Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 10, No. 2: November 2026
Page 491-521

Development of an Ethnomathematics-Based Mathematics Learning Module for Junior High School Students

Yosafat Ardian Kristiarta[1)], Ratih Kusumo Wardani[2)], Ayatul Ulya[3)], Nerru Pranuta Murnaka[4)]

Mathematics Education Departement, Faculty of Teacher Training and Education, Parahyangan Catholic University[1), 3)]
Primary School Teacher Education Departement, Faculty of Teacher Training and Education, Parahyangan Catholic University[2)]
Science Education Departement, Faculty of Teacher Training and Education, Parahyangan Catholic University[4)]

*Corresponding e-mail: ayatul.ulya@unpar.ac.id

Abstract. *This study examined the classroom implementation of an ethnomathematics-based mathematics learning module using the Batik Geblek Renteng motif as a cultural context for geometry learning. The study was conducted as part of a Young Lecturer Research project at Parahyangan Catholic University and involved 31 eighth-grade students at SMP Negeri 52 Bandung. Data comprised paired pre-test and post-test grades, a 30-item student-response questionnaire, two expert-validation documents, and a written summary of interviews with one mathematics teacher and six students. The mean grade increased from 38.00 (SD = 17.25) before implementation to 46.58 (SD = 19.39) afterward. A paired-samples t-test indicated a statistically significant mean difference of 8.58 points, t(30) = 2.445, p = 0.021, with a 95% confidence interval of [1.41, 15.75] and Cohen's d = 0.44. The average questionnaire response was 4.04 on a five-point scale. Both validators recorded an overall judgement that the instructional materials were usable. Interview summaries indicated favorable perceptions of the module's visual presentation and cultural context, while problem-solving instructions were identified as an area for improvement. These findings provide preliminary classroom evidence concerning the module's implementation, while the one-group design limits causal interpretation.*

Keywords: *ethnomathematics; mathematics module; geometry*

INTRODUCTION

Mathematics education requires students to move between concrete experiences, visual representations, symbolic procedures, and abstract relationships. Geometry is particularly relevant to this process because students need to recognize shapes, interpret their properties, establish relationships between figures, and apply those relationships when solving problems (Clements and Battista 2006). Difficulties may arise when mathematical concepts are presented mainly through formal symbols or routine exercises without sufficient connections

to objects and situations that students can interpret meaningfully (Fitriani and Rohaeti 2020; Waluyo and Nuraini 2021). Contextual approaches can provide opportunities for students to connect mathematical ideas with real-world situations and to interpret mathematical information beyond the classroom (Geiger, Goos, and Forgasz 2015; Gravemeijer 1994; OECD 2019; Treffers 1987).

Ethnomathematics offers one perspective for making these connections by examining mathematical ideas in cultural practices, artefacts, and everyday activities (Barton 1996; Rosa and Orey 2011; Ubiratan D'Ambrosio 2001). Its educational relevance lies in the possibility of connecting formal mathematics with knowledge and practices that have meaning within particular communities. Cultural contexts, however, do not automatically produce meaningful mathematical learning. They need to be integrated into instructional activities that guide students to identify mathematical features, interpret relationships, and connect their observations to formal concepts (Orey and Rosa 2021; Suhartini and Martyanti 2017). Recent reviews of ethnomathematics research have similarly discussed the importance of translating cultural exploration into learning designs and classroom resources rather than treating cultural artefacts only as illustrations (Ayuningtyas and Setiana 2019; Rahmawati, Nusantara, and Rohati 2026).

Batik is a relevant cultural resource for geometry learning because its motifs often contain repeated shapes, patterns, and spatial arrangements that can be analyzed mathematically (Ayuningtyas and Setiana 2019; D'Ambrosio Ubiratan and Rully Charitas Indra Prahmana 2020; Manoy and Purbaningrum 2021). Previous research has documented geometric ideas in Indonesian batik and examined how these ideas may be used in mathematics education (D'Ambrosio Ubiratan and Rully Charitas Indra Prahmana 2020; Fatkhurohman et al. 2021; Wulandari and Kusumah 2022). The Batik Geblek Renteng motif associated with Kulon Progo, Yogyakarta, has specifically been explored in relation to geometric transformations. Its repeated visual elements offer a potential starting point for discussing geometric forms and relationships in a culturally situated context (Fatkhurohman et al. 2021).



Figure 1. Batik Geblek Renteng Motif

The educational value of such a motif depends on how it is used in the learning process. Students need opportunities to progress from noticing visual patterns to identifying relevant mathematical concepts and explaining their reasoning. A learning module can provide this structure by organizing learning objectives, explanations, examples, guided tasks, and assessment activities into a coherent sequence. Ethnomathematics-based learning resources have been developed in various Indonesian cultural settings, including traditional games, crafts, and batik, to connect mathematical content with local knowledge and student experience (Disnawati and Nahak 2019; Faqih, Nurdiawan, and Setiawan 2021; Febrina et al. 2022). These studies support the potential of culturally contextualized resources while also highlighting the need to consider the suitability of materials for the students and mathematical content concerned.

Previous studies have investigated the integration of ethnomathematics into mathematics education through the development of culturally contextualized learning resources and the identification of mathematical concepts in cultural artefacts. Disnawati and Nahak (2019), Faqih, Nurdiawan, and Setiawan (2021), and Febrina et al. (2022) examined ethnomathematics-based learning resources in different cultural contexts, including traditional games, crafts, and batik. Other studies, including Fatkhurohman et al. (2021), explored the geometric potential of the Batik Geblek Renteng motif, particularly in relation to geometric transformations. Meanwhile, research on Problem-Based Learning has examined its role in supporting mathematical reasoning and problem-solving, as discussed by

Hmelo-Silver (2004), Savery (2006), and Suparman et al. (2021). Collectively, these studies provide a foundation for integrating cultural contexts and problem-oriented learning into mathematics instruction. However, the studies address different aspects of ethnomathematics, cultural resources, and instructional approaches, indicating the importance of examining how these elements can be brought together within a structured learning module for junior high school mathematics.

Despite these contributions, a specific research gap remains in the development and evaluation of a mathematics learning module that explicitly integrates the Batik Geblek Renteng motif, geometric concepts, and Problem-Based Learning into a coherent instructional sequence for junior high school students. In particular, the identification of geometric elements in a cultural motif does not, by itself, establish how those elements can be transformed into structured learning activities that guide students from cultural observation to mathematical interpretation and problem-solving. Similarly, the development of ethnomathematics-based learning resources does not necessarily demonstrate their suitability for a particular student population or the mathematical content being taught. Therefore, the present study addresses this gap by developing an ethnomathematics-based mathematics learning module using the Batik Geblek Renteng motif and a Problem-Based Learning framework, and by examining the module through expert validation and classroom implementation. The study thus contributes a context-specific instructional resource and evidence concerning its suitability for junior high school mathematics learning.

Problem-Based Learning (PBL) offers a pedagogical structure for integrating cultural contexts with mathematical reasoning. It places problems at the center of learning and encourages students to interpret situations, organize information, investigate possible solutions, communicate findings, and reflect on their reasoning (Hmelo-Silver 2004; Savery 2006; Suparman et al. 2021). A recent systematic review of PBL in school mathematics indicates continued interest in its implementation and outcomes, while also pointing to the importance of examining how specific learning designs are enacted in practice (Ayari et al. 2025). When a

cultural artefact is connected to a carefully designed mathematical problem, it can provide the context from which students identify mathematical information and select suitable procedures.

Developing a module therefore requires attention to both the cultural content and the instructional sequence. A visually attractive module may not be sufficient if its explanations or problem-solving steps remain difficult to follow. Likewise, a mathematically accurate module may not fully support learning if its tasks do not make the connection between the cultural motif and the intended concepts explicit. Research on instructional-material development emphasizes the importance of systematic design, review, implementation, and evaluation when producing educational resources (Artigue and Baptist 2012; Branch 2009; Masamah 2018; Sunzuma and Umbara 2025). Evaluation should therefore examine several forms of evidence, including expert judgements, students' performance, questionnaire responses, and reported classroom experiences.

The present study was conducted as part of the 2026 Young Lecturer Research scheme at Parahyangan Catholic University under the project entitled Development of an Ethnomathematics-Based Learning Module for Junior High School Students. The research initially identified SMP Santa Angela Bandung as the intended implementation site. Following consultation with the research supervisor and consideration of administrative and implementation feasibility, the classroom implementation was conducted at SMP Negeri 52 Bandung. This change concerned the implementation arrangements rather than the central objective of developing and examining an ethnomathematics-based mathematics learning module.

The study aimed to examine the classroom implementation of the module, describe changes in students' pre-test and post-test grades, summarize student responses, and identify strengths and areas requiring improvement. By reporting these forms of evidence together, the study provides classroom-specific information about the implementation and preliminary evaluation of an ethnomathematics-based learning module. The findings are interpreted within the limits of a one-group design and are not presented as definitive causal evidence of effectiveness.

Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 10, No. 2: November 2026
Page 491-521

METHODS

Research Design and Participants

The study adopted a development-oriented approach framed by the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation (Branch 2009). The framework was used to organize the development and classroom evaluation of the module. The present article focuses on the documented expert review, classroom implementation, and evaluation evidence available from the project. Within this framework, the study was carried out in a specific school context to examine the implementation of the developed module using Batik Geblek Renteng as a cultural context for geometry learning. The development-oriented design provided a systematic structure for examining the instructional materials and their use in an authentic classroom setting. Particular attention was given to the relationship between the cultural context, the learning activities, and the documented evidence of the module's suitability and implementation.



Figure 2. ADDIE framework used to organize the module development and classroom evaluation.

The implementation took place at SMP Negeri 52 Bandung, West Java, Indonesia. Participants were 31 students from Class 8.4. The learning resource used the Batik Geblek Renteng motif as a cultural context for geometry learning and was accompanied by student worksheets (Lembar Kerja Peserta Didik, LKPD). The project was conducted under the 2026 Young Lecturer Research scheme at Parahyangan Catholic University. The combination of the learning module and the accompanying LKPD was intended to provide structured opportunities for students to engage with geometric concepts through culturally contextualized activities. This classroom setting provided the basis for documenting the implementation process

and examining the available evaluation evidence within the scope of the research project.

To evaluate the implementation of the learning module, the study drew on four sources of evidence: paired pre-test and post-test grades from the 31 participating students, responses to a 30-item questionnaire, validation documents completed by two experts, and a written summary of interviews with one mathematics teacher and six students. Both validators provided overall judgements that the instructional materials were usable. Quantitative data were analyzed to describe changes in students' grades and their questionnaire responses, while the written interview summary was used to contextualize the quantitative findings.

Learning Module and Validation

The module was developed to connect visual features of Batik Geblek Renteng with geometric concepts through structured learning activities. The accompanying LKPD was intended to guide students in observing the motif, interpreting mathematical information, and working through contextual problems. The validation documentation included forms for the teaching module, LKPD, critical-thinking test, and student motivation questionnaire. These validation documents provided the basis for examining the expert judgments on the suitability of the developed instructional materials before their classroom implementation. The inclusion of multiple instructional components enabled the review to address not only the learning resource itself but also the instruments intended to assess students' learning outcomes and motivation. This alignment between the module, worksheets, and assessment instruments was relevant to examining the coherence of the instructional design as a whole.

Two validators reviewed the instructional materials. The first validator signed the validation document on 7 May 2026, while the second validator signed the corresponding document on 8 May 2026. Both sets of documentation recorded an overall *Layak Digunakan* (Suitable for Use) judgement for the relevant materials. These outcomes are reported descriptively because the available documents use different item structures and do not provide a single common numerical index that

can appropriately be combined across all materials. Accordingly, the validation findings are presented in accordance with the judgments recorded in the available documentation rather than through a pooled numerical score. This reporting approach preserves the distinctions among the reviewed materials while providing a transparent account of the documented expert evaluation.

Data Sources and Analysis

Four sources of evidence were analyzed. First, paired pre-test and post-test grades were available for 31 students. Second, a 30-item questionnaire using a five-point response scale was completed by the same number of students. Third, the two expert-validation documents provided the documented judgements concerning the usability of the instructional materials. Fourth, a written summary recorded interviews with one mathematics teacher, coded G-01, and six students, coded S-01 to S-06. These sources provided complementary perspectives on the implementation of the module, encompassing student performance, questionnaire responses, expert judgments, and participants documented perceptions. The analysis considered the contribution of each source according to its nature and the extent of the information available in the research documentation.

Descriptive statistics were calculated for pre-test and post-test grades, including the mean, standard deviation, median, and range. Individual changes were calculated as post-test minus pre-test grades. A Shapiro–Wilk test was conducted on the paired differences, followed by a two-sided paired-samples t-test with a 95% confidence interval. Cohen's d was calculated as the mean paired difference divided by the standard deviation of the differences. A Wilcoxon signed-rank test was also conducted as a sensitivity analysis. These procedures were used to describe the observed changes within the participating class; the absence of a comparison group prevents causal attribution of the changes to the module alone (Anderson-Cook 2005). The combination of descriptive statistics, inferential testing, and an effect-size estimate provided several complementary ways to characterize the magnitude and statistical evidence of the observed score changes. The findings were interpreted in relation to the participating class and the study design, with

appropriate caution regarding the extent to which the results may apply to other educational settings.

Questionnaire data were summarized using the total score, mean response per item, observed range, percentage of the theoretical maximum, and item-level means. Cronbach's alpha was calculated to describe internal consistency. Because the questionnaire covered several aspects of students' responses to the module, alpha was not interpreted as proof of one-dimensionality or construct validity (Tavakol and Dennick 2011). The questionnaire was therefore treated as a measure of students' responses to the module rather than as a fully validated unidimensional motivation scale. The descriptive summaries were intended to characterize the distribution of responses and identify patterns across the questionnaire items. This interpretation maintained a distinction between the consistency of responses across items and the broader validity of the questionnaire as a measure of a specific psychological construct.

The interview summary was reviewed descriptively to identify recurring points concerning the module's presentation, the cultural context, and the guidance provided for problem solving. Because full transcripts and a detailed coding protocol were not available, the qualitative findings are reported as a summary of documented perceptions rather than as the result of a comprehensive thematic analysis. This approach allowed the available interview evidence to complement the documented evaluation of the instructional materials. The resulting summary was used to provide contextual insights into the development and implementation of the module without extending the interpretation beyond the available evidence. The interview summary was considered alongside the quantitative results to provide additional context for understanding participants documented experiences with the learning materials. Any convergence between these sources was interpreted as complementary descriptive evidence rather than as independent confirmation of the module's effectiveness.

RESULTS AND DISCUSSION

Results of the ADDIE Development Process

The development of the ethnomathematics-based mathematics learning module followed the five stages of the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation (Branch 2009). These stages provided a framework for connecting the cultural features of Batik Geblek Renteng with geometry learning and for examining the suitability of the resulting instructional materials in a classroom setting.

During the analysis stage, the development process focused on connecting geometry learning with a recognizable cultural context and providing students with structured opportunities to interpret visual patterns mathematically. Batik Geblek Renteng was selected as the contextual resource because its visual features offered opportunities to explore geometric forms and relationships. The instructional focus was subsequently translated into a learning design that linked cultural observation with the interpretation of mathematical concepts.

In the design stage, the module was organized around learning objectives, explanations, examples, guided activities, and assessment tasks. The accompanying student worksheets (*Lembar Kerja Peserta Didik*, LKPD) were designed to support students in observing the Batik Geblek Renteng motif, identifying relevant mathematical information, and working through contextual problems. Assessment instruments were also prepared to document students' learning outcomes and responses to the instructional materials. This design established the intended connections among the cultural context, learning activities, and evaluation procedures.

The development stage resulted in an instructional package comprising the teaching module, LKPD, critical-thinking test, and student motivation questionnaire. The materials were reviewed by two validators, both of whom recorded an overall *Layak Digunakan* (Suitable for Use) judgement in the available validation documents. Because the documents used different item structures and scoring formats, the validation results were reported descriptively rather than combined into a single numerical index. These judgements provided documented evidence of the materials' initial suitability for classroom implementation.

During the implementation stage, the module and accompanying LKPD were used with 31 eighth-grade students from Class 8.4 at SMP Negeri 52 Bandung. The implementation provided several sources of evidence for evaluating the instructional materials, including paired pre-test and post-test scores, responses to a 30-item questionnaire, and a written summary of interviews with one mathematics teacher and six students. These data enabled the evaluation to consider student performance alongside their responses to the learning materials and the documented experiences of the teacher and selected students.

The evaluation stage brought together the expert-validation judgements, student performance data, questionnaire responses, and interview summary. The mean student score increased from 38.00 before implementation to 46.58 afterward, representing a mean paired difference of 8.58 points. Students' questionnaire responses were also generally favorable, with a mean response of 4.04 on a five-point scale. The interview summary further indicated positive perceptions of the module's visual presentation and cultural context, although the problem-solving instructions were identified as an aspect requiring improvement. Taken together, these findings indicate that the module was considered usable by the validators and received generally favorable responses during classroom implementation, while also revealing opportunities to strengthen the instructional guidance. In particular, clearer scaffolding for interpreting contextual problems and developing mathematical solutions should be considered in subsequent revisions. Nevertheless, because the study employed a one-group pre-test–post-test design without a comparison group, the observed score increase is interpreted as preliminary evidence from the implementation rather than definitive evidence that the module alone caused improvements in student performance.

Expert Validation of the Learning Materials

The two expert-validation documents recorded an overall *Layak Digunakan* (Suitable for Use) judgement for the instructional materials reviewed. The documentation covered the teaching module, LKPD, critical-thinking test, and student motivation questionnaire. The written comments in the second validation

document described the materials as suitable for use. These judgements provide documented evidence that the materials were considered usable by the two reviewers. The scope of the validation therefore extended beyond the presentation of the learning module to include the worksheets and instruments intended to support and assess the learning process. Taken together, the documented judgements provide a basis for describing the initial suitability of the instructional materials while keeping the interpretation within the scope of the available expert-review evidence.

The validation results should nevertheless be distinguished from evidence of learning effectiveness. Expert review concerns the suitability of instructional materials according to the criteria used by the reviewers, whereas changes in students' grades concern observed performance during classroom implementation. These forms of evidence are complementary but not interchangeable. Systematic development approaches emphasize that instructional materials should be reviewed, implemented, and evaluated, with findings from each stage informing subsequent revisions (Artigue and Baptist 2012; Branch 2009). Accordingly, the validation findings are interpreted as evidence concerning the materials' suitability rather than as direct evidence that the module improved students' mathematical performance or motivation. This distinction is important for maintaining alignment between the claims made in the discussion and the specific types of evidence collected during the development and implementation process.

The two validation documents also differ in their item structures and scoring formats. For this reason, the current study reports the recorded overall judgements rather than calculating a combined validity coefficient. This avoids implying that the two instruments generated directly comparable numerical measurements. Future reporting could be strengthened by presenting item-level scores for each validator, documenting revisions made in response to expert feedback, and explaining the decision rule used to determine overall usability. Such information would make the relationship between individual expert assessments, subsequent revisions, and the final usability judgement more transparent to readers. It would also provide a clearer basis for examining how specific recommendations were

addressed during the development process and for replicating the validation procedure in future studies.

Changes in Students' Pre-Test and Post-Test Grades

The mean pre-test grade was 38.00 (SD = 17.25), increasing to 46.58 (SD = 19.39) in the post-test. The average paired change was 8.58 points. The median increased from 38 to 50, while individual changes ranged from a decline of 38 points to an increase of 50 points. Of the 31 students, 20 obtained higher post-test grades, two obtained unchanged grades, and nine obtained lower grades. These descriptive results show that the overall increase in the class mean was accompanied by different patterns of individual performance. Examining both the central tendency and the distribution of individual changes provides a more complete description of the students' performance than relying on the mean difference alone.

Table 1. Descriptive Statistics for Pre-Test and Post-Test Grades

Statistic	Pre-test	Post-test
Number of students	31	31
Mean	38.00	46.58
Standard deviation	17.25	19.39
Median	38	50
Minimum	4	0
Maximum	70	80

The Shapiro–Wilk test for the paired differences was not statistically significant, W = 0.962, p = 0.335. The paired-samples t-test indicated a statistically significant mean difference, t (30) = 2.445, p = .021, with a 95% confidence interval of [1.41, 15.75]. The standardized paired effect was Cohen's d = 0.44. The Wilcoxon signed-rank sensitivity analysis also indicated a statistically significant difference, p = .015. Taken together, these findings indicate that the post-test grades were higher on average than the pre-test grades in the participating class. The confidence interval indicates that the estimated mean increase was positive,

although its magnitude remains subject to sampling variability. The agreement between the paired-samples t-test and the Wilcoxon signed-rank analysis provides additional evidence that the observed difference was not dependent solely on the choice of statistical test.

The observed increase is consistent with the possibility that a culturally contextualized module can provide a useful structure for engaging students with geometry. The Batik Geblek Renteng motif offers visual features that can be examined in relation to mathematical forms and transformations, creating opportunities to connect observation with formal concepts (D'Ambrosio 2020; Fatkhurohman et al. 2021). Studies of ethnomathematics-based learning resources have similarly explored the use of cultural contexts to support mathematics learning and the development of instructional materials (Disnawati and Nahak 2019; Hartindya, Sunardi, and Yuliati 2022; Ika Krisdiana et al. 2025; Rosa and Orey 2011). In this approach, the cultural motif serves as a starting point for mathematical exploration, while structured learning activities help students connect visual observations with geometric reasoning. The present findings extend this discussion by documenting score changes in a classroom where Batik Geblek Renteng was incorporated into a geometry learning module (Ernaningsih 2021; Fatkhurohman et al. 2021; Yosafat Ardian Kristiarta, Wahyu Setyaningrum, and Marsigit 2023).

The size and distribution of the observed changes, however, require careful interpretation. Although the mean difference was positive and statistically significant, nine students had lower post-test grades. The post-test standard deviation was also larger than the pre-test standard deviation, indicating that variation among students remained substantial. Therefore, the class-level average does not represent an identical learning trajectory for all students. Some students may require additional examples, more explicit procedural guidance, or differentiated support when working with contextual problems. The variation in individual results suggests that students may differ in how they engage with the learning activities and apply the geometric concepts presented in the module (Clements and Battista 1992; Huang and Witz 2011; Yudianto, Susanto, and Priciliya 2020). Future instructional refinements could therefore consider additional

scaffolding and opportunities for guided practice to address the range of learning needs observed in the class.

The results also do not establish that the module caused the observed increase. The study used a one-group pre-test–post-test design without a comparison group. Consequently, the analysis cannot rule out other explanations, such as regular classroom instruction, familiarity with the assessment, or changes in student effort. Methodological literature on non-randomized educational studies cautions that within-group changes should not automatically be interpreted as causal effects (Hake 1999; Vu et al. 2022). The results are therefore best described as preliminary evidence of improvement following classroom implementation. This limitation means that the observed score differences should be interpreted in relation to the implementation context rather than as an isolated effect of the developed module. Further research involving a comparison group and a larger sample would help clarify the extent to which similar learning outcomes can be attributed to the module across different classroom settings.

Student Responses to the Module

All 31 students completed the 30-item questionnaire, and no missing responses were recorded in the dataset. The mean total score was 121.26 (SD = 13.63), the median was 123, and the observed range was 97–144. The mean response per item was 4.04 on a five-point scale, equivalent to 80.84% of the theoretical maximum. Cronbach's alpha was 0.909, indicating high internal consistency among the recorded responses. While these aggregate statistics reflect a highly positive overall reception, a closer examination of individual items reveals more nuanced student perceptions. Specifically, analyzing the contrasting responses at the item level provides targeted insights for future refinements of the learning materials.

Table 2. Summary of Student Questionnaire Responses

Indicator	Result

Respondents	31
Number of items	30
Mean total score	121.26
Standard deviation	13.63
Median total score	123
Observed range	97–144
Mean per item	4.04 out of 5
Percentage of theoretical maximum	80.84%
Cronbach's alpha	0.909

At the item level, Q5, which concerned the neatness of the module layout, had the highest mean response (4.419). Q10, which concerned the ease of following the problem-solving steps, had the lowest mean (3.548). This contrast provides a specific direction for improving the learning resource. The visual presentation was rated particularly favorably, while the sequence of problem-solving instructions may require more explicit explanations and worked examples. The difference between these item-level means suggests that students' responses varied across specific features of the learning materials rather than reflecting a uniform evaluation of the entire module. Examining these differences at the item level can help prioritize revisions by identifying aspects that were perceived positively and those that may benefit from clearer instructional support.

These findings suggest that the module's presentation and its instructional guidance should be considered separately during revision. A well-organized visual layout may make the materials more approachable, but students still need sufficient support to interpret problems, identify relevant information, select mathematical procedures, and explain their solutions. Research on problem-based mathematics learning highlights the importance of structuring student investigation and supporting the transition from problem interpretation to solution development (Ayari et al. 2025). The current results indicate that such support should remain a priority in future revisions. In the context of the Batik Geblek Renteng module, this support could include more explicit prompts that guide students from observing the

motif to identifying geometric properties and applying relevant mathematical concepts (D'Ambrosio Ubiratan and Rully Charitas Indra Prahmana 2020; Dewi, Hartawan, and Sukajaya 2019; Muhammad, Marsigit, and Soeharto 2021; Yosafat Ardian Kristiarta et al. 2023). Worked examples and intermediate guiding questions could also help make the problem-solving process more accessible without removing opportunities for students to develop their own reasoning.

The questionnaire findings must also be interpreted within the instrument's scope. The items cover multiple aspects of students' responses, including layout, cultural relevance, perceived understanding, and independent learning. Cronbach's alpha provides information about internal consistency but does not establish that all items measure a single construct or that the questionnaire is a validated measure of motivation (Tavakol and Dennick 2011). Accordingly, the results are reported as student responses to the module, rather than as definitive evidence of increased motivation. This distinction is important because favorable responses to particular learning materials do not necessarily demonstrate changes in students' motivation over time. Future studies could strengthen the interpretation by examining the questionnaire's underlying dimensions and combining student response data with additional measures specifically designed to assess changes in motivation.

Interview Summary and the Role of the Cultural Context

The written interview summary documented favorable perceptions of the module's layout and presentation. The teacher and interviewed students described the materials as practical and visually accessible. The summary also indicated that the Batik Geblek Renteng motif helped provide a context for discussing geometric ideas, including plane shapes and rotation. The teacher reported greater enthusiasm and participation compared with the use of a conventional printed textbook, while the structured learning activities were described as helpful for approaching mathematical word problems. These accounts highlight the perceived relevance of both the module's visual presentation and its culturally contextualized learning activities to the participants' classroom experiences. The reported responses also suggest that the combination of familiar cultural features and structured

mathematical tasks was considered useful for supporting students' engagement with the learning materials.

These reported experiences provide context for interpreting the quantitative findings. The cultural motif was not merely a decorative element; it was intended to serve as a visual starting point for identifying mathematical features and connecting them to formal geometry. Research on batik patterns has documented geometric concepts that can be used as resources for mathematics learning (Fatkhurohman et al. 2021; Prahmana and D'Ambrosio 2020; Wulandari and Kusumah 2022). More broadly, ethnomathematics research has examined ways to relate local cultural practices and artefacts to classroom mathematical ideas (Barton 1996; Ernaningsih 2021; Fauzi and Setiawan 2020; Rosa and Orey 2011). From an instructional perspective, this connection provides an opportunity for students to move from observing recognizable visual patterns toward identifying and discussing the geometric properties represented in those patterns. The cultural context may therefore help situate abstract mathematical concepts within a more recognizable setting, provided that the learning activities explicitly guide students toward the relevant mathematical relationships.

The findings are also consistent with the view that contextual materials can support mathematical learning when they are accompanied by deliberate instructional guidance. Ethnomathematics-based worksheets and learning resources have been developed around traditional crafts, games, and local cultural practices to connect students' experiences with mathematical tasks (Dinata, Wicaksono, and Prihastari 2022; Faqih et al. 2021; Hisni, Ansori, and Sari 2022). The present study adds classroom-specific evidence about the use of Batik Geblek Renteng within a module intended for junior high school geometry. In this context, the instructional value of the cultural motif depends not only on its visual features but also on how learning activities guide students to interpret those features mathematically. This distinction highlights the importance of integrating cultural representation with explicit mathematical tasks rather than treating local cultural elements as contextual illustrations alone. The accompanying LKPD can support this process by organizing students' observations into questions and activities that require them to

identify geometric features, interpret mathematical information, and formulate solutions. Such an approach emphasizes that the educational contribution of ethnomathematics lies not simply in introducing cultural artefacts, but in using them purposefully to structure mathematical exploration and reasoning.

Nevertheless, the interview evidence is limited to a written summary rather than complete transcripts. It should therefore be treated as descriptive corroboration of reported perceptions, not as a comprehensive qualitative analysis. The accounts cannot independently demonstrate that the module improved achievement or motivation. Their principal contribution is to clarify which features of the learning resource participants regarded positively and which aspects may need refinement. Accordingly, the interview findings are interpreted alongside the quantitative results to provide contextual understanding rather than to establish an independent explanation for the observed changes in student performance. This cautious interpretation preserves the contribution of participants reported experiences while acknowledging the limitations of the available qualitative documentation.

Implications for Module Refinement

Three implications follow from the combined evidence. First, the module should preserve the visual organization and cultural context that received favorable responses. The motif offers a potentially meaningful context for exploring geometric features, provided that activities explicitly connect visual observation with mathematical concepts. This aligns with research examining the mathematical structures found in Indonesian cultural artefacts and their potential use in mathematics education (D'Ambrosio Ubiratan and Rully Charitas Indra Prahmana 2020; Fatkhurohman et al. 2021; Manoy and Purbaningrum 2021; Prahmana and D'Ambrosio 2020). Maintaining this cultural connection may help preserve the contextual relevance of the learning resource while ensuring that the mathematical content remains central to the learning process. Future revisions should therefore focus on strengthening the links between specific features of Batik Geblek Renteng and the geometric concepts students are expected to identify and understand.

Second, the problem-solving sequence should be made more explicit. The lower mean for Q10 suggests that some students may need clearer guidance when progressing through a contextual problem. A revised sequence could prompt students to identify known information, determine what must be found, select the relevant geometric relationship, complete the calculation, and explain the result (Febrina et al. 2022; Nopianda, Octaria, and Nopriyanti 2023; Rahmi, Cesaria, and Mardiyah 2023). This is a practical recommendation derived from the questionnaire findings; its effectiveness should be tested in a subsequent implementation rather than assumed. These prompts could be incorporated into the LKPD as a series of scaffolded questions that gradually guide students from understanding the problem to constructing and communicating a mathematical solution. The revised materials could then be evaluated to determine whether the additional guidance improves students' ability to follow the problem-solving process while still allowing them to develop independent reasoning.

Third, subsequent evaluation should use a design that supports stronger inferences. A larger sample, additional classes, and an appropriate comparison condition would help determine whether observed score changes exceed those associated with ordinary instruction or other influences. Further work should also document assessment alignment and examine the dimensionality of the questionnaire before making claims about motivation as a distinct construct. The present study therefore provides a starting point for iterative refinement rather than a final demonstration of effectiveness. A subsequent study could also examine whether changes in specific instructional features correspond to differences in student performance and questionnaire responses across implementation cycles. Documenting these revisions and their associated evaluation results would provide a clearer evidence base for refining the module and determining the conditions under which it may be useful in other mathematics classrooms.

Limitations

This study involved one class of 31 students and used a one-group pre-test–post-test design. The observed increase in grades cannot therefore be attributed exclusively to the module. The questionnaire included several aspects of students' responses and should not be interpreted as a validated unidimensional measure of motivation. In addition, the qualitative evidence was based on a written interview summary, and the available validation documents provided overall judgements rather than a common numerical validity index. These limitations constrain the generalizability and causal interpretation of the findings, while also identifying clear priorities for future evaluation.

CONCLUSION

This study examined the classroom implementation of an ethnomathematics-based mathematics learning module using the Batik Geblek Renteng motif as a context for geometry learning. The mean grade increased from 38.00 before implementation to 46.58 afterward, and the paired-samples analysis indicated a statistically significant mean difference of 8.58 points. Student responses were generally favorable, averaging 4.04 on a five-point scale. Both expert-validation documents recorded an overall judgement that the relevant instructional materials were usable. The interview summary further indicated positive perceptions of the module's visual presentation and cultural context. Taken together, these findings illustrate how a locally grounded cultural context can be incorporated into geometry learning through a structured module and accompanying student worksheets. The results also highlight the importance of considering student performance, perceived usability, and participants' documented experiences as complementary sources of evidence when evaluating an instructional resource.

The findings provide preliminary evidence concerning the implementation of the module in one junior high school class. They do not establish that the module alone caused the observed score increase or that the same outcomes would occur in other settings. The questionnaire and interview findings suggest that the module's visual organization and cultural context should be retained, while the problem-solving instructions require further refinement. Future research should include more

complete validation reporting, stronger evidence of assessment quality, and an appropriate comparison design to evaluate the module's contribution to mathematics learning more rigorously. Further development should prioritize clearer scaffolding in the LKPD and a more explicit connection between the visual characteristics of Batik Geblek Renteng and the geometric concepts addressed in the learning activities. By combining these refinements with a more rigorous evaluation design, subsequent studies could provide stronger evidence regarding the module's educational value and its potential applicability to other mathematics classrooms.

ACKNOWLEDGMENT

The authors acknowledge the support of Parahyangan Catholic University through the 2026 Young Lecturer Research scheme. The authors also thank the participating school, mathematics teacher, students, and validators for their contributions to the development and evaluation of the learning materials. Their cooperation and engagement were valuable in facilitating the classroom implementation and documenting the evaluation of the instructional module. The authors further appreciate the support of all parties who contributed to the research process and helped make the completion of this study possible.

REFERENCES

Anderson-Cook, Christine M. 2005. "Experimental and Quasi-Experimental Designs for Generalized Causal Inference." *Journal of the American Statistical Association* 100(470):708. doi: 10.1198/jasa.2005.s22.

Arnelis, Fira Febrina; Ahmad Fauzan; Elita Zusti Jamaan; Arnelis. 2022. "Pengembangan Perangkat Pembelajaran Terintegrasi Etnomatematika Permainan Congklak Materi Operasi Hitung Pada Peserta Didik Kelas II SD/MI." *JEMS: Jurnal Edukasi Matematika Dan Sains* (Vol 10, No 1 (2022)):157–63.

Artigue, Michèle, and Peter Baptist. 2012. "Inquiry in Mathematics Education." *The Fibonacci Project*.

Ayari, Mohamed Arselene, Abdellatif Sellami, Malavika E. Santhosh, Khalid Kamal Naji, Abdulla Al-Ali, and Saleh Mohammad Ali Al-Hazbi. 2025. "From Problems to Performance: A Systematic Review of Problem-Based Learning in K-12 Mathematics." *Frontiers in Education* Volume 10. doi:

10.3389/feduc.2025.1731307.

Ayuningtyas, Annis Deshinta, and Dafid Slamet Setiana. 2019. "Pengembangan Bahan Ajar Matematika Berbasis Etnomatematika Kraton Yogyakarta." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 8(1):11–19. doi: 10.24127/ajpm.v8i1.1630.

Barton, Bill. 1996. "Making Sense of Ethnomathematics: Ethnomathematics Is Making Sense." *Educational Studies in Mathematics* 31(1):201–33. doi: 10.1007/BF00143932.

Branch, R. M. 2009. *Instructional Design: The ADDIE Approach*. New York: Springer Science+Business Media / Springer US.

Clements, Douglas H., and Michael T. Battista. 1992. "Geometry and Spatial Reasoning." Pp. 420–64 in *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics.* New York, NY, England: Macmillan Publishing Co, Inc.

Clements, Douglas H., and Michael T. Battista. 2006. "Geometry and Spatial Reasoning" edited by D. A. Grouws. *Handbook of Research on Mathematics Teaching and Learning: A Project of the National Council of Teachers of Mathematics* 420–64.

D'Ambrosio, U. 2020. "An Essay on Philosophy, Mathematics and Culture." *Revista Pesquisa Qualitativa* 8(18):571–94.

D'Ambrosio Ubiratan, and Rully Charitas Indra Prahmana. 2020. "Mempelajari Geometri Dan Nilai Dari Pola: Etnomatematika Pada Pola Batik Yogyakarta, Indonesia." *Jurnal Pendidikan Matematika* 11(3):439–56.

Dewi, L. Intan Puspa, I. .. G. N. Yudi Hartawan, and I. N. Sukajaya. 2019. "Etnomatematika Dalam Tari Bali Ditinjau Dari Klasifikasi Tari Bali." *Jurnal Pendidikan Dan Pembelajaran Matematika Indonesia* 8(1):39–48.

Dinata, Pranita Marta, Anggit Grahito Wicaksono, and Ema Butsi Prihastari. 2022. "Efektivitas LKPD Berbasis Etnomatematika Dalam Meningkatkan Motivasi Belajar Di Era New Normal." *Jurnal Educatio FKIP UNMA* 8(3):1128–34. doi: 10.31949/educatio.v8i3.3123.

Disnawati, Hermina, and Selestina Nahak. 2019. "Pengembangan Lembar Kerja Siswa Berbasis Etnomatematika Tenun Timor Pada Materi Pola Bilangan." *Jurnal Elemen* 5(1):64–79. doi: 10.29408/jel.v5i1.1022.

Ernaningsih, Zeny. 2021. "Ethnomatematics In Typical Crafts Of Kulon Progo, Daerah Istimewa Yogyakarta." *Daya Matematis : Jurnal Inovasi Pendidikan Matematika* 9(1):17–27. doi: 10.26858/jdm.v9i1.16322.

Faqih, Ahmad, Odi Nurdiawan, and Andi Setiawan. 2021. "Pengembangan Media Pembelajaran Multimedia Interaktif Alat Masak Tradisional Berbasis Etnomatematika." *Mosharafa: Jurnal Pendidikan Matematika* 10(2):301–10. doi: 10.31980/mosharafa.v10i2.876.

Fatkhurohman, Annis Deshinta Ayuningtyas, Muchamad Subali Noto, and Sri Adi

Widodo. 2021. "Etnomathematics: Exploration of Geblek Renteng Batik in Transformation Geometry." *Numerical: Jurnal Matematika Dan Pendidikan Matematika* 5(2):79–90. doi: 10.25217/numerical.v5i2.1506.

Fauzi, Asri, and Heri Setiawan. 2020. "ETNOMATEMATIKA: KONSEP GEOMETRI PADA KERAJINAN TRADISIONAL SASAK DALAM PEMBELAJARAN MATEMATIKA DI SEKOLAH DASAR." *Didaktis: Jurnal Pendidikan Dan Ilmu Pengetahuan* 20(2):118–28. doi: https://doi.org/10.30651/didaktis.v20i2.4690.

Febrina, Fira, Ahma Fauzan, Elita Zusti Jamaan, and Arnelis Arneli. 2022. "Pengembangan Perangkat Pembelajaran Terintegrasi Etnomatematika Permainan Congklak Materi Operasi Hitung Pada Peserta Didik Kelas II SD/MI." *JEMS (Jurnal Edukasi Matematika Dan Sains)* 10(1):157–63. doi: 10.25273/jems.v10i1.12035.

Fitriani, Nelly, and Euis Eti Rohaeti. 2020. "Miskonsepsi Siswa Pada Materi Geometri Di Tingkat Sekolah Menengah Pertama." *Teorema: Teori Dan Riset Matematika* 5(1):9–16. doi: 10.25157/teorema.v5i1.3267.

Geiger, Vince, Merrilyn Goos, and Helen Forgasz. 2015. "A Rich Interpretation of Numeracy for the 21st Century: A Survey of the State of the Field." *ZDM* 47(4):531–48. doi: 10.1007/s11858-015-0708-1.

Gravemeijer, KPE. 1994. "Developing Realistic Mathematics Education." *Developing Realistic Mathematics Education* 222.

Hake, R. R. 1999. "ANALYZING CHANGE/GAIN SCORES." 1–4.

Hartindya, Rizkhy Permata, Sunardi Sunardi, and Nanik Yuliati. 2022. "PENGEMBANGAN PERANGKAT PEMBELAJARAN BERORIENTASI ETNOMATEMATIKA BATIK NUSANTARA MATERI TRANSFORMASI GEOMETRI TERHADAP KETERAMPILAN BERPIKIR TINGKAT TINGGI." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 11(3):2257–68. doi: https://doi.org/10.24127/ajpm.v11i3.5775.

Hisni, Muhammad, Hidayah Ansori, and Asdini Sari. 2022. "Pengembangan Lembar Kerja Peserta Didik Berbasis Etnomatematika Budaya Banjar Materi Bangun Ruang Sisi Datar." *Jurmadikta (Jurnal Mahasiswa Pendidikan Matematika)* 2(1):23–30. doi: 10.20527/jurmadikta.v2i1.1218.

Hmelo-Silver, C. E. 2004. "Problem-Based Learning: An Instructional Model and Its Constructivist Framework. In D. H. Jonassen (Ed.)." *Handbook of Research on Educational Communications and Technology* 235–67.

Huang, Hsin-Mei E., and Klaus G. Witz. 2011. "Developing Children's Conceptual Understanding of Area Measurement: A Curriculum and Teaching Experiment." *Learning and Instruction* 21(1):1–13. doi: https://doi.org/10.1016/j.learninstruc.2009.09.002.

Ika Krisdiana, Titin Masfingatin, Wasilatul Murtaifiah, Febriana Nor Fadhilla, and Gerald DG. Mabuti. 2025. "Uncovering Mathematical Activities and Concepts in Batik Pendekar of Madiun City through the Lens of Ethnomathematics."

Jurnal Elemen 11(3):630–47. doi: 10.29408/jel.v11i3.29982.

Manoy, Janet Trineke, and Mayang Purbaningrum. 2021. "Mathematical Literacy Based on Ethnomathematics of Batik Sidoarjo." *Jurnal Didaktik Matematika* 8(2):160–74. doi: 10.24815/jdm.v8i2.21644.

Masamah, Ulfa. 2018. "PENGEMBANGAN PEMBELAJARAN MATEMATIKA DENGAN PENDEKATAN ETNOMATEMATIKA BERBASIS BUDAYA LOKAL KUDUS." *Jurnal Pendidikan Matematika* 1(2):123–44. doi: http://dx.doi.org/10.21043/jpm.v1i2.4882.

Muhammad, Azamul Fadhly Noor, Marsigit Marsigit, and Soeharto Soeharto. 2021. "Konsep Luas Daerah Bangun Datar Sederhana Melalui Artefak Candi Borobudur Untuk Matematika Sekolah Dasar." *Ethnomathematics Journal* 2(2):43–50. doi: 10.21831/ej.v2i2.39885.

Nopianda, Wiwi, Dina Octaria, and Tika Dwi Nopriyanti. 2023. "PENGEMBANGAN LKPD BERBASIS ETNOMATEMATIKA MATERI BANGUN RUANG SISI DATAR UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KRITIS Wiwi." *Nabla Dewantara: Jurnal Pendidikan Matematika* 8(2):58–73. doi: https://doi.org/10.51517/nabla.v8i2.262.

OECD. 2019. *PISA 2018 Assessment and Analytical Framework*. PISA. Paris: OECD Publishing.

Orey, D. C., and M. Rosa. 2021. "Ethnomodelling as a Glocalization Process of Mathematical Practices through Cultural Dynamism." *The Mathematics Enthusiast* 18(3):439–68.

Prahmana, Rully Charitas Indra, and Ubiratan D'Ambrosio. 2020. "Learning Geometry and Values from Patterns: Ethnomathematics on the Batik Patterns of Yogyakarta, Indonesia." *Journal on Mathematics Education* 11(3):439–56. doi: 10.22342/jme.11.3.12949.439-456.

Rahmawati, Dessy, Duano Sapta Nusantara, and Rohati Rohati. 2026. "Mapping the Landscape of Ethnomathematics in Mathematics Education: Trends, Pedagogical Designs, and Future Directions." *Jurnal Pendidikan Matematika (Kudus)* 9(1):73. doi: 10.21043/jpmk.v9i1.35240.

Rahmi, Agusti, Anna Cesaria, and Ainil Mardiyah. 2023. "Validitas Lembar Kerja Peserta Didik (Lkpd) Berbasis Realistic Mathematics Education (Rme) Pada Materi Aritmatika Sosial Validity of Student Work Sheet (Lkpd) Based on Realistic Mathematics Education (Rme) on Social Arithmetic Materials." *JURNAL PEMBELAJARAN DAN MATEMATIKA SIGMA (JPMS)* 9(2):163–71. doi: https://doi.org/10.36987/jpms.v9i2.4683.

Rosa, Milton, and Daniel Orey. 2011. "Ethnomathematics: The Cultural Aspects of Mathematics." *Revista Latinoamericana de Etnomatemática* 4(2):32–54.

Savery, J. R. 2006. "Overview of Problem-Based Learning: Definitions and Distinctions." *Interdisciplinary Journal of Problem-Based Learning* 1(1):9–20. doi: https://doi.org/10.7771/1541-5015.1002.

Suhartini, Suhartini, and Adhetia Martyanti. 2017. "Meningkatkan Kemampuan Berpikir Kritis Pada Pembelajaran Geometri Berbasis Etnomatematika." *Jurnal Gantang* 2(2):105–11. doi: 10.31629/jg.v2i2.198.

Sunzuma, Gladys, and Uba Umbara. 2025. "Ethnomathematics-Based Technology in Indonesia: A Systematic Review." *Asian Journal for Mathematics Education* 4(1):129–53. doi: 10.1177/27527263241305812.

Suparman, Suparman, Maximus Tamur, Yunita Yunita, Tommy Tanu Wijaya, and Syaharuddin Syaharuddin. 2021. "Using Problem-Based Learning to Enhance Mathematical Abilities of Primary School Students: A Systematic Review and Meta-Analysis." *JTAM (Jurnal Teori Dan Aplikasi Matematika)* 5(1):144. doi: 10.31764/jtam.v5i1.3806.

Tavakol, M., and R. Dennick. 2011. "Making Sense of Cronbach's Alpha." *Int J Med Educ* 2:53–55. doi: 10.5116/ijme.4dfb.8dfd.

Treffers, Adrian. 1987. *Three Dimensions: A Model of Goal and Theory Description in Mathematics Instruction—the Wiskobas Project.* Dordrecht, Netherlands: D Reidel Publishing Co.

Ubiratan D'Ambrosio. 2001. *Educação Matemática - Elo Entre as Tradições e a Modernidade*.

Vu, Tuong Van, Lucía Magis-Weinberg, Brenda R. J. Jansen, Nienke van Atteveldt, Tieme W. P. Janssen, Nikki C. Lee, Han L. J. van der Maas, Maartje E. J. Raijmakers, Maien S. M. Sachisthal, and Martijn Meeter. 2022. *Motivation-Achievement Cycles in Learning: A Literature Review and Research Agenda*. Vol. 34. Educational Psychology Review.

Waluyo, Edy, and Nuraini Nuraini. 2021. "Analisis Kesulitan Belajar Matematika Siswa Materi Bangun Datar Sekolah Menengah Pertama." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 10(2):1273. doi: 10.24127/ajpm.v10i2.3586.

Wulandari, Diana Ayu, and Yaya Sukjaya Kusumah. 2022. "Eksplorasi Konseptual Matematis Pada Batik Trusmi Khas Cirebon Ditinjau Dari Aspek Etnomatematika." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 11(4):3556. doi: 10.24127/ajpm.v11i4.6171.

Yosafat Ardian Kristiarta, Wahyu Setyaningrum, and Marsigit. 2023. "Problem Solving Approach Based on Blended Learning on Trigonometric Comparison of Right Triangles on Mathematical Concept Understanding Ability." *Journal for Lesson and Learning Studies* 6(3):516–26. doi: 10.23887/jlls.v6i3.67275.

Yudianto, Erfan, Susanto Susanto, and Sinta Priciliya. 2020. "Etnomatematika Pada Batik Lukis Daun Singkong Di Rumah Produksi Daweea Batik Bondowoso." *Jurnal Elemen* 6(2):199–210. doi: 10.29408/jel.v6i2.2002.

Anderson-Cook, Christine M. 2005. "Experimental and Quasi-Experimental Designs for Generalized Causal Inference." *Journal of the American Statistical Association* 100(470):708. doi: 10.1198/jasa.2005.s22.

Arnelis, Fira Febrina; Ahmad Fauzan; Elita Zusti Jamaan; Arnelis. 2022.

"Pengembangan Perangkat Pembelajaran Terintegrasi Etnomatematika Permainan Congklak Materi Operasi Hitung Pada Peserta Didik Kelas II SD/MI." *JEMS: Jurnal Edukasi Matematika Dan Sains* (Vol 10, No 1 (2022)):157–63.

Artigue, Michèle, and Peter Baptist. 2012. "Inquiry in Mathematics Education." *The Fibonacci Project*.

Ayari, Mohamed Arselene, Abdellatif Sellami, Malavika E. Santhosh, Khalid Kamal Naji, Abdulla Al-Ali, and Saleh Mohammad Ali Al-Hazbi. 2025. "From Problems to Performance: A Systematic Review of Problem-Based Learning in K-12 Mathematics." *Frontiers in Education* Volume 10. doi: 10.3389/feduc.2025.1731307.

Ayuningtyas, Annis Deshinta, and Dafid Slamet Setiana. 2019. "Pengembangan Bahan Ajar Matematika Berbasis Etnomatematika Kraton Yogyakarta." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 8(1):11–19. doi: 10.24127/ajpm.v8i1.1630.

Barton, Bill. 1996. "Making Sense of Ethnomathematics: Ethnomathematics Is Making Sense." *Educational Studies in Mathematics* 31(1):201–33. doi: 10.1007/BF00143932.

Branch, R. M. 2009. *Instructional Design: The ADDIE Approach*. New York: Springer Science+Business Media / Springer US.

Clements, Douglas H., and Michael T. Battista. 1992. "Geometry and Spatial Reasoning." Pp. 420–64 in *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics.* New York, NY, England: Macmillan Publishing Co, Inc.

Clements, Douglas H., and Michael T. Battista. 2006. "Geometry and Spatial Reasoning" edited by D. A. Grouws. *Handbook of Research on Mathematics Teaching and Learning: A Project of the National Council of Teachers of Mathematics* 420–64.

D'Ambrosio, U. 2020. "An Essay on Philosophy, Mathematics and Culture." *Revista Pesquisa Qualitativa* 8(18):571–94.

D'Ambrosio Ubiratan, and Rully Charitas Indra Prahmana. 2020. "Mempelajari Geometri Dan Nilai Dari Pola: Etnomatematika Pada Pola Batik Yogyakarta, Indonesia." *Jurnal Pendidikan Matematika* 11(3):439–56.

Dewi, L. Intan Puspa, I. .. G. N. Yudi Hartawan, and I. N. Sukajaya. 2019. "Etnomatematika Dalam Tari Bali Ditinjau Dari Klasifikasi Tari Bali." *Jurnal Pendidikan Dan Pembelajaran Matematika Indonesia* 8(1):39–48.

Dinata, Pranita Marta, Anggit Grahito Wicaksono, and Ema Butsi Prihastari. 2022. "Efektivitas LKPD Berbasis Etnomatematika Dalam Meningkatkan Motivasi Belajar Di Era New Normal." *Jurnal Educatio FKIP UNMA* 8(3):1128–34. doi: 10.31949/educatio.v8i3.3123.

Disnawati, Hermina, and Selestina Nahak. 2019. "Pengembangan Lembar Kerja Siswa Berbasis Etnomatematika Tenun Timor Pada Materi Pola Bilangan."

Jurnal Elemen 5(1):64–79. doi: 10.29408/jel.v5i1.1022.

Ernaningsih, Zeny. 2021. "Ethnomatematics In Typical Crafts Of Kulon Progo, Daerah Istimewa Yogyakarta." *Daya Matematis : Jurnal Inovasi Pendidikan Matematika* 9(1):17–27. doi: 10.26858/jdm.v9i1.16322.

Faqih, Ahmad, Odi Nurdiawan, and Andi Setiawan. 2021. "Pengembangan Media Pembelajaran Multimedia Interaktif Alat Masak Tradisional Berbasis Etnomatematika." *Mosharafa: Jurnal Pendidikan Matematika* 10(2):301–10. doi: 10.31980/mosharafa.v10i2.876.

Fatkhurohman, Annis Deshinta Ayuningtyas, Muchamad Subali Noto, and Sri Adi Widodo. 2021. "Etnomathematics: Exploration of Geblek Renteng Batik in Transformation Geometry." *Numerical: Jurnal Matematika Dan Pendidikan Matematika* 5(2):79–90. doi: 10.25217/numerical.v5i2.1506.

Fauzi, Asri, and Heri Setiawan. 2020. "ETNOMATEMATIKA: KONSEP GEOMETRI PADA KERAJINAN TRADISIONAL SASAK DALAM PEMBELAJARAN MATEMATIKA DI SEKOLAH DASAR." *Didaktis: Jurnal Pendidikan Dan Ilmu Pengetahuan* 20(2):118–28. doi: https://doi.org/10.30651/didaktis.v20i2.4690.

Febrina, Fira, Ahma Fauzan, Elita Zusti Jamaan, and Arnelis Arneli. 2022. "Pengembangan Perangkat Pembelajaran Terintegrasi Etnomatematika Permainan Congklak Materi Operasi Hitung Pada Peserta Didik Kelas II SD/MI." *JEMS (Jurnal Edukasi Matematika Dan Sains)* 10(1):157–63. doi: 10.25273/jems.v10i1.12035.

Fitriani, Nelly, and Euis Eti Rohaeti. 2020. "Miskonsepsi Siswa Pada Materi Geometri Di Tingkat Sekolah Menengah Pertama." *Teorema: Teori Dan Riset Matematika* 5(1):9–16. doi: 10.25157/teorema.v5i1.3267.

Geiger, Vince, Merrilyn Goos, and Helen Forgasz. 2015. "A Rich Interpretation of Numeracy for the 21st Century: A Survey of the State of the Field." *ZDM* 47(4):531–48. doi: 10.1007/s11858-015-0708-1.

Gravemeijer, KPE. 1994. "Developing Realistic Mathematics Education." *Developing Realistic Mathematics Education* 222.

Hake, R. R. 1999. "ANALYZING CHANGE/GAIN SCORES." 1–4.

Hartindya, Rizkhy Permata, Sunardi Sunardi, and Nanik Yuliati. 2022. "PENGEMBANGAN PERANGKAT PEMBELAJARAN BERORIENTASI ETNOMATEMATIKA BATIK NUSANTARA MATERI TRANSFORMASI GEOMETRI TERHADAP KETERAMPILAN BERPIKIR TINGKAT TINGGI." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 11(3):2257–68. doi: https://doi.org/10.24127/ajpm.v11i3.5775.

Hisni, Muhammad, Hidayah Ansori, and Asdini Sari. 2022. "Pengembangan Lembar Kerja Peserta Didik Berbasis Etnomatematika Budaya Banjar Materi Bangun Ruang Sisi Datar." *Jurmadikta (Jurnal Mahasiswa Pendidikan Matematika)* 2(1):23–30. doi: 10.20527/jurmadikta.v2i1.1218.

Hmelo-Silver, C. E. 2004. "Problem-Based Learning: An Instructional Model and

Its Constructivist Framework. In D. H. Jonassen (Ed.)." *Handbook of Research on Educational Communications and Technology* 235–67.

Huang, Hsin-Mei E., and Klaus G. Witz. 2011. "Developing Children's Conceptual Understanding of Area Measurement: A Curriculum and Teaching Experiment." *Learning and Instruction* 21(1):1–13. doi: https://doi.org/10.1016/j.learninstruc.2009.09.002.

Ika Krisdiana, Titin Masfingatin, Wasilatul Murtaifiah, Febriana Nor Fadhilla, and Gerald DG. Mabuti. 2025. "Uncovering Mathematical Activities and Concepts in Batik Pendekar of Madiun City through the Lens of Ethnomathematics." *Jurnal Elemen* 11(3):630–47. doi: 10.29408/jel.v11i3.29982.

Manoy, Janet Trineke, and Mayang Purbaningrum. 2021. "Mathematical Literacy Based on Ethnomathematics of Batik Sidoarjo." *Jurnal Didaktik Matematika* 8(2):160–74. doi: 10.24815/jdm.v8i2.21644.

Masamah, Ulfa. 2018. "PENGEMBANGAN PEMBELAJARAN MATEMATIKA DENGAN PENDEKATAN ETNOMATEMATIKA BERBASIS BUDAYA LOKAL KUDUS." *Jurnal Pendidikan Matematika* 1(2):123–44. doi: http://dx.doi.org/10.21043/jpm.v1i2.4882.

Muhammad, Azamul Fadhly Noor, Marsigit Marsigit, and Soeharto Soeharto. 2021. "Konsep Luas Daerah Bangun Datar Sederhana Melalui Artefak Candi Borobudur Untuk Matematika Sekolah Dasar." *Ethnomathematics Journal* 2(2):43–50. doi: 10.21831/ej.v2i2.39885.

Nopianda, Wiwi, Dina Octaria, and Tika Dwi Nopriyanti. 2023. "PENGEMBANGAN LKPD BERBASIS ETNOMATEMATIKA MATERI BANGUN RUANG SISI DATAR UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KRITIS Wiwi." *Nabla Dewantara: Jurnal Pendidikan Matematika* 8(2):58–73. doi: https://doi.org/10.51517/nabla.v8i2.262.

OECD. 2019. *PISA 2018 Assessment and Analytical Framework*. PISA. Paris: OECD Publishing.

Orey, D. C., and M. Rosa. 2021. "Ethnomodelling as a Glocalization Process of Mathematical Practices through Cultural Dynamism." *The Mathematics Enthusiast* 18(3):439–68.

Prahmana, Rully Charitas Indra, and Ubiratan D'Ambrosio. 2020. "Learning Geometry and Values from Patterns: Ethnomathematics on the Batik Patterns of Yogyakarta, Indonesia." *Journal on Mathematics Education* 11(3):439–56. doi: 10.22342/jme.11.3.12949.439-456.

Rahmawati, Dessy, Duano Sapta Nusantara, and Rohati Rohati. 2026. "Mapping the Landscape of Ethnomathematics in Mathematics Education: Trends, Pedagogical Designs, and Future Directions." *Jurnal Pendidikan Matematika (Kudus)* 9(1):73. doi: 10.21043/jpmk.v9i1.35240.

Rahmi, Agusti, Anna Cesaria, and Ainil Mardiyah. 2023. "Validitas Lembar Kerja Peserta Didik (Lkpd) Berbasis Realistic Mathematics Education (Rme) Pada

Materi Aritmatika Sosial Validity of Student Work Sheet (Lkpd) Based on Realistic Mathematics Education (Rme) on Social Arithmetic Materials." *JURNAL PEMBELAJARAN DAN MATEMATIKA SIGMA (JPMS)* 9(2):163–71. doi: https://doi.org/10.36987/jpms.v9i2.4683.

Rosa, Milton, and Daniel Orey. 2011. "Ethnomathematics: The Cultural Aspects of Mathematics." *Revista Latinoamericana de Etnomatemática* 4(2):32–54.

Savery, J. R. 2006. "Overview of Problem-Based Learning: Definitions and Distinctions." *Interdisciplinary Journal of Problem-Based Learning* 1(1):9–20. doi: https://doi.org/10.7771/1541-5015.1002.

Suhartini, Suhartini, and Adhetia Martyanti. 2017. "Meningkatkan Kemampuan Berpikir Kritis Pada Pembelajaran Geometri Berbasis Etnomatematika." *Jurnal Gantang* 2(2):105–11. doi: 10.31629/jg.v2i2.198.

Sunzuma, Gladys, and Uba Umbara. 2025. "Ethnomathematics-Based Technology in Indonesia: A Systematic Review." *Asian Journal for Mathematics Education* 4(1):129–53. doi: 10.1177/27527263241305812.

Suparman, Suparman, Maximus Tamur, Yunita Yunita, Tommy Tanu Wijaya, and Syaharuddin Syaharuddin. 2021. "Using Problem-Based Learning to Enhance Mathematical Abilities of Primary School Students: A Systematic Review and Meta-Analysis." *JTAM (Jurnal Teori Dan Aplikasi Matematika)* 5(1):144. doi: 10.31764/jtam.v5i1.3806.

Tavakol, M., and R. Dennick. 2011. "Making Sense of Cronbach's Alpha." *Int J Med Educ* 2:53–55. doi: 10.5116/ijme.4dfb.8dfd.

Treffers, Adrian. 1987. *Three Dimensions: A Model of Goal and Theory Description in Mathematics Instruction—the Wiskobas Project.* Dordrecht, Netherlands: D Reidel Publishing Co.

Ubiratan D'Ambrosio. 2001. *Educação Matemática - Elo Entre as Tradições e a Modernidade*.

Vu, Tuong Van, Lucía Magis-Weinberg, Brenda R. J. Jansen, Nienke van Atteveldt, Tieme W. P. Janssen, Nikki C. Lee, Han L. J. van der Maas, Maartje E. J. Raijmakers, Maien S. M. Sachisthal, and Martijn Meeter. 2022. *Motivation-Achievement Cycles in Learning: A Literature Review and Research Agenda*. Vol. 34. Educational Psychology Review.

Waluyo, Edy, and Nuraini Nuraini. 2021. "Analisis Kesulitan Belajar Matematika Siswa Materi Bangun Datar Sekolah Menengah Pertama." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 10(2):1273. doi: 10.24127/ajpm.v10i2.3586.

Wulandari, Diana Ayu, and Yaya Sukjaya Kusumah. 2022. "Eksplorasi Konseptual Matematis Pada Batik Trusmi Khas Cirebon Ditinjau Dari Aspek Etnomatematika." *AKSIOMA: Jurnal Program Studi Pendidikan Matematika* 11(4):3556. doi: 10.24127/ajpm.v11i4.6171.

Yosafat Ardian Kristiarta, Wahyu Setyaningrum, and Marsigit. 2023. "Problem Solving Approach Based on Blended Learning on Trigonometric Comparison

of Right Triangles on Mathematical Concept Understanding Ability." *Journal for Lesson and Learning Studies* 6(3):516–26. doi: 10.23887/jlls.v6i3.67275.

Yudianto, Erfan, Susanto Susanto, and Sinta Priciliya. 2020. "Etnomatematika Pada Batik Lukis Daun Singkong Di Rumah Produksi Daweea Batik Bondowoso." *Jurnal Elemen* 6(2):199–210. doi: 10.29408/jel.v6i2.2002.