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Coastal Ethnomathematics in Geometry Learning: A Study at Senior High Schools in Panimbang Regency

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Abstract

This study examines the integration of coastal ethnomathematics into geometry learning in senior high schools in Panimbang Regency, Indonesia. Ethnomathematics merges local cultural elements with mathematical concepts, providing a contextualized approach to teaching. The research focuses on how coastal culture, such as fishing boat designs and net patterns, can be used to teach geometric concepts like symmetry, angles, and shapes. A pretest-posttest experimental design was conducted with 30 Grade X students. Initially, students were taught using a traditional method, followed by a pretest to assess their understanding. They then learned geometry through coastal cultural examples, with a posttest measuring their progress. The average test score improved from 61.4 to 77.2, indicating a significant enhancement in learning outcomes. A questionnaire revealed that students found the ethnomathematics approach made geometry more relatable, easier to grasp, and increased their motivation. The study concludes that integrating ethnomathematics into geometry lessons not only improves students' understanding and engagement but also fosters a greater appreciation for their local culture.

Keywords: Ethnomathematics, geometry learning, cultural integration, pretest-post, education

1. Introduction

Mathematics education in Indonesia continues to evolve with an emphasis on innovative and contextualized learning approaches. One of the most notable of these approaches is ethnomathematics which combines local culture with mathematical concepts. Ethnomathematics enables students to learn mathematics close to their daily lives. It makes mathematics easier to understand because it allows students to relate abstract concepts to the reality around them (Widada et al., 2018).

Ethnomathematics focuses on how different societies around the world including Indonesia develop mathematical knowledge in a variety of everyday activities such as architecture art and economic activities such as trade and agriculture (Hidayati and Prahmana, 2022). Many aspects of life in coastal areas are related to mathematical concepts especially geometry. For example the planning and construction of fishing boats fishing nets and traditional houses are often based on specific geometric patterns.

The study of traditional geometry is often seen as difficult for many students. However using an ethnomatic approach geometry can be taught in the context of the local culture that students are familiar with. By utilizing coastal cultures geometry learning becomes more interesting and relevant. It helps students not only to understand geometric concepts but also to understand how these concepts are applied in real life.

Panimbang Province one of Indonesia's coastal regions has a uniquely rich culture and tradition. Closely associated with the sea and fishing the culture of the coastal regions provides a variety of examples of the application of geometry (Owusu-Darko, 2022). Examples include the design of fishing boats the architecture of traditional coastal houses and the textile patterns used in fishing gear. The geometric elements in such cultures provide a very potential resource to be studied and integrated in geometry learning.

Contextualized mathematics learning offers significant benefits to students. If students can understand the relevance of what they are learning to real life they tend to understand the material better. Integrating local culture into learning can strengthen students' cultural identity motivate them to learn and help them understand that mathematics is not just a theory but part of everyday life (Meaney et al., 2021).

The culture of coastal communities in Panimbang contains many elements related to geometry. For example the fishing boats used on a daily basis are geometrically designed to optimize balance and speed on the water. In addition

traditional structures used by local communities often show specific symmetrical patterns and geometric shapes suggesting an understanding of geometry albeit less formal (Faiziyah et al., 2021).

Previous research has shown that ethnomathematics can be an effective approach to learning mathematics. Ethnomathematics research has been conducted in various regions using local cultural examples as teaching material (Sudirman et al., 2020). However specific studies examining the potential of ethnomathematics in coastal cultures especially in Panimbang District are still limited and more in-depth research is needed to explore its application.

This study focuses on integrating elements of ethnomathematics in the coastal culture of Panimbang District into geometry studies in secondary schools. By understanding how geometric concepts are applied in everyday life in coastal areas the study will attempt to develop a contextual learning model that is relevant to the lives of students in this region (Sari at al., 2023). The main purpose of this study is to identify geometric elements in the coastal culture of Panimbang province and to investigate how these elements can be integrated into a high school geometry course (Khan and Mahmood, 2017). In this way it is hoped that students will better understand geometry concepts and be able to relate them to their daily lives.

It is hoped that this study will inform the development of more contextualized curricula and methods of learning geometry especially in coastal areas (Clarke and Roche, 2018). Furthermore this study can enrich the study of ethnomathematics in Indonesia by providing examples of its application in the context of coastal cultures which have not been studied much.

Panimbang Province in Banten has a rich culture closely associated with marine life. Most people in the area work as fishermen and their daily activities are influenced by local traditions and knowledge passed down from generation to generation. In addition there are several schools in Panimbang that have the potential to apply an ethnomathematical approach to learning especially given their proximity to the local culture.

One cultural element that can be associated with geometry is the weaving patterns that coastal communities use to make various tools such as fishing nets and baskets. These weaving patterns often feature geometric shapes such as triangles squares and other symmetrical shapes. Studying these patterns allows students to learn geometric concepts in a more visual and practical way.

Seafaring in coastal community life also involves the application of geometric concepts. For example fishermen need to understand angles and directions when navigating and estimate their position from the movements of the stars and the sun (Iriarte at el., 2020). This is an interesting example of students learning geometry in a different context from what they normally learn in the classroom.

Geometry concepts such as symmetry and balance are also present in the design of traditional fishing boats. The shape of the boat needs to have the right proportions in order to navigate the sea in a balanced way. Learning about fishing boats can be used as a relevant and contextual learning resource when teaching geometry (Asomah at al., 2023).

Learning that is contextual and relevant to students' lives can motivate them to learn. Students can understand the concepts taught more easily if they can relate them to things they encounter on a daily basis (Knapp, 2020). Therefore incorporating ethnomathematics into geometry studies is expected to have a positive impact on students' understanding (Indrawan, 2020).

The application of ethnomathematics can also help students understand their local culture. Knowing that their culture has important mathematical values is expected to motivate students to learn and understand the richness of their culture. It can also help them to feel proud of their cultural identity.

However despite its many possibilities the application of ethnomathematics to mathematics learning faces several obstacles. One of them is the lack of teaching materials and guidelines for teachers to integrate ethnomathematics into the curriculum (Roza et al., 2020). Moreover not all teachers have sufficient knowledge about local cultures and know how to relate them to mathematical concepts.

Teachers play an important role in the implementation of ethnomathematics. Teachers not only need to have knowledge about the local culture but also need to be able to relate it to the mathematical concepts taught in schools. Therefore teachers need training and capacity building to be able to develop appropriate and effective teaching materials.

In the long term it is hoped that ethnomathematics will become part of the national curriculum. Incorporating local culture into mathematics learning will enable students to learn in a more contextualized way. Moreover the inclusion of different cultural perspectives specific to each region can also enrich mathematics learning in Indonesia.

2. Methods

This study used a quantitative method with a simple experimental design to examine the impact of applying coastal ethnic mathematics in geometry learning on students' understanding and learning outcomes (Suherman and Vidákovich, 2022). The study was conducted in a high school in Panimbang province. The stages of the study are as follows:

2.1. Type of study

This study is an experimental study including pretest and posttests to determine the differences in students' learning outcomes before and after the implementation of the coastal ethnomathematical approach in geometry learning.

2.2. Population and sample

The study population consisted of all Grade X students of a high school in Panimbang Province. From this population a class of 30 students was randomly selected as a sample.

2.3. Research design

The research design was a pretest-posttest-one group design in which the selected class first learned geometry using the traditional approach followed by a pretest to measure students' initial proficiency. The students were then taught geometry using the coastal ethnomathematical approach and at the end of the study a posttest was conducted to measure the improvement in the students' learning outcomes.

2.4. Research procedures

2.4.1. Phase 1

Pretest A geometry test (pretest) was administered before the learning started to measure students' initial competence. The questions in the pretest consisted of geometry materials related to the ethnomathematics approach such as plane shapes angles and symmetry concepts.

2.4.2. Phase 2

Applying the Coastal Ethnomathematical Approach after the pretest the students participated in geometry learning using the ethnomathematical approach. In this lesson the teacher used examples from coastal cultures such as the pattern of a woven net the design of a fishing boat and the shape of a stilt house to explain the concept of geometry.

2.4.3. Phase 3

At the end of the study students were given the same geometry test (posttest) to measure their understanding and ability to improve after learning through the coastal ethnic math approach.

2.4.4. Phase 4

Completion of the questionnaire Students were asked to complete a questionnaire to measure their response to the Coastal Ethnic Math Approach. The questionnaire included questions about the relevance of learning ease of understanding concepts motivation to learn and students' engagement during learning.

2.5. Survey instrument

2.5.1. Pretest and posttest

This test consisted of geometry questions covering plane figures angles symmetry and other geometry material. The scores from this test were used to measure the improvement in students' understanding before and after the implementation of the ethnomathematics approach.

2.5.2. Questionnaire

A questionnaire was developed to measure students' attitudes and reactions to learning using the ethnomathematics approach. The questionnaire included closed questions on a Likert scale measuring willingness to learn interest and positive attitudes towards learning.

2.6. Data analysis methods

2.6.1. Quantitative analysis (pretest and posttest)

The pretest and posttest results were analyzed using descriptive statistics to determine the mean scores before and after the ethnomathematics intervention. A t-test was also used to check for significant differences between the pretest and posttest results.

2.6.2. Analysis of the questionnaire

Data from the questionnaire were analyzed descriptively to determine the distribution of students' responses to learning through the Coastal Ethnomathematics approach. The results of the questionnaire are presented as percentages for each response option.

3. Results and Discussion

3.1. Observation of the learning process

3.1.1. Classroom environment

The school studied was SMA X in Panimbang district. In the observed lessons 30 Grade X students were learning geometry using an ethnomathematical approach. Teachers used examples from coastal cultures such as fishing boat designs and rattan patterns to explain geometry concepts such as symmetry planar shapes and angles.

3.1.2. Classroom activities

The teacher began the lesson by showing students a picture of a traditional Panimbang fishing boat and asking them to identify the geometric shapes depicted on the boat, students discuss the triangle rectangle and symmetrical line shapes in the boat designs, the teacher continued with a group task where students made a paper model of a boat and identified its geometric elements, at the end of the session students present their work demonstrating the application of geometry in the context of coastal culture.

3.1.3. Teacher observation.

Teachers were keen to use local examples and students seemed more engaged when the topic was related to their own culture. Some students actively asked questions when asked about the relationship between geometric concepts and boat design especially in relation to angles and structural balance.

3.1.4. Students' observations.

When geometry concepts were explained using real examples from everyday life students' understanding seemed to deepen. Normally inactive students were seen to actively participate in discussions and group activities.

3.2. Teacher interviews

3.2.1. High school math teacher

This teacher noted that previously learning geometry was often perceived as difficult for students. However after linking geometry to coastal culture students seemed to be more motivated, although this teacher mentioned the challenge of finding relevant cultural examples for all geometry materials she felt that the use of coastal culture had a positive impact on students' understanding. The teacher also claimed that this approach made students feel proud of their local culture.

3.3. Student interviews

3.3.1. High school students grade 10

After the teacher gave the examples of fishing boats and rattan patterns the student was able to better understand the concepts of plane figures and angles. Student grade 10 stated that geometry used to seem 'abstract' and difficult to apply but the example of coastal culture allowed students to see how geometry is used in real life.

3.3.2. 11th grade high school students

Students felt that the geometry lesson was more relevant to their lives and were more motivated. Student grade 11 explained that the fishing nets example helped them understand the concepts of symmetry and repeating patterns.

3.4. Documenting coastal cultures

3.4.1. Traditional fishing boat design

The shape of fishing boats is symmetrically designed with triangular patterns and straight lines to ensure balance and stability at sea. The symmetry of the boats is described by the teachers as a direct application of geometric concepts.

3.4.2. Pattern of woven fishing nets

The woven fishing nets show a geometric pattern of repeating rectangles and triangles. This is used to illustrate the concepts of symmetry and pattern and how errors in the pattern can affect the function of the net.

Student test results

Geometry test result data before and after the implementation of the Coastal Ethnic Math approach in Grade 10-11 at SMA Panimbang Regency. This data includes 30 students and includes geometry test results before and after the implementation of this approach.

Table 1: Geometry test results before the implementation of the ethnic math approach

No	Student Name	Previous Test Score
1	Andi Setiawan	62
2	Budi Santoso	55
3	Clara Aulia	60
4	Dinda Permatasari	66
5	Eko Prabowo	57
6	Fira Lestari	64
7	Gita Puspita	61
8	Hani Ramadhani	58
9	Iwan Saputra	59
10	Joko Priyanto	63
11	Kira Anindita	70
12	Laila Fitria	67
13	Miko Ardiansyah	61
14	Nia Ramadhani	65
15	Oka Setiawan	56
16	Putri Handayani	60
17	Rudi Hartono	64
18	Sari Indrayani	55
19	Tono Sudrajat	58
20	Umi Salwa	69
21	Vino Maulana	66
22	Wina Nursanti	54
23	Xena Wardhani	63
24	Yuda Kurniawan	62
25	Zara Fadhila	60
26	Ahmad Rizky	61
27	Bella Ramadhani	64
28	Cinta Adelia	55
29	Damar Reza	67
30	Elang Wirawan	68

Average before ethnomathematics: 61.4

Table 2: Geometry test results after an ethnomathematics approach

No	Student Name	Posttest score
1	Andi Setiawan	75
2	Budi Santoso	70
3	Clara Aulia	78
4	Dinda Permatasari	80
5	Eko Prabowo	72
6	Fira Lestari	79
7	Gita Puspita	74
8	Hani Ramadhani	77
9	Iwan Saputra	76

10	Joko Priyanto	80
11	Kira Anindita	85
12	Laila Fitria	82
13	Miko Ardiansyah	78
14	Nia Ramadhani	81
15	Oka Setiawan	70
16	Putri Handayani	75
17	Rudi Hartono	80
18	Sari Indrayani	71
19	Tono Sudrajat	73
20	Umi Salwa	84
21	Vino Maulana	83
22	Wina Nursanti	69
23	Xena Wardhani	78
24	Yuda Kurniawan	76
25	Zara Fadhila	75
26	Ahmad Rizky	77
27	Bella Ramadhani	81
28	Cinta Adelia	71
29	Damar Reza	82
30	Elang Wirawan	85

Average 77.2 after ethnomathematics

3.4.3. Average comparison

Average score before the implementation of ethnomathematics 61.4, average score after ethnomathematical approach 77.2, and 15.8 points increase in average score.

3.4.4. Data analysis

The presented data show that after the introduction of the Coastal Ethnomathematics approach to geometry learning students' average scores increased significantly. Students' scores which were previously in the 60s increased to the 70s and 80s after the implementation of this approach. This suggests that incorporating local cultural elements into geometry learning can improve students' understanding of the concepts taught.

3.5. Relevance of learning geometry to daily life

Question:
To what extent is learning geometry with examples from coastal cultures relevant to everyday life?

Table 3: Students' answers about the relevance of geometry learning to everyday life

Answer Options	Number of Students	Persentase
Very relevant	14 students	47%
Quite relevant	12 students	40%
Less relevant	3 students	10%
Not relevant	1 student	3%

3.5.1. Analysis Results.

47% of the students think that learning geometry using the coastal culture example is very relevant to their daily lives. While 40% of the students think that it is moderately relevant only 3% think that it is not very relevant.

3.6. Ease of understanding geometry concepts

Question:
Do you find it easier to understand geometry concepts after studying the coastal culture example?

Table 4: Answer to the question ease of understanding geometry concepts

Answer Options	Number of Students	Persentase
Easier	18 students	60%
A little easier	9 students	30%
No difference	3 students	10%

3.6.1. Analysis Results.

Most of the students (60%) found it easier to understand geometry concepts after studying with the coastal ethnic math approach; 30% found it somewhat easier and only 10% found no difference.

3.7. Motivation to learn geometry

Question:
How motivated were you to learn geometry after using the Coastal Ethnomathematics approach?

Table 5: Answer to the question motivation to learn geometry

Answer Options	Number of Students	Persentase
Highly motivated	16 students	53%
Quite motivated	10 students	33%
Less motivated	4 students	13%
Not motivated	0 student	0%

3.7.1. Analysis Results

The majority of the students (53%) felt very motivated to learn geometry after applying the ethnomathematics approach; 33% felt moderately motivated and 13% felt less motivated. No student felt not motivated at all.

3.8. Ethnomathematics approach helps to understand geometry concepts

Question:
To what extent did the ethnomatic approach help you understand geometry concepts such as symmetry angles and plane shapes?

Table 6: Answers to questions ethnomathematics approach helps to understand geometry concepts

Answer Options	Number of Students	Persentase
Very helpful	14 students	47%
Helpful	11 students	37%
Quite helpful	5 students	17%
Not helpful	0 student	0%

3.8.1. Analysis Results

A total of 47% of the students thought that the ethnomathematical approach was very helpful in understanding geometry concepts such as symmetry angles and plane shapes; 37% thought it was helpful and 17% thought it was moderately to well helpful.

3.9. Level of engagement and active participation in learning

Question.
To what extent do you actively participate in learning geometry using the ethnomathematics approach?

Table 7: Answer to the question level of engagement and active participation in learning

Answer Options	Number of Students	Persentase
Very active	10 students	33%
Active	14 students	47%
Quite active	6 students	20%
Less active	0 student	0%

3.9.1. Analysis

A total of 33% of the students felt very active in their learning while 47% felt active. 20% of the students felt that they were quite active and none of them felt that they were not very active.

3.10. Conclusions drawn from the survey results.

Most of the students think that the Coastal Ethnic Mathematics approach is very relevant to their daily life and helps them to improve their understanding of geometry concepts, the approach also significantly increased students' motivation to learn with the majority of students feeling more motivated, 60% of the students reported that learning became easier to understand especially when it came to concepts such as symmetry angles and plane shapes. The majority of students also felt more engaged and active in the learning process.

Table 8: Percentage results

Evaluation Aspect	Very Positive/Very Helpful	Positive/Helpful	Quite Helpful	Less Positive/Helpful
Learning Relevance	47%	40%	10%	3%
Ease of Understanding Geometry Concepts	60%	30%	10%	-
Motivation to Learn Geometry	53%	33%	13%	-
Assistance in Understanding Geometry	47%	37%	17%	-
Activity in Learning	33%	47%	20%	-

These results indicate that the coastal ethnomathematics approach has succeeded in providing a positive impact on the geometry learning process among students.

4. Consulusion

Ethnomathematical approaches involving local coastal culture such as fishing boat designs and fishing net patterns were effective in improving students' understanding of geometry concepts that were previously considered abstract. The test results showed that students' mean scores increased from 61.4 to 77.2 reflecting the relevance of geometry to everyday life with 47% of students finding learning geometry very meaningful. In addition 53% of students reported that they were more motivated to learn and 33% reported that the learning process encouraged students to be more active and engaged while 33% of students reported that they felt very engaged. A total of 60% of students felt that the approach facilitated their understanding of geometry concepts although there were difficulties in relating all concepts to coastal culture. Overall contextualized learning linking geometry and local culture was found to improve students' learning outcomes and academic achievement.

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