



ETHNOMATHEMATICS: MATHEMATICAL CONCEPTS IN SIGALE-GALE STATUES

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ABSTRACT

This study aims to investigate the mathematical concept of the Sigale-gale statue so that it can be utilized as an instructional resource in mathematics. The study employs qualitative approaches using an ethnographic approach. The researcher served as the data collector for the study, and the informants were the Batak people. Primary data-gathering methods include observation, interviews, documentation, and comprehensive literature reviews. The data analysis technique is descriptive analysis in the form of data reduction, data presentation, and conclusion drawing. The results revealed that the Sigale-gale Sculpture contains mathematical concepts such as plane geometry, spatial geometry, reflection transformation, dilation transformation, and angles. Ethnomathematics can be an innovation as well as a breath of fresh air in the classroom learning process so that the methods used are not monotonous, ethnomathematics-based learning models, student worksheets, and visual videos that illustrate mathematical concepts on the Sigale-gale Statue are used, thereby increasing student motivation and interest, and student learning outcomes are also increasing.

ETNOMATEMATIKA: KONSEP MATEMATIKA PADA PATUNG SIGALE-GALE

Kata Kunci:

Etnomatematika
 Konsep Matematika
 Patung *Sigale-gale*

ABSTRAK

Penelitian ini bertujuan untuk mengeksplorasi konsep matematika pada patung Sigale-gale, agar dapat dijadikan sebagai bahan ajar dalam matematika. Metode penelitian menggunakan metode kualitatif dengan pendekatan etnografi. Instrumen penelitian ini ialah peneliti itu sendiri sebagai pengumpul data dan informan adalah masyarakat suku Batak. Teknik pengumpulan data primer berupa observasi, wawancara, dokumentasi juga studi literatur yang dilakukan secara terperinci. Teknik analisis data yakni analisis deskriptif berupa reduksi data, menyajikan data kemudian menarik kesimpulan. Hasil penelitian diperoleh bahwa terdapat konsep-konsep matematika pada Patung Sigale-gale: konsep geometri bidang, geometri ruang, konsep transformasi refleksi, transformasi dilatasi, serta sudut. Sehingga etnomatematika dapat menjadi inovasi sekaligus angin segar dalam proses pembelajaran di kelas agar metode yang digunakan tidak monoton diterapkan melalui model pembelajaran berbasis etnomatematika, lembar kerja siswa maupun video visual yang menggambarkan konsep matematika pada Patung Sigale-gale sehingga meningkatkan motivasi dan minat siswa dan hasil belajar peserta didik pun semakin meningkat

1. INTRODUCTION

Indonesia is famous for its natural wealth and cultural diversity throughout the archipelago. Wealth is the main attraction for foreign tourists and even the Indonesian people. In society, culture cannot be separated from everyday life and becomes an ingrained object. Culture also needs to be separated from education. One example is mathematics [1]. Mathematical concepts greatly contribute to culture. Therefore, mathematics is said to be a cultural product [2].

However, in reality, mathematics is still considered a subject that is independent of culture [3]. Moreover, mathematical concepts that are abstract in nature as well as learning mathematics at school, which is too formal, rigid, and irrelevant to the life experienced by students, results in students thinking that mathematics is difficult and scary so that student's interest in learning is reduced, which results in students experiencing difficulties when working on math problems and student learning outcomes are also low [4]. Even though there are so many mathematical concepts that we can encounter in our daily lives. One example is *getuk lindri*. *Getuk lindri* is a traditional Javanese cake widely available in traditional markets. The Javanese have unconsciously practiced mathematics in making this cake. *Getuk Lindri*, whose shape resembles a block, can introduce an example of a geometric shape to the public [5].

Nonetheless, students' negative perceptions of mathematics can change if they find it easy and fun to learn mathematics. The ease of learning can be felt in the context of learning in the classroom and is related to daily activities. One way is to take a realistic learning approach. If the delivery of mathematics material taught in class applies a realistic learning approach, students' ability to understand mathematical concepts is superior, and student learning outcomes increase [6], [7]. This learning approach is very influential when applied when learning mathematics because the material taught will be contextual and relevant to students' daily lives [8].

One of the most relevant things in everyday life is culture. Humans cannot live without culture. Therefore, incorporating cultural elements into mathematics learning can provide positive changes and increase student interest in learning [9]. As a bridge between culture and mathematics, the term *ethnomathematics* is present [10].

The presence of *ethnomathematics* in the mathematics learning process provides fresh air and a new nuance to educators and students that learning mathematics does not have to be confined to the classroom but can also be connected to the outside world by making the surrounding culture a medium for learning mathematics. One example of mathematics learning media that can be utilized is *ethno-mathematics-based learning video media*. Based on the results of the research, it can be concluded that utilizing *ethnomathematics-based learning videos* has a positive impact that can increase students' interest and learning outcomes [11], [12].

Aside from being a learning medium, *ethnomathematics* can also be oriented to classroom learning methods. One example is the SAVI learning method (Somatic, Auditory, Visualization, Intellectual). The study's results proved that learning using the *ethnomathematics-based SAVI approach* was better than using conventional learning on students' mathematical communication skills [13]. These mathematical communication skills must be owned by students so that they can be involved in the process of learning mathematics. Because based on facts in the field, during the mathematics learning process in the class, the teacher dominates more than the students. Students tend only to hear and need more experience conveying what is on their minds, causing low mathematical communication skills.

However, these mathematical communication skills can increase if students learn ethnomathematics-based learning methods. This statement is under several previous studies, such as research by Hartinah, which says that the ethnomathematics-based Probing-Prompting learning method influences mathematical communication skills so that students become more involved in learning mathematics in class [14].

Mathematical communication skills and the ability to understand mathematical concepts are equally important and must be mastered by students. The indicators that affect the ability to understand mathematical concepts are: (1) students' basic abilities, (2) learning models and strategies, and (3) guidelines for mathematics material together [15].

Besides improving students' mathematical communication skills, ethnomathematics-based learning models also successfully increase students' mathematical understanding abilities [16]. With the ability to understand mathematical concepts, students can identify, understand and apply mathematical ideas, translate and interpret the meaning of symbols, and make and explore [17]. Exploring mathematics based on well-known cultural norms and practices can increase students' interest in learning mathematics. In addition, students will also better understand how culture is related to mathematics so that the noble values of national culture are instilled, which influence the character education of students, namely love for local culture [18].

One of the tribes in Indonesia whose culture is widely known by the general public is the Batak tribe. Batak culture also contains a lot of mathematical concepts, be it special food, traditional houses, ulos cloth, Batak script (Batak letters), musical instruments, and statues. A statue that is familiar to tourists and tourists and, of course, an iconic Batak tribe is the Sigale-gale Statue. Sigale-gale is a wooden statue used during dance performances during the funeral ceremony for the corpses of the Batak tribe on Samosir Island, North Sumatra. The origin of Sigale-gale is "gale," which means weak. Like other Batak cultures, the Sigale-gale statue is not spared from mathematical concepts. It is also very well known among the public, tourists, and tourists so the Sigale-gale statue can be utilized as a source of ethnomathematics-based mathematics learning in schools.



Figure 1. Sigale-gale Statue

Several researchers have previously researched the Sigale-gale statue. Some of them are conveying the meaning of the Sigale-gale statue collection past and present [19], the value of Sigale-gale dance in enhancing cultural tourism in Tomok village, Samosir Regency [20], and the revitalization of Toba Batak Sigale-gale statue folklore into teaching materials for English subjects for junior high school [21]. But no one has studied ethnomathematics on the Sigale-gale statue. Based on the explanation above, researchers are encouraged to conduct research related to Ethnomathematics: Mathematical concepts on the Sigale-gale statue, which are considered to influence

students' mathematical communication abilities and skills in understanding mathematical concepts so that learning outcomes and students' interest in mathematics become superior. It is also hoped that the nation's culture's noble values can be embedded to foster the character of loving local culture.

The purpose of this study is to review the use of ethnomathematics concepts on the Sigale-gale statue. The novelty of this research is in the form of a review used, specifically on the concept of mathematics, in contrast to previous studies that examined Sigale-gale statues but with a review of other scientific fields. The mathematical concepts used in the Sigale-gale statue are the topic of this study.

2. METHOD

This research is qualitative research with an ethnographic approach. Qualitative research aims to dig deeper into information about human and social problems, not just to explain the surface of a fact [22]. This study aims to examine the mathematical concepts contained in cultural elements. Descriptive data is in the form of words and pictures. Meanwhile, this ethnographic method focuses on socio-language and cultural research, namely explaining, describing, and analyzing cultural elements of a society or ethnic group using a more modern language.

The research instrument is the researcher himself as the instrument and data collector. Other supporting instruments are in the form of field notes from observations. Meanwhile, those who play the role of informants are people who know and understand Batak culture.

The object of this research is the Sigale-gale statue in Tomok, Samosir. Primary data collection techniques include observation, interviews, documentation, and detailed literature studies. Observations were conducted to observe and record parts of the statue that contained mathematical concepts. The results of the observations were then documented with pictures/photos and field notes. Then interviews were conducted to discover several things the researcher needed to know, such as the name Ulos used on the statue, the type of Batak Gorga, and so on. At the same time, the literature review is obtained from articles, scientific journals, and theses. The data analysis technique in this study is descriptive analysis in the form of data reduction, presenting data, and then drawing a conclusion. Data validation was carried out using the triangulation method. Source triangulation is carried out so that researchers get data that is truly believed to be valid [23]. In this study, data validity was obtained from interviews with informants and literature review, observation, and supported by documentation.

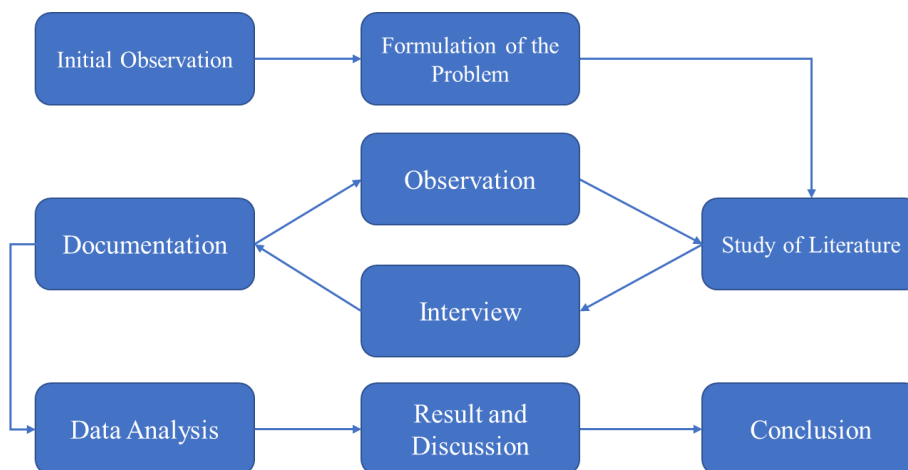


Figure 2. Research Flow

3. RESULTS AND DISCUSSION

3.1 History and Origin of the Sigale-gale Statue

Based on the results of interviews and exploration conducted by researchers, it is known that the Sigale-gale statue is a wooden statue used as a dance performance during the burial rituals of the Batak tribe. Sigale-gale originally came from the Toba-Holbung area of the North Tapanuli district, then spread to Samosir Island in the middle of Lake Toba. At funerals, Sigale-gale is used especially for people who die without having children (purpur) or if they die without having children because their children have died first, especially for someone in a high position, such as a king or a public figure [19]. Because for the Batak people, sons are very important for the family and custom to continue the lineage (marga). Based on the results of interviews with several people with the Batak tribe and launching from several previous studies tracing history, Sigale-gale was originally a doll to comfort the king who was grieving due to the death of the king's son in war [20].

The name of the king's son is Manggale. As a result, the king was very sad and frustrated because Manggale was the only son of the king, who was the heir to the kingdom. Because of the king's prolonged sadness, the king finally fell ill so badly that he had no hope of living. Every effort has been made, but none of the ways work, and no effective medicine. Finally, the king's advisers held a meeting and discussion until an agreement was reached to summon a shaman to make a wooden statue resembling the king's son Manggale [21]. But it didn't stop there. The elders summoned the Manggale spirit by blowing a bamboo flute (Sordam) and playing the Gondang Sadinding so that the spirit would enter the Sigale-gale statue that had been made [24]. Finally, the statue entertained the king, who was seriously ill, with his dance. The king slowly recovered from his illness. This statue is known as the 'Sigale-gale Statue,' which is named after the name Manggale. And until now, it is still used as a regional Samosir performance.

3.2 Mathematical Concepts on the Sigale-gale Statue

To find out the mathematical concepts of the Sigale-gale statue, the researcher divided the Sigale-gale statue into two research objects, including a) the Sigale-gale statue and b) the movements of the Sigale-gale tortor dance.

3.2.1 Sigale-gale Statue

The shape of the Sigale-gale statue which resembles a human is wrapped in adult clothing and a typical Batak cloth is slung over its shoulder. And remember that on the head of the statue. There is also a head covering typical of the Batak tribe, dominated by red, black, and white. From the results of the analysis in Figure 3, the head of the statue, which is covered by a head covering typical of the Batak tribe, forms a semicircle. After being analyzed, it can be concluded that the flat shape above is part of a circle.



Figure 3. Head of the Sigale-gale Statue

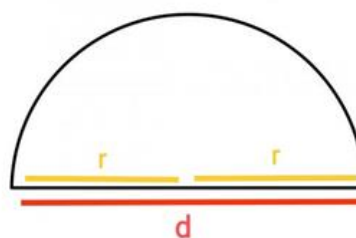


Figure 4. Semicircular Flat Shape

The characteristics of a flat circular shape are: it has one central point, has one side, has no vertices, the total angles are 360° because the Sigale-gale statue is a semicircle, the angles are 180° , it has a diameter and a radius "rad," in Figure 4 the diameter is indicated by the red line denoted by d and the radius is shown by the yellow line and denoted by r , has area and circumference, where the formula for the area of a circle is πr^2 and the formula for the circumference of a circle is πd [25].

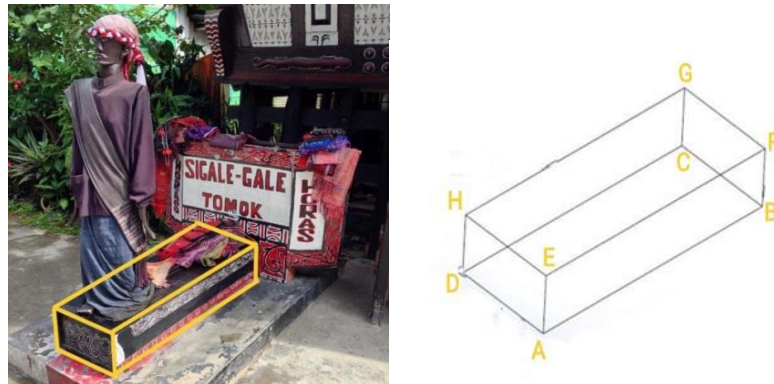


Figure 5. The Podium where the Sigale-gale Statue Stands

The Sigale-gale statue has legs connected to the podium where the statue stands, as shown in Figure 5. On the podium, a rope is connected to the statue so that the statue can dance the tortor dance. After observation, the podium in Figure 4 looks like a geometric plane with length, width, and height. Based on the researcher's analysis, the podium is a beam, as shown in Figure 5 above.

The geometrical properties of the beam are: it has six sides, namely sides ABEF, CDGH, ABCD, EFGH, ADEH, and BCFG; has 12 ribs, namely wide ribs, long ribs, and high ribs every four pieces. AB, CD, EF, and GH are long ribs; AD, BC, EH, and FG are wide ribs; and AE, BF, CG, and DH are tall ribs; has six rectangular fields facing each other, namely $ABCD = EFGH$, $AEFB = DHGC$, and $AEHD = BFGC$; The beam angle has 8 points consisting of $\angle A$, $\angle B$, $\angle C$, $\angle D$, $\angle E$, $\angle F$, $\angle G$, and $\angle H$.

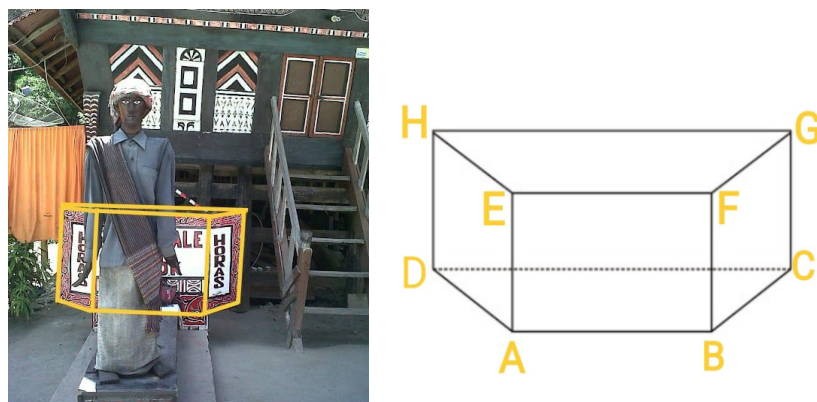


Figure 6. The Podium where the Ropes Move the Sigale-gale Statue in the Shape of a Trapezoidal Prism

The Sigale-gale statue is not a statue that can move and dance on its own like mystical stories that are widespread. However, there is an officer who moves the rope so that the Sigale-gale statue can dance and entertain the public. The rope is connected to the legs and the podium where the statue stands, which is connected to the podium behind the statue as a place for the statue moving officer. Based on the analysis results in Figure 6, the podium shape where the driving rope of the Sigale-gale statue is in the form

of a trapezoid with two equal sides; the top and bottom have a pair of parallel sides. Based on this analysis, the podium pattern includes an isosceles trapezoidal prism shape. The characteristics of this geometric figure are that it has a pair of trapezoidal shapes as well as four rectangular shapes. In Figure 6, the rectangular pattern is shown by the sides ABEF, ADEH, BCFG, and CDGH. The ABCD and EFGH sides show the trapezoidal pattern.

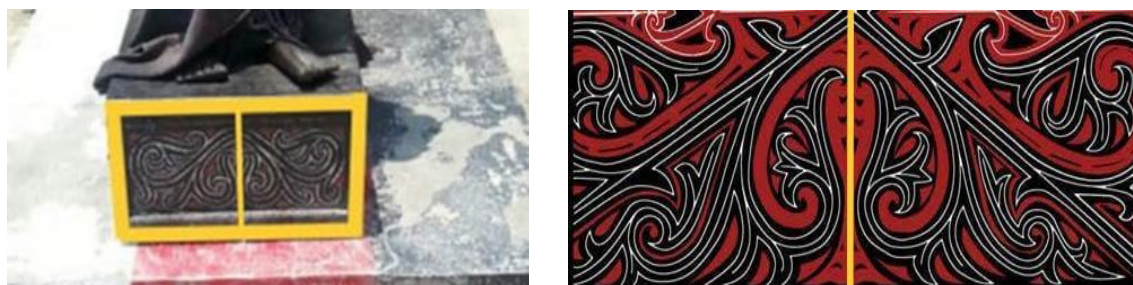


Figure 7. Batak Gorga Pattern on the Statue Podium

Figure 7 shows a mathematical concept reflecting the Batak Gorga pattern. The type of the Batak gorga is the Simeol-meol Gorga. It has the origin of the word 'meol-meol,' meaning wave. If you pay close attention to the carvings on the gorga, the lines are curved and wriggled out with beauty, giving the impression of a classic style. This type of gorga has a meaning as a symbol of joy and serves to add beauty [26]. This is intended so that the Sigale-gale statue performance is not too scary like the previous mystical stories. The audience can also be entertained and happy as they enjoy watching the tortor dance and dancing with the Sigale-gale statue. Reflection is a type of transformation or mirroring in which each point is moved with the same size and distance by utilizing the image properties of a flat mirror [27], [28]. Figure 7 shows the reflection on the right or left with the yellow line axis.



Figure 8. Ulos Sigale-gale Statue Motif

The ulos worn by the Sigale-gale statue are Sirara's ulos. This ulos is often found at every traditional Batak tribal event. Usually, this ulos is worn by men. Ulos Sirara is often used during traditional Batak parties for dead people. This ulos is also worn for people who have died, who then change their name to ulos Saput. The analysis results in Figure 8 shows that the ulos motif, marked with a yellow box, has a translation process of n scales of n . The translation is the movement of all points of a shape where the distance and direction are the same [29]. Meanwhile, the motif marked with a red box occurs in reflection or mirroring. In Figure 8 reflection on the bottom or top with the red line axis

3.2.2 Sculpture Dance

The second object studied is dance. The Sigale-gale statue will dance when the music of the gonggong beats, and its body moves like a tortor dancer. If people see it, they will also be lulled and then dance. The Sigale-gale statue is moved by someone on duty behind the podium by pulling a rope connected to the statue's feet. It is said that the number of ropes on a statue corresponds to the number of veins in a human. Sigale-gale dances to the accompaniment of 2 gonggong music, the first of which is the first gonggong as a start for the tortor dance. Next is the gonggong somba-somba, intended to be a tribute to God. And then, it ends with the Horas slogan three times [30].

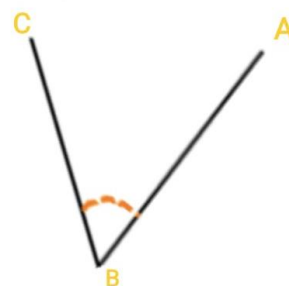


Figure 9. The Movement of the Sigale-gale Statue's Tortor Dance **Figure 10.** Sharp Angle

From the analysis results in Figure 9, the hand movements in the Sigale-gale statue dance have an angle. An angle is formed when two lines meet at a point with the same origin [31]. Angles can be expressed in 2 types of units, namely degrees ($^{\circ}$) & radians (rad). The angle is denoted by the symbol " \angle " [32]. $0^{\circ} < \alpha < 90^{\circ}$.

Based on the research and exploration results and supported by theory, the Sigale-gale sculpture contains the concepts of plane geometry, spatial geometry, reflection transformation, dilation transformation, and angles. The concept of a flat shape like a circle on the head of the Sigale-gale statue can be applied to learning material at the 6th-grade elementary school level, such as finding the area of a semicircle and the circumference of a circle. Furthermore, the material at the 8th-grade junior high school level is about calculating the elements of a circle.

The concept of geometric shapes in the form of blocks on the podium of the standing statue and the shape of the trapezoidal prism on the podium where the statue's string actuators can be used as teaching materials for grade 8 junior high school level, namely calculating volume, nets of flat sides of geometric shapes, also calculating surface area.

The concept of reflection (reflection transformation) of the Batak gorga motif found on the podium where the statue stands and the concept of translational transformation of the ulos motif used by the Sigale-gale statue can be used as teaching materials for grade 11 high school level. The findings in the above research can be used as a source of teaching materials by educators, such as learning module media, student worksheets when learning in class, as well as objects of observation in the form of visual videos that illustrate mathematical concepts on the Sigale-gale Statue that are relevant to everyday life.

4. CONCLUSION

Based on data analysis of the Sigale-gale Statue, it can be concluded that: 1) There are mathematical concepts in the Sigale-gale Statue such as points, angles, lines, parallel lines, squares, rectangles, trapezoids, circles, beams, isosceles trapezoidal prisms, reflection, and translation. 2) The findings of these mathematical concepts can be evidence that mathematics and culture are two interconnected things. Exploring mathematics through one's culture is the most effective way to make students understand and realize that mathematics is closely related to our daily lives. Besides that, ethnomathematics-based learning strategies (methods) can positively impact students' communication skills and understanding of concepts. They can increase students' interest in learning as well as student motivation. Thus, ethnomathematics can be an innovation as well as a breath of fresh air in the learning process in the classroom so that the methods used are not monotonous to increase student motivation and interest as well as increase student learning outcomes. The method is applied through module learning media, ethnomathematics-based learning models, student worksheets, and visual videos illustrating mathematical concepts on the Sigale-gale Statue.

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