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ETHNOMATHEMATICS POP-UP BOOK ON GEOMETRY IN TRADITIONAL LAMPUNG HOUSES

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Abstract

This study aims to develop an ethnomathematics-based pop-up book as a learning medium, integrating geometric concepts within the context of traditional Lampung houses, to enhance students' conceptual understanding of mathematics and to evaluate the responses of teachers and students as well as the effectiveness of the media. The research employed the Borg & Gall development model with seven steps: data collection, planning, initial draft development, preliminary testing, product revision, main field testing, and dissemination and implementation. Data were analyzed using qualitative and quantitative descriptive methods. Validation results indicated that the media fell into the "highly feasible" category, with a score of 90% from material and media experts. Small-scale testing received a "very interesting" response of 92%, while large-scale testing achieved a 94% positive response from 29 students. Improvement in conceptual understanding was evidenced by an N-Gain score of 0.89 (high category), and the media's effectiveness was shown by an effect size of 1.06 (effective category). The findings imply that the ethnomathematics-based pop-up book is effective in supporting culturally responsive mathematics learning and can serve as an innovative and contextual alternative learning medium.

Keywords: Ethnomathematics; Geometry; Pop-Up Book; Research and Development; Traditional Lampung Houses

INTRODUCTION

Mathematics instruction in schools continues to face various challenges (Vinnervik, 2022), particularly the limited access to educational media (Ramlah et al., 2022). This condition results in monotonous (Jumrah, 2025; Tang et al., 2022) and uninterested towards learning mathematics (Prasanna et al., 2023), ultimately leading to poor performance (Caviola et al., 2022) and limited conceptual understanding (Saha et al., 2024). To address these issues, innovation in the development of learning media is essential, one of which can be achieved through an ethnomathematics-based learning materials (Simbolon, 2024).

According to D'Ambrosio (1999), Ethnomathematics is a "program in history and epistemology with an intrinsic pedagogical action … .taking into account the cultural differences that have determined the cultural evolution of humankind and political dimensions of mathematics". Referring to the concept proposed by D'Ambrosio (1999), ethnomathematics in this study is defined as the integration of mathematical concepts with local cultural practices. In this research, the cultural context is represented by the geometry found in traditional Lampung houses, which is then developed into a pop-up book learning medium to support students' conceptual understanding of mathematics.

Ethnomathematics is a highly relevant approach because it connects mathematical concepts with local cultural contexts that are familiar to students. Ethnomathematics can introduce students to multicultural views of mathematics that challenge and strengthen the concepts and methods taught in mathematics classes (Batiibwe, 2024).

These cultural activities can offer significant and pertinent settings that promote learning and enhance learners'

proficiency in mathematics (Meaney et al., 2022). Its significance is further reflected in the academic field, as the keyword 'Ethnomathematics' is the most widely used in 43 publications indexed in Scopus (Pradana et al., 2022), indicating growing interest and recognition among researchers.

According to, According to Yanti (2025), by relating mathematical content to surrounding cultural practices, students can more easily comprehend abstract concepts through concrete examples. In the context of Lampung society, traditional houses represent cultural heritage rich in geometric elements. Some studies reveal that geometry is an essential element in the design of traditional houses (Riadi et al., 2025), such as pyramidal roofs, rectangular structures, and symmetrical carvings. These elements not only reflect cultural richness but also provide a natural bridge for integrates geometric concepts with cultural elements (Maharbid et al., 2025) through appropriately designed learning media.

In line with this perspective, Lampung traditional houses as learning objects not only enrich students' cultural knowledge but also introduce concrete and contextual representations of three-dimensional geometric shapes. When students recognize cubes, rectangular prisms, or pyramids within the structural elements of traditional houses, they are not merely learning geometry; they are also participating in the preservation of cultural heritage.

Consequently, mathematics learning becomes less abstract and disconnected from real-life situations (Schwarts et al., 2025), instead serving as a medium for strengthening cultural identity while improving mathematical literacy. Therefore, the need for learning media that can provide concrete and enjoyable learning experiences has become increasingly important so that the integration of culture and mathematics can be effectively accepted by students.

One innovative instructional medium that can be used to integrate geometric concepts with cultural elements is the pop-up book. This medium offers interactive (Cordray et al., 2022) and visually engaging three-dimensional visual effects (Gerasymenko & Li, 2025). The 3D visualizations help students better understand the concepts of solid figures (Angherayati & Witanto, 2024), without relying solely on abstract imagination. In addition, pop-up books can stimulate students' imagination (Nasution et al., 2025), strengthen memory retention (Sabrina & Akrima, 2025), and foster learning interest (Lisdayanti et al., 2025). These visual and interactive potentials make pop-up books a relevant alternative for presenting more concrete geometry learning, particularly in linking mathematical concepts to real-life contexts (Pradana et al., 2025a).

The results of an interview with a teacher at SMP Negeri 4 Bandar Lampung indicated that the instructional media used at the school remain limited to textbooks and instructional videos. The teacher reported that students continue to experience difficulties in understanding the material, including mathematics. The use of textbooks often fail to assist students develop their critical thinking abilities (Pradana et al., 2025b) and fail to establish meaningful connections to real-world situations (Noura et al., 2025). authority Questionnaire results distributed to eighth-grade students showed that 55% of them encountered challenges in learning mathematics; however, the majority expressed strong interest in the use of pop-up books in the learning process. These findings provide initial indications that the need for more varied instructional media has become increasingly urgent to help students better understand mathematical concepts.

This interest is further supported by additional questionnaire results showing that 85.1% of students reported needing and being interested in reading mathematics books in pop-up form. This data indicates that conventional instructional media are no longer effective, and students require new media that are more visual, contextual, and engaging to enhance their participation in the learning process. Therefore, the development of pop-up–based instructional media becomes highly relevant as an alternative capable of addressing students' current needs and preferences.

Previous studies by Halisah (2018) and Damaiyanti et al. (2021) have demonstrated that pop-up books are feasible for use as instructional media. Evaluations conducted

by various experts revealed high feasibility percentages in terms of media quality, content accuracy, language use, and student responses. However, none of these studies specifically developed an ethnomathematics-based pop-up book that incorporates local cultural elements, such as the traditional houses of Lampung. This condition indicates that although pop-up books have been proven effective, their utilization within regional cultural contexts has not yet been optimally explored. This represents the gap that the present study aims to address.

The gap in the development of instructional media lies in the absence of local cultural contexts as a foundation for mathematics learning. In fact, integrating ethnomathematics into instructional media not only enriches educational content but also enhances the relevance of learning to students' everyday lives. By incorporating local cultural values into the presentation of mathematical material, students gain learning experiences that are more meaningful and contextual. Therefore, it is necessary to develop media that can meet students' learning needs while simultaneously supporting the preservation of regional culture through an ethnomathematics-based approach.

In response to this need, the present study offers a novelty in the form of developing an ethnomathematics-based pop-up book that features Lampung traditional houses as the primary material in geometry instruction. the ethnomathematics-based pop-up book is designed by integrating geometric concepts with the architectural elements of traditional Lampung houses. Each page of the pop-up book presents three-dimensional visualizations of parts of the traditional house, such as the roof structure, pillars, stairs, and decorative ornaments, which represent various geometric concepts including triangles, rectangles, prisms, and symmetry.

Through interactive pop-up mechanisms, students can directly observe and explore the geometric forms embedded in these cultural artifacts. Therefore, the developed media not only functions as a visual learning aid but also introduces local cultural knowledge, allowing students to understand mathematical concepts through culturally relevant contexts. This characteristic distinguishes the present study from previous research, which generally developed pop-up books for mathematics learning without explicitly incorporating local cultural elements or ethnomathematical perspectives.

In line with this idea, the present study aims to examine the development process of an ethnomathematics-based pop-up book that integrates geometric concepts found in Lampung traditional houses. In addition, the study seeks to assess the attractiveness and feasibility of the resulting product, as well as to evaluate the effectiveness of the medium in improving students' understanding of geometric concepts contextualized within local culture. Thus, this research not only produces an innovative instructional product but also provides empirical evidence regarding the benefits of culturally based media in mathematics learning.

METHOD

This study was conducted at SMP Negeri 4 Bandar Lampung during the second semester of the 2021/2022 academic year, involving mathematics teachers and eighth-grade students as the research subjects. The study employed a Research and Development (R&D) approach. This study implemented six stages of the modified Borg and Gall model, namely problem identification, planning, product design, preliminary testing, design revision, and field testing.

Table 1. Implementation of the Modified Borg and Gall Development Stages

No.	Development Stage	Activities
1.	Problem Identification	Classroom observations and interviews with teachers were conducted to identify students' learning difficulties and the lack of culturally integrated mathematics learning media.
2.	Planning	The researchers analyzed the curriculum, determined learning objectives, and planned the development of an ethnomathematics-based pop-up book integrating elements of Lampung traditional houses.
3.	Product Design	The initial prototype of the pop-up book was developed, including the structure of the material, visual design, pop-up mechanisms, and the integration of mathematical concepts with cultural elements.
4.	Preliminary Testing	The prototype was validated by experts in mathematics education, instructional media, and cultural studies to evaluate the feasibility and relevance of the developed product.
5.	Design Revision	The product was revised based on suggestions and feedback provided by the validators to improve the content, design, and clarity of the learning material.
6.	Field Testing	The final product was introduced to teachers and shared as a reference learning medium integrating ethnomathematics and local culture.

The dissemination stage was not conducted in this study due to time limitations.

To obtain comprehensive data, this study employed both qualitative and quantitative instruments, including questionnaires, interviews, documentation, and tests. To provide a clearer description of the data collected in this study and the instruments used, the types of data and research instruments are presented in Table 2.

Table 2. Types of Data and Instruments Used in the Study

No.	Type of Data	Instrument	Respondents	Purpose
1.	Qualitative	Validation questionnaire	Material and media experts	To evaluate the feasibility and validity of the pop-up book
2.		Interviews and documentation	Teachers and students	To support and strengthen the research findings
3.	Quantitative	Pre-test and post-test	Students	To measure the effectiveness of the developed media
4.		Response questionnaire		To assess students' perceptions and attractiveness of the media

The research employed a sequential mixed approach in which qualitative and quantitative procedures were conducted in different stages. The qualitative stage was carried out first during the product validation process. In this stage, material experts and media experts evaluated the developed ethnomathematics-based pop-up book and

provided suggestions and feedback for improvement. The qualitative feedback was then used to revise and refine the product.

After the revision process, the study proceeded to the quantitative stage through product trials involving students. Quantitative data were collected through pretests and posttests to measure students' learning outcomes, as well as questionnaires to assess students' responses to the attractiveness and feasibility of the media. The quantitative data were analyzed using descriptive statistics, including normalized gain and effect size calculations, to determine the effectiveness of the developed instructional media.

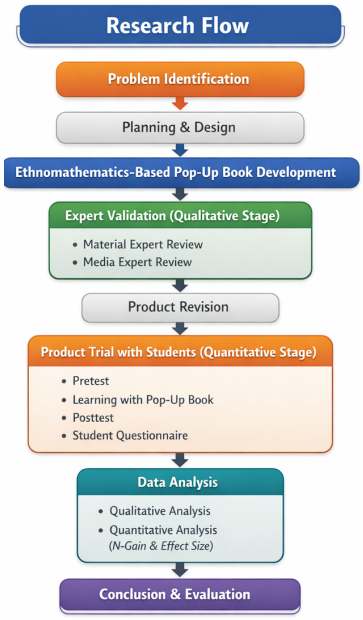


Figure 1. Research Flow

RESULTS OF RESEARCH AND DISCUSSION

Problem Identification

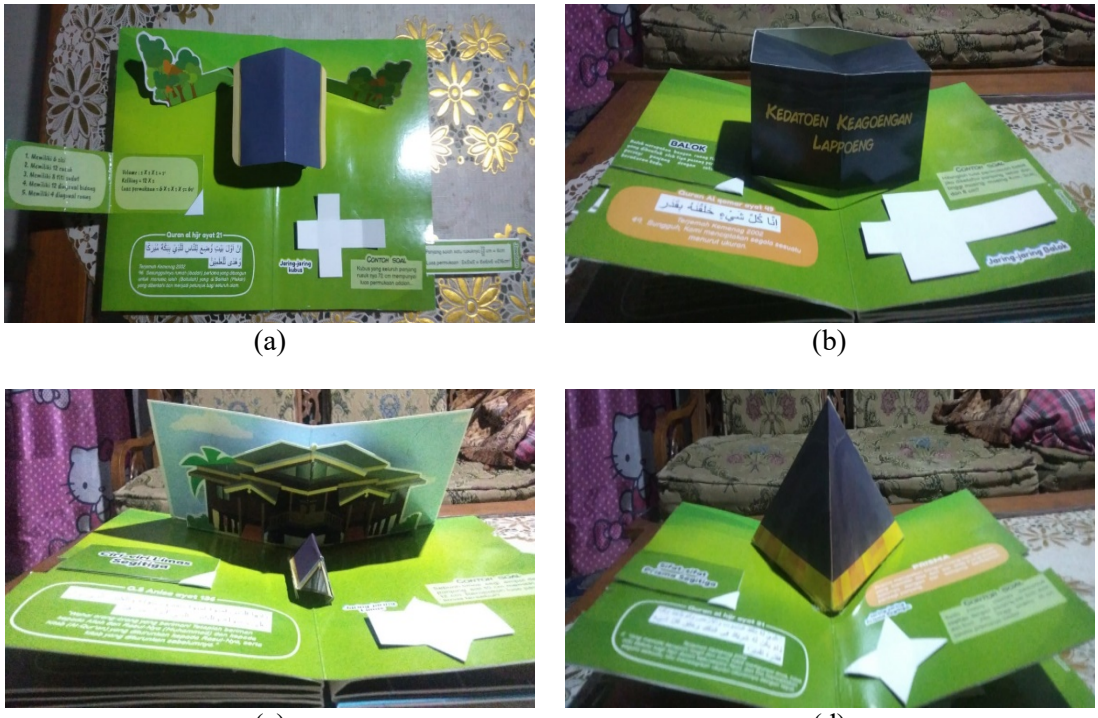
Initial findings from an interview with a teacher at SMP Negeri 4 Bandar Lampung revealed that the learning process at the school still relies on printed media such as textbooks and instructional videos. However, students continue to experience difficulties in understanding the material presented, particularly in mathematics. Up to this point, no instructional media in the form of a pop-up book has ever been used at the school. Therefore, the development of this medium is expected to enhance students' interest in learning.

Planning

The planning stage was carried out after the initial data were collected. The researcher designed the instructional media in alignment with the basic competencies outlined in the 2013 Curriculum. During this stage, the necessary tools and materials for media development were also prepared, along with the construction of validation questionnaires to be used by material experts, media experts, and students in assessing the feasibility of the product.

Product Design

The researcher developed the initial format of the instructional media. The design process was carried out using Microsoft Word and Adobe Photoshop. The resulting design consisted of several main components, including visually appealing front and back covers created using Adobe Photoshop. The content of the pop-up book focused on the topic of three-dimensional geometric shapes with flat surfaces, including cubes, rectangular prisms, prisms, and pyramids. Each topic was complemented with relevant Qur'anic verses, nets of the shapes, formulas, and example problems connected to real-life contexts.



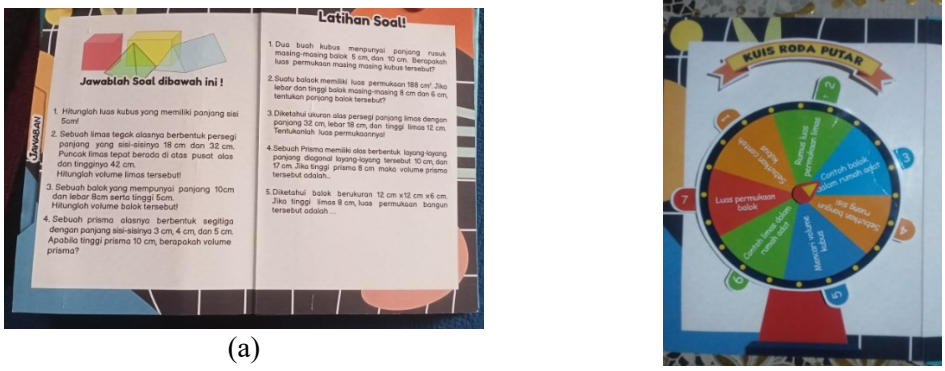
(a) (b)

(c) (d)

Figure 2. Material display: (a) cube; (b) rectangular; (c) pyramid; and (d) triangular prism

Based on Figure 2, several parts can be identified as having geometric shapes in mathematics. The main body of the building shows a cube shape. The monument and nameplate show a rectangular shape. The roof of the building, when viewed from the side, shows a triangular prism shape. Meanwhile, the tip or peak of the roof shows a pyramid shape.

In addition, the medium also provides practice exercises to reinforce students' understanding, as well as an interactive quiz in the form of a spinning-wheel game. This quiz allows students to spin the wheel and answer the questions provided based on where the pointer stops, making the learning process more engaging and less monotonous.



(a) (b)

Figure 3. Display of: (a) practice questions; and (b) spin-the-wheel quiz

Preliminary Testing

After the product was developed, a feasibility test was conducted through a validation process. The validation was carried out by three material experts and three media experts, consisting of two lecturers and one mathematics teacher. This validation aimed to assess whether the developed media

were suitable for use in the learning process and effective in enhancing students' interest and understanding of mathematical concepts.

The validation by material experts was conducted to ensure that the content was coherently aligned with the instructional media being developed, while the validation by media experts aimed to evaluate the quality and feasibility of the product. The validators provided assessments along with suggestions and feedback regarding both the material and the media. The results of the material and media expert evaluations are presented in Table 1.

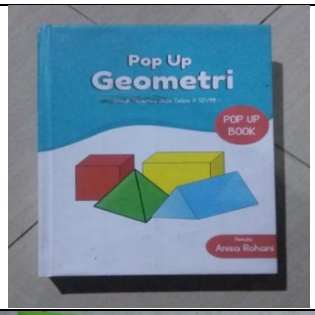
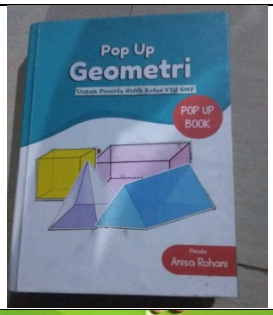
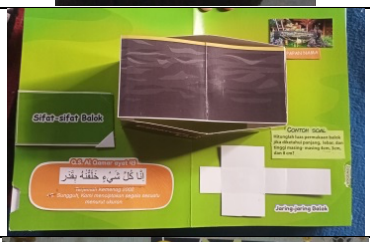
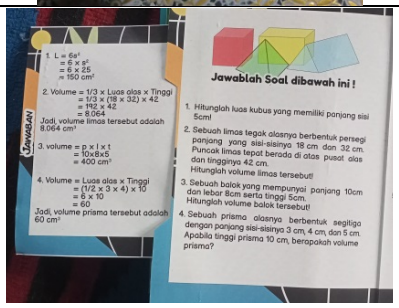
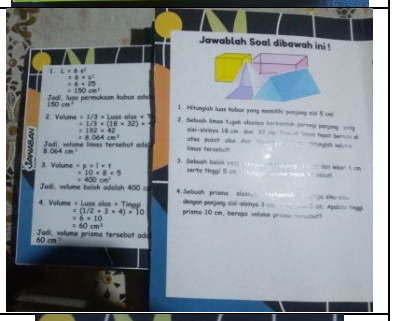
Table 3. Evaluation Results from Content and Media Experts

No.	Section	Type of Error	Suggestion for Improvement
Content Expert			
1.	Cover	The depiction of the flat-faced 3D shapes is inaccurate	Add shadow lines to the flat-faced 3D shapes so they appear correctly
2.	Qur'anic Verse	Incorrect writing of the verse	Correct the verse according to proper punctuation and diacritics
3.	Quiz	There are mistakes in the writing	Correct the errors in the text
4.	Soal	1. Question description uses "Adalah" 2. Inconsistent writing of "cm" 3. Conclusion in the answer must be consistent 4. No images in the question	1. Revise the questions for clarity in descriptive items 2. Correct spacing and ensure consistency 3. Improve and add conclusions in the sample answers 4. Add images and related questions illustrating the prism roof
5.	Image Illustration	1. Not accurate for cube depiction 2. No description for the roof in the prism illustration	1. Depict the cube as it appears in reality 2. Add descriptions of the shapes present on the roof of the Kedaton Keagungan traditional house
Media Expert			
6.	Formula	1. Errors in writing 2. There is no rectangular prism formula there yet	1. Correct the writing errors 2. nclude the formula for rectangular prism
7.	Verse	Incorrect writing of the verse	Correct the verse writing accurately
8.	Illustration	Cube illustration is inaccurate	Replace and correct the roof depiction on the cube

Design Revision

Based on the improvement suggestions listed in Table 3, the researcher revised the product to refine the quality of the developed instructional media, ensuring that it becomes more effective, relevant, and aligned with user needs.

Table 4. Comparison of the Product Before and After Revision

Validator Notes	Comparison of the Product	
	Before Revision	After Revision
The cover depiction lacked shadow lines on the flat-faced 3D shapes, making them appear inaccurate.		
Formulas were elaborated and accompanied by illustrations of the actual building structures.		
Explanations were added to the sample question answers.		
Writing still contained errors or typos.		

After the revisions were completed, the media were revalidated by the material experts and media experts. For the material experts, three aspects were assessed: content quality, accuracy of coverage, and language. The results of the material expert validation are presented in Table 5.

Table 5. Validation Results by Content Expert

No.	Assessment Aspect	Number of Items	Validator Score		
			I	II	III
1	Content Quality	6	23	23	23
2	Accuracy of Coverage	3	11	11	12
3	Language	3	12	12	12
Total Score			**46**	**46**	**47**
x_i			**95,83%**	**95,83%**	**97,92%**
$\sum_{i=1}^{n} x_i$			**289,58%**		
$\bar{x}$			**96,53%**		
Criteria			**Highly Feasible**		

"Based on Table 5, the validation results from the material experts show a percentage of 96.53% for material feasibility, which is categorized as 'highly feasible.' This finding indicates that the presented material meets high-quality standards. Furthermore, the validation results from the media experts, who evaluated the visual and design aspects of the product, are presented in Table 6.

Table 6. Validation Results by Media Expert

No.	Assessment Aspect	Number of Items	Validator Score		
			I	II	III
1	Cover Design	6	22	24	24
2	Accuracy of Coverage	10	35	37	38
Total Score			**57**	**61**	**62**
x_i			**89,06%**	**95,31%**	**96,88%**
$\sum_{i=1}^{n} x_i$			**281,25%**		
$\bar{x}$			**93,75%**		
Criteria			**Highly Feasible**		

Based on Table 6, the validation results provided by the media experts show a percentage of 93.75% for content feasibility, which falls into the 'highly feasible' category. After being declared feasible by the validators, the ethnomathematics-based pop-up book integrating geometric concepts within the context of the Lampung traditional house was deemed ready for implementation in the field-testing phase.

Field-Testing

In the field-testing phase, the researcher conducted trials with students to determine the attractiveness of the developed media. The instructional media were tested in Grade VIII at SMP Negeri 4 Bandar Lampung through two stages: a small-scale trial involving 15 students and a large-scale trial involving 29 students. The trials conducted included assessments of the product's attractiveness and effectiveness.

The results of the attractiveness test are presented in Table 7.

Table 7. Trial Results of Attractiveness

	Jumlah Skor	
	Small-Scale	***Large-Scale***
Total Score	552	1083
Maximum Score	600	1160
Percentage	92%	93%
Criteria	Sangat Menarik	Very Attractive

Based on Table 7, the results of the attractiveness test conducted on a small scale involving eighth-grade students at SMP Negeri 4 Bandar Lampung showed a percentage score of 92%, categorized as 'Very Attractive.' Furthermore, the large-scale attractiveness test involving 29 students yielded a percentage score of 93%, which falls under the same category, namely 'Very Attractive.'

Thus, based on both test results, the ethnomathematics-based pop-up book learning media can be categorized as 'Very Attractive' and is deemed suitable for use as a learning medium for eighth-grade SMP students.

The interpretation of the N-Gain results is presented in Table 8.

Table 8. Interpretation of N-Gain

N-Gain Average (%)	**Interpret**	**Std. Deviation**
88,81	High	19,32552

Based on Table 8, the average N-Gain score of 88,81% indicates that the improvement in students' learning outcomes after using the media or receiving the given treatment falls into the high category.

Furthermore, the effectiveness test was conducted using the effect size analysis. The results of the effect size test are presented in Table 9.

Table 9. Effect Size Results

Category	**N**	**Mean**	**Std. Deviation**	***Effect Size***
Pretest	29	48,71	14,99	1,06
Posttest	29	89,27	9,36	

Based on Table 9, the Effect Size value of 1.06 indicates that the impact of the treatment on students' learning outcomes is considered large (high effect). Statistically, this value exceeds the standard threshold for strong effectiveness, implying that the learning media used serves as a dominant factor in enhancing student competence compared to other external variables. Thus, the media is highly effective in improving learning outcomes, as it exerts a significant influence on the changes in scores from the pretest to the posttest. This surge in scores is not merely a statistical coincidence but a reflection of a profound transformation in conceptual understanding during the intervention.

The improvement in students' learning outcomes can be qualitatively observed from their posttest answers. Their responses indicate that students have a better understanding of the geometry problems presented (Kiptiyah et al., 2021). Geometry is often perceived as an abstract and difficult domain; however, this media successfully bridges the gap between formal geometric objects and student visual perception.

These results indicate that the learning media used is highly effective, not only in facilitating the understanding of the material but also in significantly enhancing learning achievement, particularly when the media employs an ethnomathematics-based approach. The use of cultural context acts as

an intellectual "scaffold" that eases the transition from concrete to abstract reasoning.

Yuliana et al. (2023) states that ethnomathematics can improve students' cognitive abilities. This occurs because learning is no longer perceived as a mechanistic burden but as a process of guided reinvention. Furthermore, integrating cultural context into mathematical learning helps students relate abstract concepts to real-life experiences. When students identify geometric patterns within their own cultural artifacts, psychological barriers toward mathematics are reduced, leading to stronger and more durable memory retention of the material.

These findings offer a new perspective on understanding the application of mathematical concepts in expressions of local culture, and they underscore the importance of preserving cultural heritage that holds educational value (Nuriyah et al., 2025). In addition, the integration of mathematics learning and the cultures in a particular area was the best promotion to every student regarding the importance of maintaining their culture Indriati et al. 2022). Consequently, this media serves a dual purpose: as a cognitive tool for numeracy literacy and as an instrument for conserving national identity amidst modern global shifts.

The high effectiveness demonstrated in this study serves as a solid basis for recommending that teachers use similar learning media more broadly, especially when teaching concepts that require visualization or a contextual approach, such as geometry linked to local culture. Furthermore, integrating ethnomathematics with learning models can optimize the development of students' mathematical abilities across holistic domains, including affective, cognitive, and psychomotor aspects (Primaniarta & de Mattos, 2022). Therefore, future curricula should be more adaptive toward local wisdom to create a more inclusive and meaningful educational ecosystem.

CONCLUSION

Based on the research findings, it can be concluded that the ethnomathematics-based pop-up book featuring traditional Lampung houses is highly feasible for use in mathematics learning, as validated by material and media experts. Furthermore, teacher and student responses to the media are highly positive, demonstrating a high level of attractiveness. The media is also proven to be effective in enhancing students' conceptual understanding of mathematics, as evidenced by an Effect Size value of 1.06, which is categorized as a high effect.

It is recommended that the ethnomathematics-based pop-up book on traditional Lampung houses be utilized more widely, as it has been proven feasible, engaging, and effective in improving learning outcomes. Teachers can employ it as a contextual media to link geometry with local culture. Future research should consider using larger and more diverse samples, replicating the study in other regions, and developing an interactive digital version to better adapt to educational technology and enhance the learning experience.

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