

Development of Ethnomathematics-Based Numeracy Literacy Questions in Peci Tapis Lampung

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ABSTRACT

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The low contextual relevance of conventional mathematics learning materials often results in limited student engagement and understanding, especially in diverse cultural settings. To address this gap, this study aims to develop valid, practical, and effective ethnomathematics-based numeracy literacy questions by integrating the cultural elements of Peci Tapis Lampung into mathematics instruction. The research employed a Research and Development (R&D) method using the 4D model (Define, Design, Develop, Disseminate). In the development phase, the questions were validated by four experts in material, design, and assessment using expert validation sheets. Student responses were measured through a practicality questionnaire. Quantitative data from expert validation were analyzed using descriptive statistics to determine the validity level, while student response data were processed to assess practicality. The validation results indicated that the questions were "Very Valid" with a score of 84%, and student responses revealed a practicality level of 83.75%, categorized as "Very Practical". Additionally, the normalized gain (N-Gain) was calculated at 61.03%, indicating a "High" effectiveness level in improving students' numeracy literacy. These findings suggest that incorporating local cultural contexts into numeracy literacy can enhance the meaningfulness of mathematical learning and foster a greater appreciation for regional heritage. The ethnomathematics approach, therefore, offers a promising strategy for creating culturally responsive mathematics education.



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A. INTRODUCTION

Numeracy literacy is one of the basic competencies that is very important for students to master in facing global challenges (Aini et al., 2024; Tenny et al., 2021). Numerical literacy is not only limited to skills in performing mathematical calculations, but also includes the ability to think logically, solve problems, and apply numeracy concepts in various daily life contexts (Pangesti, 2018). In Indonesia, the results of evaluations such as PISA (Programme for International Student Assessment) and AKSI (Indonesian Student Competency Assessment) show that the level of numeracy literacy of students is still below average (Kemendikbud, 2023; Schleicher, 2019; Stacey, 2015). This condition shows an urgent need for a more contextual and culturally relevant approach to mathematics education.

The concept of ethnomathematics has emerged as a potential innovation to address the limitations of conventional mathematics learning. Ethnomathematics refers to the study of the relationship between mathematics and culture, where mathematical ideas are drawn from cultural practices and artifacts (Achilla, 2024; Pratiwi et al., 2022; Rawani & Fitra, 2022). This

approach seeks to increase the relevance of mathematics by connecting it with students' social and cultural experiences (Ashari, 2024; Cervantes-Barraza & Araujo, 2023; Cesaria et al., 2022; Khan & Rizvi, 2024). Especially in multicultural contexts, ethnomathematics helps bridge the gap between abstract concepts and students' lived realities (Bhuda, 2024; Ergene et al., 2020; Ilma & Usodo, 2024; Putra, 2024).

The challenge that arises is how to develop numeracy literacy questions that are relevant to local culture, especially Peci Tapis Lampung. Many of the questions taught in schools are still conventional and do not reflect local wisdom. Therefore, it is necessary to develop ethnomathematics-based numeracy literacy questions that can enrich learning. The potential of ethnomathematics continues to grow, supported by modern technology such as ethnomathematics-based learning apps that increase student engagement (Isa et al., 2024; Johnson et al., 2022; Supriyadi et al., 2024). In addition, analytical tools like Vosviewer help map ethnomathematical research trends, with a focus on themes such as culture-based geometry and numeracy literacy (De Matos Gondim, 2020). One of the approaches that holds great potential to enhance students' numeracy literacy is ethnomathematics, which involves mathematical concepts derived from local cultural practices (Endu et al., 2024; Surat, 2018; Utama et al., 2023). Ethnomathematics enables students to connect abstract mathematical ideas with real-life cultural contexts, thereby making learning more meaningful and accessible. In this regard, Lampung, as one of the culturally rich provinces in Indonesia, offers valuable resources for such an approach.

Lampung's cultural heritage includes customary numerical systems, symmetrical and geometric motifs in traditional arts, and other local practices that align well with core concepts in numeracy (Franjaya et al., 2023; Rezky et al., 2022; Utama et al., 2023). However, despite the richness of these traditions, efforts to integrate them into mathematics learning, particularly to improve numeracy literacy, remain very limited. Current educational practices still tend to rely on conventional learning materials that lack cultural relevance and contextual depth. Therefore, it is necessary to design learning tools that incorporate local cultural elements into the mathematics curriculum in a structured and measurable way.

Several studies have explored ethnomathematical elements in various aspects of Lampung culture. These include ethnomathematics on the Siger Tower Marian & Saputra (2023), culture-based mathematical activities Rakhmawati (2016), tapis fabric as a learning resource Dewi et al. (2019), and ethnomathematical patterns in traditional houses and clothing (Khasanah et al., 2021; Larasaty & Arisetyawan, 2021; Loviana et al., 2020). Other research has investigated traditional games Merliza (2021), gemisegh realm practices Riswati et al. (2021), batik motif applications Sutrisno & Saija (2021), and comprehensive literature reviews on traditional attributes Amanda & Putra (2022) and Pepadun culture (Dinata & Junaidi, 2022). Although these studies provide valuable insights, they are largely descriptive or exploratory and have not resulted in the development of structured assessment instruments for numeracy literacy based on ethnomathematical concepts.

In response to the identified gap, this study focuses on developing numeracy literacy questions grounded in the ethnomathematical characteristics of Lampung culture, particularly the Peci Tapis. These traditional hats feature rich mathematical representations, including symmetrical and repetitive geometric patterns that align with key numeracy concepts such as

symmetry and number sequences. The novelty of this study lies in constructing questions that not only assess students' mathematical abilities but also cultivate their understanding and appreciation of local culture. The developed questions incorporate authentic cultural contexts such as the patterns found in Peci Tapis and the geometric designs of traditional Lampung houses. This approach is expected to provide a more meaningful and relevant learning experience while contributing to the preservation of regional cultural values.

Based on the background described, this study focuses on the development of numeracy literacy questions that serve a dual purpose: to assess students' mathematical abilities in contextual situations and to enhance their understanding of local culture. Specifically, this research aims to: (1) identify mathematical concepts embedded in the traditional design of Peci Tapis Lampung, such as geometric patterns and symmetry; and (2) develop a set of numeracy literacy questions based on the ethnomathematical concept of Peci Tapis Lampung that is valid, practical, and effective.

B. METHODS

1. Type of Research

This study employs a Research and Development (R&D) design aimed at producing a valid, practical, and effective set of ethnomathematics-based numeracy literacy questions grounded in local Lampung culture. The development model used is the 4D model proposed by Thiagarajan, Semmel, and Semmel, which consists of four stages: Define, Design, Develop, and Disseminate. Each stage was systematically implemented to ensure the validity, practicality, and cultural relevance of the instrument developed. The flow diagram of the development model is presented in Figure 1.



Figure 1. Modification of Teaching Material Development Model from 4D Model

2. Research Procedure

a. Define Stage

This stage involved a literature review and field observations to analyze the needs and contextual background for developing the instrument. Literature related to numeracy literacy, ethnomathematics, and Lampung cultural elements especially Peci Tapis was reviewed. Observations were also conducted to identify mathematical elements (e.g., symmetry, geometry, patterns) in Peci Tapis as the cultural basis for item development.

b. Design Stage

In this stage, a blueprint of the question items was created. It included the design of item formats, the development of grids linking indicators of numeracy literacy with cultural components, and the initial drafts of the test instruments. Practicality questionnaires and expert validation sheets were also prepared.

c. Develop Stage

This stage comprised three main cycles: validation by experts, limited testing with students, and iterative revisions. Validation: The instrument was validated by four

experts in the fields of material, assessment, learning design, and language. The type of validation used was content validation, aimed at ensuring content relevance, clarity, and cultural integration. Reliability Testing: The instrument's internal consistency was tested using Cronbach's Alpha coefficient. A coefficient value above 0.7 was considered acceptable for reliable instruments. Limited Trial: A limited trial was conducted on 10 Grade VIII students at SMP Negeri 1 Banjar Baru during the even semester of the 2024/2025 academic year. Student feedback was collected using a practicality questionnaire. Revisions: Comments from validators and students were used to revise question-wording, design layout, and cultural relevance in a stepwise fashion before finalization.

d. Disseminate Stage

The final product, having been declared valid and practical, was then disseminated through publication in journals, books, and social media.

3. Sample and Sampling Technique

The development research involved two phases of testing with different sample groups. The limited testing phase was conducted on 10 Grade VIII students from SMP Negeri 1 Banjar Baru during the even semester of the 2024/2025 academic year. This group was selected using purposive sampling, based on teacher recommendations, particularly students capable of providing constructive feedback on the readability and contextual relevance of the developed questions. The primary objective of this phase was to gather qualitative input for revising and refining the ethnomathematics-based numeracy literacy questions. To evaluate the effectiveness of the finalized questions, a wider testing phase was carried out with 25 Grade VIII students from the same school. This phase aimed to assess the impact of the developed questions on students' numeracy literacy performance through pretest and posttest comparisons.

4. Data Collection Instruments

Data were collected through several instruments designed to support different aspects of the research process. Expert validation sheets were used to assess the content validity of the developed questions, ensuring alignment with educational standards and cultural relevance. Observation sheets were employed to document student interactions and engagement during the trial phase. To evaluate the practicality of the instrument, student response questionnaires were administered, capturing feedback on clarity, interest, and usability. Additionally, item drafts and student response forms were gathered during the limited trials to facilitate empirical analysis of item performance.

5. Data Analysis

To analyze the validation of ethnomathematics-based numeracy literacy questions, the data were categorized by group and analyzed using a data processing formula that considered the entire item tested.

$$Percentage = \frac{\sum \text{Score given by the validator}}{\sum \text{Maximum score}} \times 100\%$$

Table 1. Decision-Making Process in the Revision of Numeracy Literacy Questions Based on Ethnomathematics.

Category	Rating (%)
Highly Valid	$80 < N \leq 100$
Valid	$60 < N \leq 80$
Quite Valid	$40 < N \leq 60$
Invalid	$20 < N \leq 40$
Highly Invalid	$0 < N \leq 20$

The results obtained will be compared with Table 1. For example, if the result is more than 80%, then the ethnomathematics-based numeracy literacy questions developed can be categorized as Very Valid and ready to be tested. However, if the results are not eligible, then the question needs to be revised based on criticism and suggestions from validators. Practicality data analysis was carried out using the formula for data mining per group of all items.

$$Percentage = \frac{\sum \text{Score given by the student}}{\sum \text{Maximum score}} \times 100\%$$

Table 2. Practicality Assessment Scale.

Category	Rating (%)
Very Practical	$80 < N \leq 100$
Practical	$60 < N \leq 80$
Quite Practical	$40 < N \leq 60$
Impractical	$20 < N \leq 40$
Very impractical	$0 < N \leq 20$

Based on Table 2, if the results obtained $> 80\%$, then the ethnomathematics-based numeracy literacy questions can be categorized as very practical so that they can be used as ethnomathematics-based numeracy literacy questions for students.

C. RESULT AND DISCUSSION

This research produces a valid and practical ethnomathematics-based numeracy literacy problem. The questions are designed in the context of local culture, such as the geometric patterns in Peci Tapis, which combine mathematical and cultural elements. The results of the trial showed an increase in students' understanding of mathematical concepts and appreciation of local culture. Here is a summary of the research results:

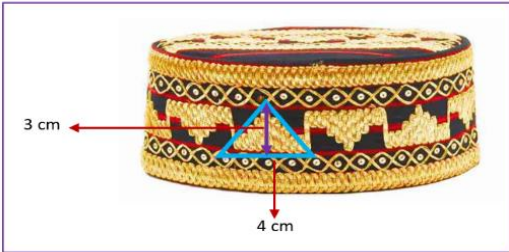
1. Define Stage

At the Define stage, the first step is to conduct a literature study to collect references related to ethnomathematics, numeracy literacy, and the local culture of Lampung, as well as conduct cultural observations to identify cultural elements relevant to the concept of numeracy, such as Peci Tapis Lampung, traditional house architecture, and calculation systems in Lampung customs. Furthermore, the formulation of aspects of numeracy and cultural context is carried out by developing a problem concept that integrates cultural elements, such as geometric patterns in Peci Tapis which are associated with the concept of symmetry and number patterns. The result of this stage is the realization of the basic concept of numeracy literacy questions based on Lampung ethnomathematics.

2. Design Stage

This stage is focused on the development of ethnomathematics-based numeracy literacy question instruments through steps that include designing questions and answer sheets, question grids, practicality questionnaires, and validation sheets. The question design is based on the findings of observation and literature studies, where numeracy literacy questions are arranged in the context of Lampung's local culture with varying levels of difficulty to measure students' ability in reasoning, problem-solving, and the application of mathematical concepts in daily life. The following is an example of a question at the *Design stage*, namely a question that has not gone through the expert validation stage, presented in Figure 2.

1.1 Perhatikan Gambar 2 di bawah ini dengan teliti!



Gambar 2. Motif bordir berbentuk segitiga pada Peci Tapis Lampung

Pada struktur Peci Tapis Lampung, terdapat pola segitiga yang berulang. Setiap segitiga memiliki alas sepanjang 4 cm dan tinggi 3 cm. Jika terdapat 14 segitiga yang mengelilingi peci dan biaya bordir untuk setiap segitiga sebesar Rp 5.000, hitunglah:

- Berapa luas keseluruhan dari semua segitiga?
- Berapa total biaya bordir untuk seluruh motif segitiga?

Figure 2. Example of Questions at the Design Stage.

Figure 2 presents an example of a numeracy literacy question developed in the Design stage before expert validation. The item integrates mathematical concepts such as symmetry and number patterns with cultural elements from Peci Tapis Lampung. Designed to promote contextual understanding, the question uses visual motifs to prompt students' reasoning within a culturally relevant context. This early version served as the foundation for further refinement based on expert feedback and student responses to ensure clarity, validity, and practical alignment with numeracy literacy goals.

3. Develop Stage

This stage is a crucial step in the development of the problem, the result of this stage is the realization of a valid and practical ethnomathematics-based numeracy literacy question instrument. Based on the results of the analysis, the instrument was revised to be more in line with students' abilities and more accurate in measuring ethnomathematics-based numeracy literacy. The results of this stage are question instruments that have been empirically tested and improved according to the results of the trial, with achievement indicators in the form of valid and practical ethnomathematics-based numeracy literacy questions. The data obtained from four validators consisted of material and design experts. Two material experts from UM Metro Mathematics Education, namely Mr. Ira Vahlia, M.Pd., and a teacher of SMP Negeri 1 Banjar Baru, Mr. Hendro Adio, M.Pd., while design experts consisting of Wardhani Utami Dewi, M.Si., and Dr. Siti Suprihatin, M.Pd. as many as 10 participants from junior high school namely SMP Negeri 1 Banjar Agung Class VIII Academic Year 2024/2025 were allowed to test the product. Data from the validation of material and design experts are shown in Table 3.

Table 3. Recapitulation of the Results of Validation of Material and Design Experts

Assessment Aspects	Total Score	Percentage (%)	Category
Material Expert	130	86,67%	Highly Valid
Design Expert	122	81,33%	Highly Valid
Average		84%	Highly Valid

Based on Table 3, shows the results of the validation of ethnomathematics-based numeracy literacy questions carried out by two groups of validators, namely material experts and design experts. From the material aspect, the question obtained a total score of 130, with a validity level of 86.67%, which is included in the "Very Valid" category. This shows that in substance, the questions have met the validity standards in measuring numeracy literacy based on local culture. Meanwhile, from the design aspect, the question obtained a score of 122, with a validity level of 81.33%, which was categorized as "Very Valid". Thus, the average validation result is 84% which is categorized as "Very Valid". This indicates that in terms of appearance and structure, the questions are quite good, although they can still be improved. With the results of this validation, the questions developed have met the criteria to be used in the trial for students. Data from the Results of the Student Response Questionnaire are displayed in Table 4.

Table 4. Results of the Student Response Questionnaire

No.	Subject	Score	Percentage (%)	Category
1	Student 1	60	75%	Practical
2	Student 2	65	81%	Practical
3	Student 3	70	88%	Very Practical
4	Student 4	75	94%	Practical
5	Student 5	75	94%	Practical
6	Student 6	60	75%	Very Practical
7	Student 7	70	88%	Very Practical
8	Student 8	60	75%	Very Practical
9	Student 9	70	88%	Very Practical
10	Student 10	65	81%	Practical
Total	–	670	83,75%	Very Practical

Based on Table 4, it shows the results of the questionnaire of students' responses to ethnomathematics-based numeracy literacy questions. Of the 10 students who were the subjects of the study, the scores obtained ranged from 60 to 75, with a percentage of practicality between 75% to 94%. Most of the participants gave a rating in the "Very Practical" category, with an overall average of 83.75%, which also falls into the "Very Practical" category. These results show that the problems developed are easy to use, relevant, and effective in helping students understand mathematical concepts through a cultural approach. Overall, the results of these two tables indicate that ethnomathematics-based numeracy literacy questions are valid and practical to be applied in learning, which is contextualized with local culture. Furthermore, several examples of the results of inputs from validators regarding the developed numeracy literacy questions are presented in Figure 3.

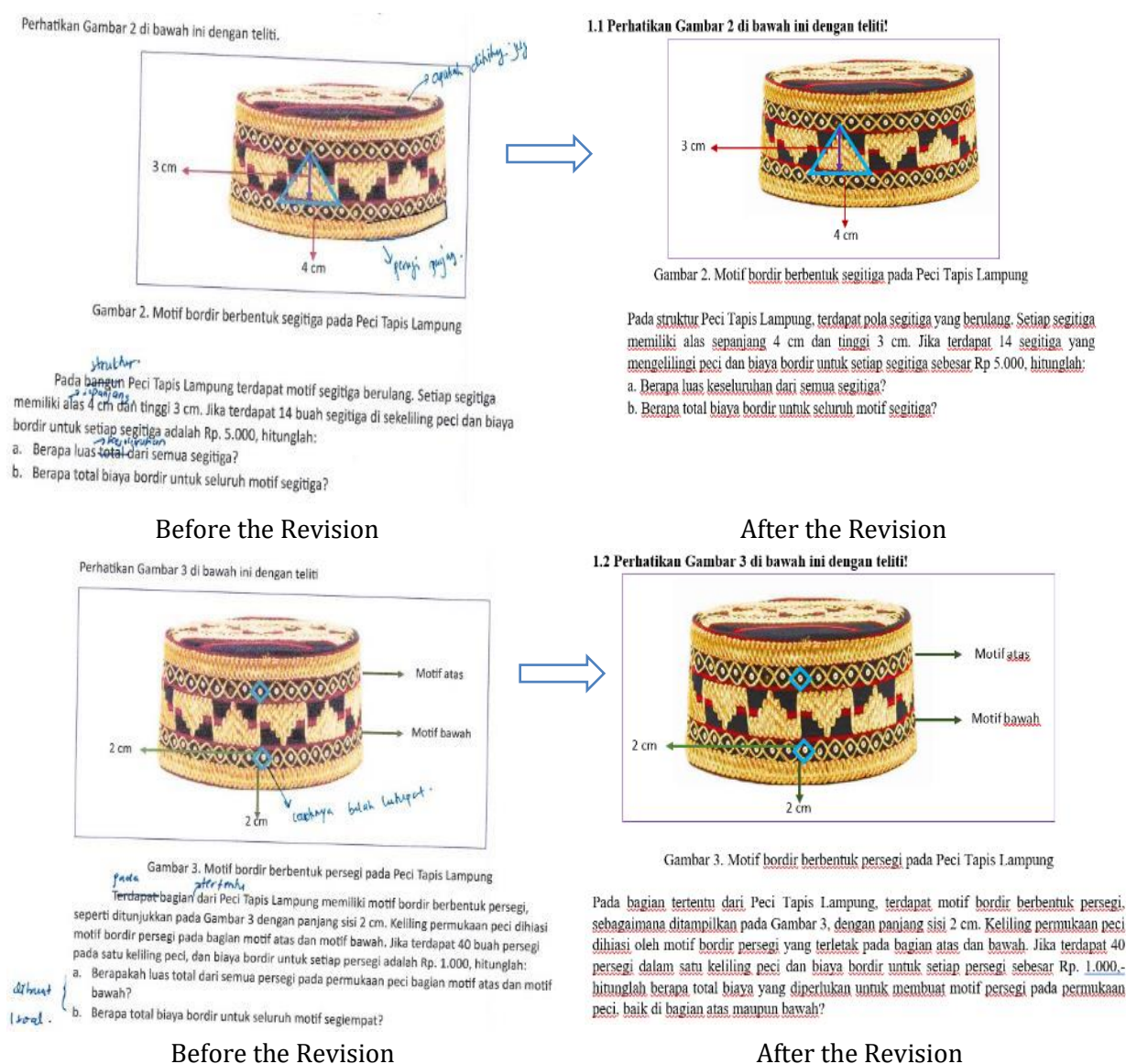


Figure 3. Numeracy Literacy Questions Before and After Revision.

Figure 3 shows a comparison of numeracy literacy questions before and after the revision process based on input from expert validators. The revisions focused on improving the clarity of language, accuracy of mathematical content, and the alignment of cultural elements specifically the patterns in Peci Tapis with the targeted numeracy indicators. Adjustments were made to ensure that the questions not only maintained cultural authenticity but also met pedagogical standards in terms of difficulty level and cognitive demand. These refinements were essential to enhance the validity and practicality of the instrument before implementation in the classroom.

To evaluate the effectiveness of the developed ethnomathematics-based numeracy literacy questions, a pretest and posttest design was implemented. The test instruments consisted of items that reflected key dimensions of numeracy literacy such as contextual problem solving, mathematical reasoning, and representation embedded within the cultural context of Peci Tapis Lampung. The results showed a substantial increase in student performance, as summarized in Table 5.

Table 5. Summary of Students' Numeracy Literacy N-Gains Score.

Category	Number of Students	Pretest Avg.	Posttest Avg.	Average N-Gain (%)	Category
Total	25	46.4	79.4	61.03	High

Based on Table 5, the average pretest score was 46.4, which increased to 79.4 in the posttest. The normalized gain (N-Gain) was calculated at 61.03%, which falls into the "High" category. These results indicate that the integration of local cultural elements in the developed questions not only enriches the learning experience but also effectively enhances students' numeracy literacy.

4. Disseminate Stage

At this stage, the questions that have been developed and tested are implemented more widely and the results of the research are disseminated. The first step is the use of question instruments in schools as part of the evaluation of students' numeracy literacy skills so that they can measure their effectiveness in the context of real learning. Furthermore, the results of the research are published in national and international scientific journals and presented in seminars or conferences to share findings and experiences in the development of ethnomathematics-based numeracy literacy questions.

The developed questions were evaluated based on material and design aspects to determine their overall validity. Validation involved assessing content accuracy, cultural relevance, clarity of language, and layout consistency. Through this process, validators provided both quantitative scores and qualitative feedback regarding the strengths and weaknesses of each item. Based on this input, several revisions were made to improve question formulation, enhance alignment with numeracy indicators, and ensure that the integration of Peci Tapis motifs effectively supported mathematical reasoning. These revised questions were then tested on students, with the trial results confirming that the final instrument achieved a high level of validity (84%), practicality (83.75%), the normalized gain (N-Gain) was calculated at 61.03%, which falls into the "High" category. These results indicate that the integration of

local cultural elements in the developed questions not only enriches the learning experience but also effectively enhances students' numeracy literacy.

Numeracy literacy is one of the main competencies that students must master in facing global challenges (Aini et al., 2024; Tenny et al., 2021). This ability not only includes mathematical calculations, but also involves problem-solving, logical reasoning, and the application of numeracy concepts in everyday life (Pangesti, 2018). Unfortunately, the results of PISA and AKSI show that the numeracy literacy level of Indonesian students is still below the international average (Schleicher, 2019; Stacey, 2011). Therefore, innovation is needed in mathematics learning to improve student understanding.

The ethnomathematical approach is an innovative alternative to mathematics learning that connects mathematical concepts with local culture (Achilla, 2024; Pratiwi et al., 2022; Rawani & Fitra, 2022). In this study, Lampung tapis peci is used as a learning medium to develop numeracy literacy questions. Cultural integration into learning is effective in increasing student motivation and understanding (Dewi et al., 2019; Marian & Saputra, 2023). This study complements previous studies that have examined ethnomathematics in siger towers, tapis cloth, traditional houses, and Lampung traditional clothing (Khasanah et al., 2021; Loviana et al., 2020; Riswati et al., 2021). This study adopts the Research and Development (R&D) method with a 4D development model: Define, Design, Develop, and Disseminate. In the Define stage, literature analysis and cultural observation were carried out to identify mathematical concepts in the Peci Tapis Lampung, such as symmetry, number patterns, and geometry. Phase Design includes the development of questions, and question grids that have considered the stage of Define.

The development stage involves the stage of validating the question set by involving expert validators from the field of mathematics education and local culture. The validity of the questions was verified which showed that the questions developed were included in the "Very Valid" category with a validity percentage of 84% (Table 3). Furthermore, the results of the test showed that ethnomathematics-based problems showed that this problem was included in the category of "very practical" with a percentage of 83.75% (Table 4). The normalized gain (N-Gain) was calculated at 61.03%, which falls into the "High" category (Tabel 5)

In the dissemination stage, the developed questions were shared through publication in scientific journals and introduced for limited use in schools as part of efforts to evaluate culture-based mathematics learning. This stage reinforces previous findings which highlight that integrating local cultural elements into mathematics instruction can foster more contextualized, engaging, and meaningful learning experiences for students (Amanda & Putra, 2022; Dinata & Junaidi, 2022; Sudirman et al., 2024; Wilches et al., 2023).

The results of this study confirm that the ethnomathematical approach is an effective alternative for enhancing students' numeracy literacy. By embedding mathematical concepts within culturally familiar contexts such as Peci Tapis Lampung, students were able to grasp abstract ideas such as symmetry, patterns, and geometry more intuitively. The significant increase in students' post-test scores and N-Gain results demonstrates how culturally responsive tasks can promote deeper understanding. These findings are in line with prior studies on culture-based geometry, which emphasize that traditional patterns like batik and carvings can serve as effective tools for teaching mathematical concepts (De Oliveira et al., 2023;

Kyeremeh et al., 2023). This study makes a new contribution to the development of culture-based numeracy literacy evaluation instruments, which have not been widely developed in Indonesia. However, this study still has some limitations, such as sample coverage that is limited to one school in Lampung. Therefore, further research is recommended to expand the implementation of this problem to different regions with different cultures. In addition, the development of a more systematic ethnomathematics-based learning model is also needed to increase the effectiveness of learning.

D. CONCLUSION AND SUGGESTIONS

This study shows that integrating local culture through an ethnomathematical approach can enhance the variety and contextual relevance of students' numeracy literacy questions. Utilizing Peci Tapis Lampung as a learning resource enables students to better understand mathematical concepts in a meaningful way. The developed questions achieved a "Very Valid" rating with a score of 84% based on expert validation. Student testing also indicated an improved understanding of concepts such as symmetry, number patterns, and geometry. Additionally, student feedback reflected a "Very Practical" rating with a score of 83.75%. The normalized gain (N-Gain) reached 61.03%, placing it in the "High" effectiveness category. This research integration of local cultural elements into the developed questions has been shown to not only make the learning experience more meaningful but also significantly improve students' numeracy literacy.

Based on the results of the research, several suggestions can be given. Future research is encouraged to explore the integration of other local cultures across Indonesia in the development of ethnomathematics-based learning materials. Expanding the scope of participants and conducting broader empirical trials will help validate the effectiveness of such approaches. Mathematics educators are advised to incorporate culture-based problems in classroom practices, supported by adequate training and resource development. Moreover, curriculum designers should consider integrating ethnomathematical perspectives into teaching modules and textbooks to foster more relevant and engaging learning environments.

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