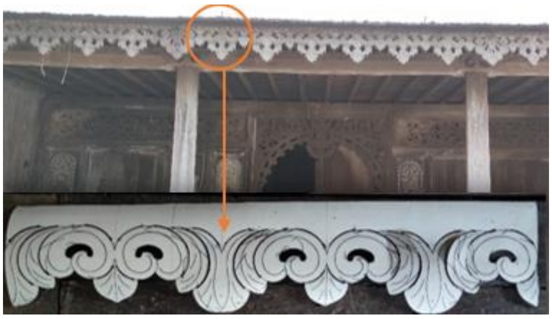


Picture 2. Overdoor panel: single vertical axis; deviation from 8–10 left–right pairs

Picture 3. Fence-module template: one vertical axis; module repeated by translation

2. Translation on *daun jeruju* friezes: straight and slanted variants (RQ1→RQ2)

Along roof-edge moldings, the straight variant of *daun jeruju* (context in Picture 4) forms a clear translational frieze: the minimal translation vector $\vec{t}$ runs parallel to the molding, and the period is the mean peak-to-peak spacing measured over successive units. The carver's explicit use of a spacing template ("*mal jarak*") to keep spacing consistent corroborates the measured periodicity. Two slanted variants (Picture 5 and 6) show that unit orientation may tilt while the shift direction remains parallel to the molding; this dissociation between orientation and the direction of $\vec{t}$ is didactically potent. A second straight variant (Picture 7) retains the period despite stylization changes, underscoring that repeat distance, not unit tilt, governs periodicity. In frieze-group terms these examples align with p1 (pure translation); if mid-period mirroring were present, classification would shift to p2 (translation + reflection), consistent with educational expositions of frieze groups (Duda, 2020; Friedenberg, 2022) and cultural pattern analysis (Washburn & Crowe, 1988). This distinction is pedagogically useful because p1 and p2 provide students with two contrasting transformation structures: one generated solely by a translation vector and one combining translation with bilateral reflection. Presenting roof-edge moldings through these classifications helps students differentiate what changes and what remains invariant under each transformation type, strengthening the conceptual basis for Teaching Material—Translation. For RQ2, the frieze yields two assessable parameters: direction of $\vec{t}$ and period (with variance over segments), directly underpinning Teaching Material—Translation.



Picture 4. Straight *daun jeruju* at roof edge: translational frieze; translation vector parallel to molding

Picture 5. Slanted *daun jeruju* (facade): tilted units; translation vector still parallel to molding

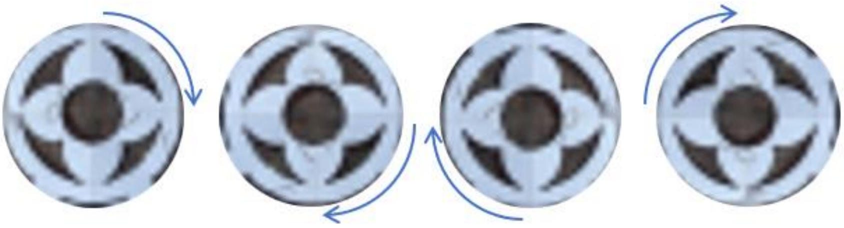
Picture 6. Sidewall slanted units: direction of the translation vector unchanged

Picture 7. Straight-unit variant: direction of the translation vector unchanged

3. Rotation on *tampuk manggis* rosettes across scales (RQ1→RQ2)

Fence-post rosettes (Figure 8) exhibit rotational symmetry about a marked center consistent with classic symmetry analysis in ornaments and tilings (Grünbaum & Shephard, 1987; Armstrong, 1988). Radial construction lines, reported by the carver and visible in tracings, determine the rotation order n as the number of congruent sectors; $n = 4$ predominates, with occasional small rosettes at $n = 6$. The reconstruction sequence in Figure 9 rotates a single petal by $360°/n$ to tile the full motif, matching standard rotational constructions used in mathematics education (Duda, 2020). Two small-scale rosettes (Figures 10a and 10b) confirm the expected variation: Figure 10a shows a rounded-petal rosette with order 5, while Figure 10b shows a cross-leaf rosette with order 4. An annotated example (Figure 10c) highlights the center and base angle used for measurement. These parameters—center, order, and base angle—directly support Teaching Material—Rotation (accuracy rubrics for center localization and correct *n*).

Picture 8. *Tampuk manggis* rosette: rotation about center; typical order 4 (some 6)



Picture 9. Order-4 demo: one petal rotated by 360°/4 = 90° to complete the motif

Picture 10a. Small rosette (rounded petals): order 5 (validated by overlay)

Fig. 10b. Small rosette (cross-leaf): order 4

Fig. 10c. Annotated rosette: rotation center and base angle; arrows show 360°/n steps

4. Composition of reflection and translation in *gigi haruan* (RQ1→RQ2)

The rear-fence zigzag (Figure 11) combines local bilateral structure (short-span reflection across facet edges) with global translation along the border—a textbook instance of the composition $T \circ R$ in cultural border patterns (Washburn & Crowe, 1988). Parameterising the facet-pair reflection and the run's period offers a gentle bridge from local symmetry to global repetition. In classroom use, this motif provides a concrete entry point for introducing composition: students can first identify the short reflection segment that produces a single "tooth," then observe how the entire zigzag emerges by translating that reflected unit along the fence. By sequencing the operations—reflect the facet pair, then apply a translation vector—students see how $T \circ R$constructs a full pattern from a local symmetry, reinforcing the idea that complex friezes arise from ordered combinations of simpler transformations. These become optional extension tasks alongside the three core teaching materials.

Picture 11. *Gigi haruan* zigzag (rear fence): reflect then translate along the edge (T∘R)

5. Accuracy, limitations, and trustworthiness (cross-cutting RQ2)

Numerical precision depends on on-plane scale bars adhered to the carving surface; when absent we report relative (pixel) measures and use centimeters only for scaled images, aligning with good practice in image-based measurement (Mondal, 2022). Ethnomathematical value does not require perfect symmetry: hand-carved departures are pedagogically useful to contrast ideal mathematical objects and material realizations (Rosa & Orey, 2016; Eglash, 1999). A relative (pixel) measure was used, for example, when the spacing template was not visible in a photograph: the peak-to-peak distance between two ridges was compared in pixels (e.g., 142 px vs. 137 px) to quantify variation, without converting to centimeters. By contrast, scaled measurements were applied only when a ruler or on-plane reference allowed centimeter-per-pixel calibration. Credibility was enhanced through member checking (annotated returns for axis/period/center), and overall trustworthiness is supported by qualitative standards of triangulation and auditability (Lincoln & Guba, 1985; Birt, Scott, Cavers, Campbell, & Walter, 2016), with coding decisions grounded in established open/axial procedures (Strauss & Corbin, 1998). These procedures collectively justify the parameters used to build the teaching materials.

CONCLUSION

This field-based ethnomathematical study shows that the woodcarvings of the Banjar Baanjung house embody core geometric transformations in ways that are both visually salient and procedurally grounded. Reflection appears on paired panels—particularly the *tawing halat* and overdoor elements—through carvers' habitual use of midlines; translation governs the *daun jeruju* friezes via stable unit spacing maintained by a spacing template; and rotation structures *tampuk manggis* rosettes through radial layout around a marked center. The *gigi haruan* zigzag additionally illustrates a composition of reflection followed by translation along a border.

Answering RQ1, these transformations are not only properties of the final motif but also operations enacted during production: drawing the axis before carving mirrored halves, stepping off constant distances to fix the repeat, and partitioning the angle around a center for petal placement. Addressing RQ2, we parameterized each case with classroom-ready quantities—local reflection axes and symmetry deviation; translation vector and period; rotation center, order n, and base angle $360°/n$. These parameters travel cleanly from site measurements to instruction. In addition, the explicitness of these parameters makes the materials suitable for teacher training sessions, enabling teachers to rehearse reading axes, vectors, and rotational orders directly from cultural artefacts before facilitating them in the classroom.

The study's main contribution is twofold. Empirically, it offers field evidence that links specific carving procedures to measurable geometric structure across multiple motifs and scales. Didactically, it converts those parameters into teaching materials for reflection, translation, and rotation, complete with analytic prompts that foreground accuracy, tolerance, and approximation—bridging ideal mathematical objects with material craft.

Limitations include uneven availability of on-plane scale bars and the small number of sites and artisans. These constraints were mitigated through triangulation (photos, tracing, interview, and demonstration) and member checking, but future work should broaden sites, standardize scaling for fuller statistical reporting (e.g., standard deviations and confidence intervals), and investigate learning impact experimentally in classrooms. More reliable measurements could also be achieved by adopting uniform scaling techniques—such as consistent on-plane calibration markers or lightweight photogrammetric frames—to minimize distortion and ensure comparable centimeter-per-pixel ratios across motifs and sites.

Overall, situating transformation geometry in Baanjung woodcarving supports culturally responsive pedagogy without sacrificing mathematical rigor. The findings invite extensions to other Banjar motifs and Southeast Asian carving traditions, including comparative analyses of symmetry in Malay traditional arts reported in recent ethnomathematics studies (Sulaiman, Samsudin, & Husain, 2020). Such regional comparisons can strengthen cross-cultural interpretations of geometric practices and inform design-based research cycles that refine the teaching materials in authentic school settings.

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to the Directorate of Research and Community Service, Directorate General of Research and Development, Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, for funding this study under the 2025 Fiscal Year Research Contract 0419/C3/DT.05.00/2025; 132/C3/DT.05.00/PL/2025; 30/LL11/KM/2025; 051/UNUKASE/LPPM/Pn/VI/2025. This support made it possible to conduct the fieldwork, data collection, analysis, and development of the instructional materials reported in this article.

REFERENCE

Armstrong, M. A. (1988). Groups and symmetry. Springer.

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? Qualitative Health Research, 26(13), 1802–1811. https://doi.org/10.1177/1049732316654870

D'Ambrosio, U. (2006). Ethnomathematics: Link between traditions and modernity. Sense Publishers.

de Freitas, E., & Sinclair, N. (2014). Mathematics and the body: Material entanglements in the classroom. Cambridge University Press.

Duda, M. (2020). Plane and frieze symmetry group determination for identifying structures of nanomaterials. Journal of Chemical Education, 97(11), 4134–4140. https://doi.org/10.1021/acs.jchemed.0c00093

Eglash, R. (1999). African fractals: Modern computing and indigenous design. Rutgers University Press.

Ericsson, K. A., & Simon, H. A. (1993). Protocol analysis: Verbal reports as data (Rev. ed.). MIT Press.

Friedenberg, J. (2022). The aesthetics of frieze patterns: Effects of symmetry, motif, and position. i-Perception, 13(6), 1–17. https://doi.org/10.1177/20416695221131112

Grünbaum, B., & Shephard, G. C. (1987). Tilings and patterns. W. H. Freeman.

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry. Sage.

Marwoto, I. (2016). The 19th-century traditional houses of the Banjar Islamic Sultanate in South Kalimantan. In Islamic Heritage Architecture and Art (pp. 195–205). WIT Press.

Mondal, H. (2022). Current status of using scale bar on clinical images and methods to insert it. Journal of Cutaneous and Aesthetic Surgery, 15(1), 1–7. https://doi.org/10.4103/JCAS.JCAS_75_21

Nemirovsky, R., & Ferrara, F. (2009). Mathematical imagination and embodied cognition. Educational Studies in Mathematics, 70(2), 159–174. https://doi.org/10.1007/s10649-008-9150-4

Riadi, A., Turmudi, T., & Juandi, D. (2023). Palimbangan: Ethnomathematics of the Banjar traditional house in South Borneo with religious contents. AIP Conference Proceedings, 2733, 030038. https://doi.org/10.1063/5.0140153

Rosa, M., & Orey, D. C. (2016). Humanizing mathematics through ethnomodelling. Journal of Humanistic Mathematics, 6(2), 3–23. https://doi.org/10.5642/jhummath.201602.08

Shaffee, N., Zakaria, S., Abdullah, N., & Taib, M. Z. M. (2013). Types of floral motifs and patterns of Malay woodcarving in Kelantan and Terengganu. Procedia – Social and Behavioral Sciences, 105, 466–475.

Silah, S. B. (2021). The beauty of Malay woodcarving motif ornamentation. KnE Social Sciences. https://doi.org/10.18502/kss.v5i3.8544

Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory (2nd ed.). Sage.

Sulaiman, R., Samsudin, M. R., & Husain, H. (2020). Symmetrical design analysis of Malay arts in ethnomathematics context. International Journal of Academic Research in Business and Social Sciences, 10(9), 996–1008. https://doi.org/10.6007/IJARBSS/v10-i9/7984

Washburn, D. K., & Crowe, D. (1988). Symmetries of culture: Theory and practice of plane pattern analysis (2nd ed.). University of Washington Press.

Zulfa, I., Dewi, N., & Subiyantoro, S. (2025). Types of flora in ornaments of Rumah Bubungan Tinggi Banjar in South Kalimantan. ISVS e-Journal, 10(12), 157–173.