DIDACTIC DESIGN OF ETHNOMATHEMATICS-BASED MATHEMATICS LEARNING: CONSTRUCTING A VARIETY OF GEOMETRIC ORNAMENTS FROM RIAU BATIK PATTERNS

Armawati[1], Susilasari[2], Mhmd Habibi
[1,2,3]Universitas Islam Negeri Sultan Syarif Kasim Riau
[1]armawati860806@gmail.com, [2]susilasari225@gmail.com
[3]mhmd_habibi@yahoo.com

ABSTRACT

This study aims to explore the integration of local cultural values, especially Riau batik with geometric patterns, into mathematics learning in elementary schools through an ethnomathematics approach. Batik as a cultural heritage not only holds aesthetic value, but also contains mathematical concepts such as symmetry, transformation, and pattern repetition. Using an exploratory qualitative method, researchers analyzed geometric patterns in several typical Riau batik motifs, such as the selembayung, pucuk rebung, and itik balik petang motifs. The results of the study indicate that the integration of ethnomathematics elements from Riau batik can improve students' understanding of geometric concepts, foster appreciation for local culture, and strengthen the relationship between mathematics and real life. This article recommends the development of contextual learning tools based on ethnomathematics as an innovative medium in the implementation of the Merdeka Curriculum in elementary schools.

Keywords: *ethnomathematics, Riau batik, geometric patterns, mathematics learning, local culture*

A. INTRODUCTION

Mathematics is often considered an abstract discipline and far from everyday life. In fact, in the cultural reality of Indonesian society, mathematical concepts have long been embedded in various forms of traditional works, one of which is batik. One of the compulsory subjects in elementary school that is very important for developing students' critical and practical thinking skills is mathematics. Math learning helps students' cognitive development in addition to improving their numeracy skills (Ain et al., 2025). This ability is essential to prepare students to face various global problems that are increasingly complex in the 21st century. However, elementary schools still use formal, procedural, and abstract approaches in teaching mathematics. As a result, this approach has less impact on students'

daily lives. Putri Dalam (Jatayu et al., 2024) said that this affects students' motivation and low learning outcomes, especially when it comes to geometry content that requires spatial and visual understanding.

Because the teaching of mathematics in elementary schools is still formal and theoretical, its application in students' daily lives is still lacking. Students' poor geometry learning outcomes demonstrate the need for a more relevant and contextual approach. According to the findings of the national assessment, the spatial and visual skills of elementary school students in Indonesia are still relatively weak (Ministry of Education and Culture, 2023).

Preliminary findings from one of the elementary school teachers in Pekanbaru show that students' understanding of mathematics and learning outcomes in general is still low, and students' knowledge of local religions in Riau, especially Malays, is also lacking. One alternative that can be used in education is the use of a culture-based teaching approach, which not only helps students understand mathematical concepts more fully but also highlights and

encourages local religious beliefs. Culture-based education informs the public about the importance of studying life to deal with entertaining situations and a relevant topic to understand this problem is ethnomathematics (Setiani et al., 2023).

One of the tools that can be used to clarify the relationship between environmental culture and In mathematics teaching is ethnomathematics (Setiani et al., 2023). According to Irawan and Kencanawaty (2017), ethnomathematics is one of the branches of mathematics education. On the other hand, according to Nursyahidah, Saputro, and Rubowo (2018), ethnomathematics is mathematics that arises from human activities in an environment influenced by culture. Based on several observations in ethnomathematics research, it can be concluded that ethnomathematics is a teaching strategy that incorporates cultural elements in mathematics education (Putra & Prasetyo, 2022).

Culture, mathematics, and education are intertwined. By relating abstract ideas to students' real experiences, incorporating cultural

components into math teaching can enhance their understanding. Thus, ethnomathematical research is an interesting field of study in the field of education. The ethnomathematical approach allows for contextual and meaningful connections between local culture and mathematics learning. One of Riau's cultural heritages that is rich in mathematical value is batik with geometric patterns.

Riau batik has distinctive motifs that are full of cultural meaning and value, such as selembayung which symbolizes greatness, bamboo shoots as a symbol of hope, and ducks returning home in the evening which reflect togetherness and order. The beauty and regularity of the motif shows the involvement of geometric elements such as folding symmetry and rotational symmetry, transformation (translation, rotation, reflection), and pattern repetition. This has great potential to be applied in mathematics learning at the elementary school level. This research seeks to explore how cultural values in Riau batik can be used as a source of mathematics learning through an ethnomathematical approach, as well as its implications for contextual and meaningful learning for students.

B. METHODS

This research uses a qualitative approach where the researcher himself acts as a key instrument (human instrument). The research design to be developed refers to Didactical Design Research (Ayu Julianti et al., 2020). DDR is the process of developing a didactic design consisting of a series of didactic situations, analyzing the students' responses to the didactic situations developed and the decisions taken during the learning process (Suryadi, 2015). This study will explore the central phenomenon in the form of students' learning obstacles to the involvement of geometric elements such as folding symmetry and rotational symmetry, transformation (translation, rotation, reflection), and pattern repetition. The research will also explain the development of didactic design on the introduction of fractional concepts by considering the learning obstacles encountered, explain the process of implementing didactic design from several perspectives and present alternative didactic design designs according to the findings during the didactic design implementation process. The participants of this study

are 31 students in class V. Data collection techniques through observation of the learning process, interviews with teachers and students, documentation of student work, analysis of test results and assignments. The data analysis technique is carried out qualitatively with the stages of data reduction, data presentation, and conclusion drawn.

The stages of the research include: 1) Initial Situation Analysis: Identification of Riau batik motifs and analysis of their mathematical content (symmetry, flat build, transformation); 2) Hypothetical Didactic Design (Design 1); 3) Prepare an initial learning plan; 4) Implementation and Reflection; Implement design and collect data through observation, interviews, and documentation; 5) Final Revision and Design (Design 2); Customizing the design based on the results of the initial implementation.

Pendekatan pembelajaran yang mengaitkan matematika dengan konteks budaya lokal, seperti etnomatematika, dapat membantu siswa memahami konsep secara lebih bermakna. Dengan memanfaatkan objek budaya sebagai sumber belajar, pembelajaran matematika menjadi lebih kontekstual dan relevan dengan kehidupan siswa, sehingga dapat meningkatkan pemahaman konsep dan minat belajar (Susanto, 2015).

C. RESULTS AND DISCUSSION
Mathematical Elements in Riau Batik Patterns

Motifs such as *shawls* show folding symmetry and rotary symmetry; *The shoots of bamboo shoots* contain triangular patterns and repetitions; while *the ducks return to the evening* display the concept of translation and the regularity of the rows of objects. Based on the analysis, it was found that most of the Riau batik motifs contain elements of symmetry (fold and rotate), flat shapes (triangles, parallelograms, squares), geometric transformations (reflection, rotation, translation), patterns and order. This is very relevant for grades 4–6 of elementary school in the Independent Curriculum.

The following is a picture of the Riau batik pattern:

1. Folding symmetrical shawl motif and rotary symmetry

2. Motif of bamboo shoots, triangle

pattern and repetition

3. Duck motif returning home in the evening, translation concept and order of row of objects

4. Circle concept cape flower motif

Learning Obstacles

To identify the initial obstacles in learning, namely the researcher gave 8 questions related to the understanding of geometry, students were asked to solve the 8 questions how they described triangles, described shapes, described circles, described squares, built semicircles, and described how they could draw triangles in order, whether triangles were in order of size or not, students were asked to describe circles of 4 circles of equal size. From the results of the analysis of students' answers, students still have difficulty in forming a symmetrical wake, a pattern that is in accordance with expectations. Students need visualization, namely from the Riau batik pattern, namely the selembayung motif, the bamboo shoot motif, the duck motif to go home in the evening to integrate the students' visualization into this building image.
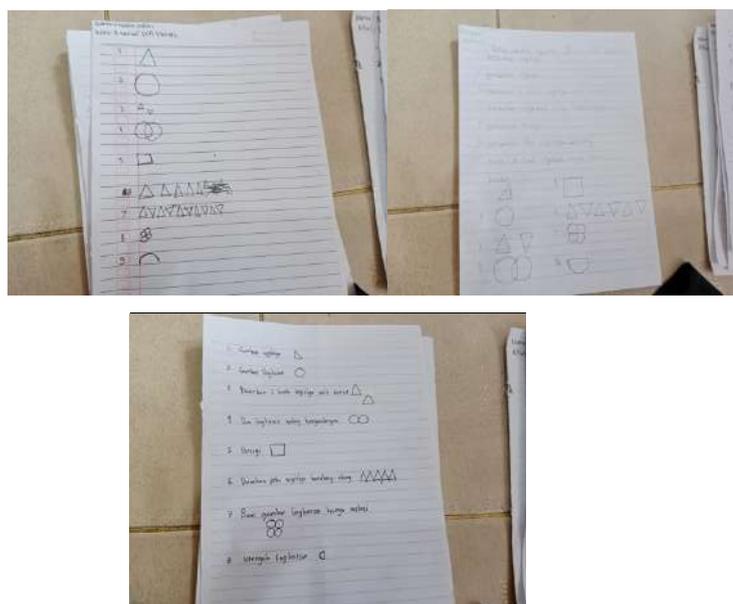

Figure 1. Learning Obstacles Understanding of Geometry Concepts

The purpose of this activity is to identify the concepts of geometry that students know and learning obstacles that arise without direct help from the teacher. Learning Obstacles found: 1) Inaccuracies in drawing geometric shapes; 2) Patterns that are asymmetrical and not repeatable; 3) The use of colors that do not show the structure of the pattern; 4) Not understanding the cultural elements of batik motifs.

According to Brousseau (1997) in the theory **of Didactical Situations in Mathematics**, *learning obstacles* are difficulties experienced by students in understanding mathematical concepts because of the difference between the structure of students' knowledge and the conceptual structure of mathematics itself. These obstacles can be classified into three main types according to the theory of **epistemological obstacles** by **Bachelard (1938)** and developed in the context of mathematical learning by didactic experts, namely:

1. **Epistemological Barriers**

    Obstacles that arise due to previous knowledge that has been established in the student's mind but is not suitable for learning new concepts. For example, students who are used to symmetrical shapes only in the form of paper folds may have difficulty understanding the concepts of rotation or reflection.

2. **Didactic Barriers**

    This obstacle arises due to teaching strategies or the way teachers present material that does not support the construction of correct understanding in students. For example, if the teacher does not provide concrete visual context when teaching geometry transformation, then students will have a hard time imagining it.

3. **Cognitive (Psychological) Barriers**

    These barriers relate to the student's limited mental abilities, such as visual-spatial abilities, abstract thinking, or procedural understanding. This is often the case in geometry learning that demands an understanding of the shape, position, and transformation of objects. In addition, Skemp

(1976) distinguishes between **instrumental understanding** (just knowing how, without knowing why) and **relational understanding** (knowing how and why). Many obstacles to learning mathematics arise because students only master instrumental comprehension.

Epistemological barriers students tend to understand the concept of flat building and geometric transformation separately and procedurally, such as only knowing formulas or shape names without understanding their relationship in visual and cultural contexts. When introduced to complex and integrated batik motifs, students have difficulty associating the geometric shapes they are familiar with the patterns in batik. For example, they have difficulty recognizing that the arrangement of triangles and parallelograms in batik motifs can form a symmetrical pattern that contains reflection or rotation. This shows a conflict between students' initial knowledge (which tends to be fragmentary and non-contextual) and new knowledge that is more conceptually and visually integrated.

Didactic obstacles arise due to the delivery of material by teachers who are still conventional and do not make use of dynamic visualization or contextualization of local culture. The absence of concrete media such as visual worksheets or manipulative tools also makes it difficult for students to understand the relationship between geometric concepts and batik patterns as a whole.

The teacher's solution uses a contextual approach based on local culture to relate mathematical concepts to students' real experiences. Providing visual and manipulative learning media, images of Riau batik motifs, as well as simple digital tools to demonstrate geometric transformation. Various studies show that cultural motifs such as batik contain mathematical concepts. Arwanto Dalam (Wijaya, 2016) revealed that Trusmi Cirebon batik contains geometric concepts such as symmetry, transformation, and confluence. Laurens (2016) shows that Moluccan culture supports the understanding of numbers, fractions, and geometry. Meanwhile, Darwis (2020) and Zayyadi (2017) found that Madura batik motifs reflect the

concept of lines, symmetry, and other geometric patterns.

Engage students in group discussions to enhance social interaction and build mutual understanding. Encouraging students' creative expression through individual and collaborative geometric batik motif making projects through batik coloring activities. Barton (2020) stated that the use of cultural context in mathematics learning can help students understand concepts more deeply. Another study by Ahmad (2025) found that students who learn mathematics through a culture-based approach have better understanding compared to conventional methods (Ain et al., 2025). Therefore, integrating the cultural reflection of the batik motifs studied to strengthen contextual linkages is essential. Provide positive formative feedback and build students' confidence in their mathematical and artistic abilities. Provide a step-based LKPD: identification – analysis – reconstruction of motives. Insert a short video about the batik making process and the philosophical value of the motif. Collaborate in small groups to produce "classroom batik drawings" from each student's results.

Early Didactic Design

Didaktis 1

The initial design was to arrange learning activities based on the introduction and analysis of Riau batik motifs. Activities include:

Phase	Learning Activities	Purpose	Predicting Student Response	Anticipation of Teachers
1. introduction	The teacher displayed several pictures of Riau batik motifs and discussed the meaning and uniqueness of the motif.	Foster interest and relate lessons to the local cultural context.	Students were enthusiastic, wondering about the batik motifs displayed.	The teacher gave a brief explanation of the cultural background and aesthetic value of Riau batik.
2. Identify Geometric Shapes	Students observe batik motifs and identify flat shapes that form patterns (squares, triangles, parallelograms).	Introducing the basic form of the batik pattern.	Some students are able to pronounce shapes precisely, some are confused about distinguishing shapes.	The teacher provides additional examples and visually shows the pattern-forming lines.
3. symmetry	The student determines the line of symmetry and the center of symmetry on the motif that has been identified.	Understand the concepts of folding symmetry and rotary	Students have difficulty determining the number of symmetry lines.	Teachers use mirrors and transparency to aid visual exploration.

		symmetry in real context.		
4. Constructing Patterns	Students make their own geometric batik ornamental patterns based on the shapes and transformations that have been learned.	Apply geometry concepts and develop creativity.	Students are enthusiastic but hesitant to draw patterns.	The teacher gives grid templates and simple examples as a guide.

Design 2 (Revision): This design is the result of a revision after the implementation of Design 1, with the following adjustments:

Phase	Learning Activities	Adjustments/Revisions	Reason for Change
1. Contextual Recognition	Featuring a short video about the process of making Riau batik and its cultural value.	Add audio-visual elements.	Increase student interest and contextual understanding.
2. Geometri exploration	Using images of Riau batik motifs.	Provide images of batik motifs.	Helping students who have difficulty distinguishing shapes.
3. Interactive Symmetry	Use simple videos to understand the symmetry of twist and fold.	Simple technology integration.	Improve understanding of concepts visually and interactively.
4. Collaborative Pattern Construction	Students work in small groups to make one large batik motif sheet with assignment division.	Collaborative, gradual scaffolding.	Reduce the fear of drawing, increase mutual responsibility.
5. Presentation and Reflection	Students present their work and explain their geometric meanings and concepts.	Project-based assessment and cultural reflection.	Develop communication skills and deepen meaning.

Design 3 (Reinforcement and Expansion)

This design was developed after the analysis of the results of the implementation of Design 2, to strengthen students' understanding and expand the application of geometry concepts in a cultural context:

Phase	Learning Activities	Purpose	Teacher Strategy
1. Advanced Motive Studies	Students analyze other batik motifs from different Riau regions.	Broadening cultural insights and the application of geometric concepts.	Teachers provide a variety of motifs and maps of Riau culture.
2. Mini Projects	Students design batik patterns from picture books and pictures presented.	Strengthening the understanding of transformation.	Teacher guides how to draw
3. Exhibition of Works	Students set up a mini gallery in class displaying their geometric pattern work.	Increase cultural appreciation and pride in one's own work.	The teacher sets up the showroom and invites other classes to see.
4. Refleksi Terbuka	Open discussion about what is learned, the difficulties faced, and the relevance of mathematics to culture.	Fostering metacognition and appreciation for learning.	Teachers guide discussions and record student feedback.

Didactic Activity 1

Didactics 1

Students are required to relate mathematics to the local cultural context through an introduction to basic geometry concepts. In getting **to know Riau batik** , Guru displays several images of typical Riau batik motifs (for example: bamboo shoots, selembayung, duck in the evening, cape flowers).
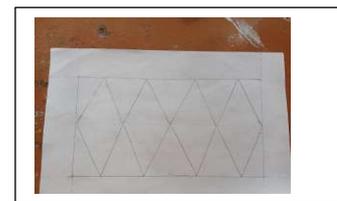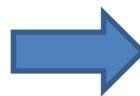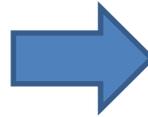

Teacher: What do you see? Have you seen this batik before?

S1: "Mom! It is triangular in shape

S2: There was a time when I visited the Museum at that time!

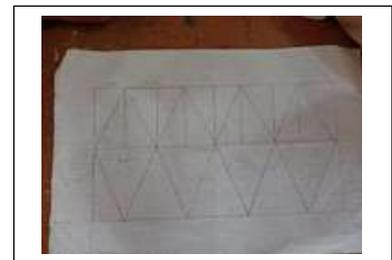*S3: It seems to be in our school building Mom, on the roof!*

Next, students identify geometric shapes. Students were given a piece of printed batik motifs. Use colored markers to mark shapes such as triangles, squares, parallelograms.

Teacher: Which form appears most often?

S1: Triangle Bu

S2:Circle Bu!

S3:A recurring triangle Mom!

Tracing Symmetry, students were asked to fold batik motif drawing paper and match the left and right sides → the folding symmetry. Use a small mirror to help explore symmetry. **Recognizing Transformation,** the Master shows how the pattern shifts (translation), is rotated (rotation), and is reflected (reflection). Students mark where you see patterns that are "repeating" or "playing". **Student Pattern** Work Students make one simple batik pattern with plain HVS paper based on geometric shapes and transformations.

In this case, students are asked to make a bamboo shoot motif with the following steps:

1. Use a measuring tool and calculate the proportions, i.e. a ruler as the standard unit
2. Teach how to read cm and mm.
3. Measure the width of the 4 cm long paper field at each corner.
4. Measure the length of paper with a size of 25 cm. Measure the width of the paper 15 cm.

5. Then line the entire length of the measured paper.

6. Draw the center line to divide the paper squares in half as large

7. Make 4 rectangular planes on paper of equal size to form a square.

8. Explain to students about vertical, horizontal and diagonal lines.

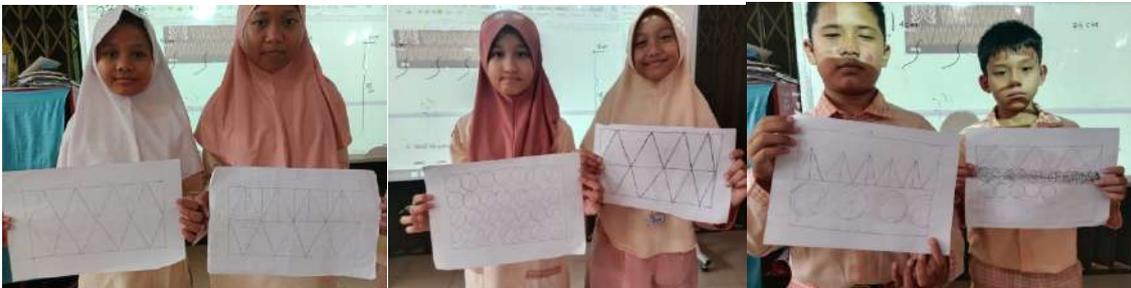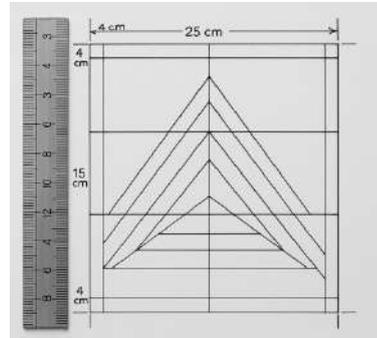9. Make a large triangle and shrink 2 cm per level.

Figure 2. Students show the results of drawings of triangles of simple bamboo shoots and cape flower patterns

Didactics 2

Students can improve interaction, clarify concepts, and encourage collaboration. Watch cultural videos. Watch short videos about making Riau batik.

Teacher: How is the process of making batik? What does it mean?

S1: very interesting, ma'am, the pattern is repetitive

The teacher introduced Riau batik motifs to the students. Then students collaborate to make batik patterns Each group draws one large

batik pattern at HVS. **Group Presentations** Each group explains the manufacturing process and the mathematical concepts used.
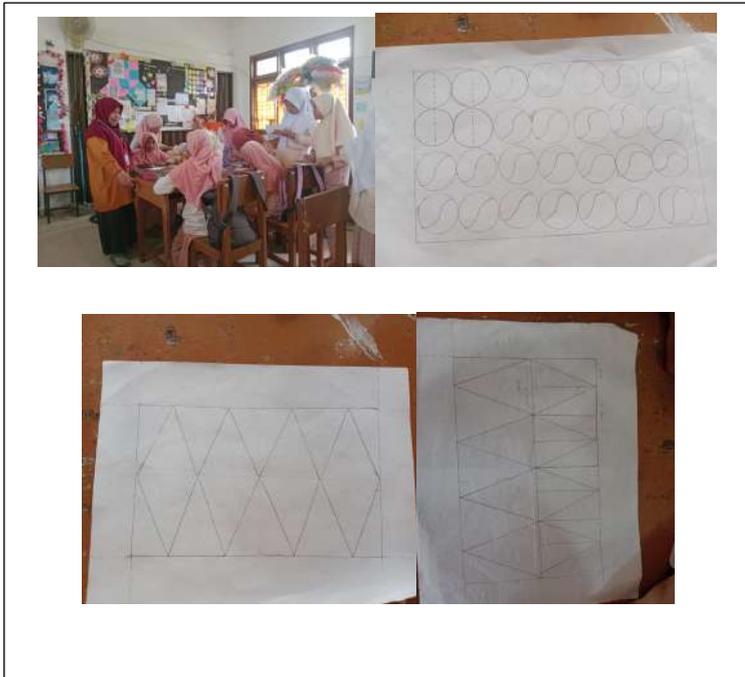

Figure 3. Students collaborate to make batik motifs of bamboo shoots and cape flowers

Didactics 3

At this stage, students conduct a follow-up study of batik motifs from various regions in Riau such as Indragiri, Kampar, and Siak. They compare the similarities and differences of shapes and the type of symmetry used in each motif. This activity was continued by making batik patterns with picture books from the images presented, so that students can apply the concept of symmetry and transformation creatively in digital form. After that, the works that have been created are exhibited in a class mini gallery. In this exhibition, students explain the

mathematical concepts they use behind the batik patterns they design. To close the learning series, the teacher leads an open-ended reflection session, where students share their experiences, challenges, and new understanding of the relationship between mathematics and local culture. They also wrote a short reflection on a post-it that was pasted on the classroom gallery board as a form of appreciation and conclusion of learning.

D. CONCLUSION

Riau batik patterns have a wealth of mathematical elements that can be used in learning mathematics in elementary schools. Through an ethnomathematical approach, teachers can relate geometry material to local cultural values contextually. This not only enhances students' conceptual understanding, but also strengthens their love for the region's cultural heritage. The development of ethnomathematics-based teaching materials is a strategic step in the implementation of differentiated learning in accordance with the spirit of the Independent Curriculum. The integration of ethnomathematics in mathematics learning not only strengthens the understanding of geometric concepts but also increases student engagement and fosters a sense of pride in the local culture. Didactic design based on Riau batik motifs has proven to be effective as a contextual and meaningful approach in geometry learning.

REFERENCES

Ain, S. Q., Lingga, L. J., Sakila, N., & Yoanda, W. (2025). Etnomatematika : Eksplorasi Konsep Geometri di Sekolah Dasar dalam Kearifan Lokal kain Songket dan Pakaian Melayu. 8, 320–328.

Ayu Julianti, F., Fuadiah, N. F., Fuadiah, N. F., Indasari, M., & Indasari, M. (2020). Desain Didaktis Pembelajaran Bilangan Cacah Untuk Kelas Iii Sd. Wahana Didaktika : Jurnal Ilmu Kependidikan, 18(3), 347. https://doi.org/10.31851/wahana didaktika.v18i3.4674

Jatayu, P. D., Wilujeng, R., Nadia, R., Hiadayah, R. N., Rahma, S. D., Miranti, S. D., & Thohir, M. A. (2024). Eksplorasi Etnomatika pada Praktik Membatik Di Sekolah Dasar. JoLLA Journal of Language Literature and Arts, 4(5), 503–511. https://doi.org/10.17977/um064v 4i52024p503-511

Putra, A. P., & Prasetyo, D. (2022). Peran Etnomatematika Dalam Konsep Dasar Pembelajaran Matematika. Intersections, 7(2), 1–9.

Setiani, D., Rahmawati, E., & Pramesti, S. L. D. (2023). Peran Etnomatematika dalam Pembelajaran Matematika di Era Society 5.0. SANTIKA : Seminar Nasional Tadris Matematika, 3, 451–461. https://proceeding.uingusdur.ac. id/index.php/santika/article/view/ 1356

Wijaya, A. P. (2016). Gaya Kognitif dan Kemampuan Pemahaman Konsep Matematis Antara Pembelajaran Langsung dan STAD. Derivat, 3(2407–3792), 1–16.