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ETHNOMATEMATICS EXPLORATION ON GONDANG BATAK MUSICAL INSTRUMENTS ASSISTED BY GEOGEBRA

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ABSTRACT

This study aims to explore the mathematical concepts that exist in the Gondang Batak musical instrument with the help of Geogebra so that it can be implemented in learning. This study used qualitative research with explorative literature related to the Gondang Batak musical instrument. This study's results indicate a flat shape concept and a spatial concept in the Gondang Batak musical instrument. This can also be demonstrated by using Geogebra so that students better understand the mathematical concepts of the Gondang Batak musical instrument. It can be concluded that the Gondang Batak musical instrument can be used as a medium for learning mathematics at the elementary and middle school levels. In addition, students can also learn Batak culture, especially related to the Gondang Batak musical instrument.

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1. INTRODUCTION

Education and culture are two elements that support and complement each other in everyday life. Education plays an important role in cultural inheritance so that cultural values need to be applied in learning. Education as a pillar of culture and culture will develop education (Patri & Heswari, 2022) [1]. In education, of course, many subjects are studied starting from elementary to university level. One of the subjects studied is mathematics. Rahmah's opinion (2013) [2] states that mathematics has several important characteristics, namely (1) having abstract objects, where mathematical objects are facts, concepts, uses and rules used in processes, and (2) having a deductive and consistent mindset. Based on this, it can be stated that mathematics is needed in everyday life and is important to learn.

The fact is that students often find mathematics difficult, too many formulas to memorize and boring. This is one of the factors that influence the low results of students' mathematics learning. The achievement results of Indonesian students when participating in TIMSS 2011 (Rosnawati, 2013) [3] can be seen in Table 1 below :

Table 1. Attainment of Indonesian Students for TIMSS Results

	TIMSS Results 2011				TIMSS Results 2015			
	Low	Medium	High	Elevated	Low	Medium	High	Elevated
Science	54%	19%	3%	0%	54%	15%	6%	0%
Mathematics	43%	15%	2%	0%	54%	15%	6%	0%

From the table it can be concluded that the mathematical ability of Indonesian students is dominant at a low level. Conditions like this should be corrected with optimal effort from teachers and students. It is hoped that students will have the ability and life skills in dealing with the times and technology developments.

In the midst of the development of Science and Technology which is in line with the times, the educational curriculum requires students to have qualified abilities, including abilities in mathematics. Not only that, in the educational curriculum it is also required to have cultural involvement in learning at school. This is intended so that Indonesia's younger generation can recognize and preserve culture as the foundation of the nation's character. Cultural practices allow the embedding of mathematical concepts and recognize that everyone develops a special way of doing mathematical activities which is called ethnomathematics (Fajriyah, 2018) [4]. This is in line with the opinion (Sitanggang, 2020) [5] that culture can be used as a source of learning mathematics that can be used in schools to facilitate learning in class.

One of the cultures in North Sumatra is the Toba Batak culture. Of the many elements in Toba Batak culture, one of the elements that can be used as a source and media for learning mathematics is the Gondang Batak musical instrument. The Gondang Batak musical instruments explored in this study consist of Panggora, Sarune Bolon, Garantung, Taganing, Gondang and Sulim. In each Gondang Batak musical instrument there are different shapes and sizes that can be observed directly. This can be used as a source of learning mathematics.

In teaching mathematical concepts to the Gondang Batak musical instrument, it is best to use visual learning media, namely Geogebra. Geogebra is software designed to assist teachers in instilling material concepts through attractive images and visualizations (Hikmah and Nengsih, 2021) [6]. This is in line with the opinion (Jelatu, Sariyasa2 and Ardana, 2018) [7] that students' understanding of mathematical concepts is better when taught with Geogebra media-assisted learning than conventional (expository) learning. There are several materials that can be taught with the help of Geogebra, including plane shapes, spatial shapes, matrices, straight line equations and algebra. Therefore, this research was conducted to explain the concept of flat shapes and any spatial shapes contained in the Gondang Batak musical instrument. There are several materials that can be taught with the help of Geogebra, including plane shapes, spatial shapes, matrices, straight line equations and algebra. Therefore, this research was conducted to explain the concept of flat shapes and any spatial shapes contained in the Gondang Batak musical instrument.

2. METHODOLOGY

As described above, this research used qualitative research with a literature study method. The data in this study were taken from books, articles, literature, reports and notes relating to the problem to be solved. This research was conducted to explore the ethnomathematics in the Gondang Batak musical instrument.

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3. RESULT AND DISCUSSION

1. Panggora

The Panggora musical instrument is a gong that is played by hitting it with a stick. Panggora has a diameter of 36 cm with a thickness of less than 6 cm (Dwi, 2020) [8].

Figure 1. Panggora

In Panggora, it can be seen that there is a flat geometry concept, that is a circle. By using Geogebra it can be described as follows:

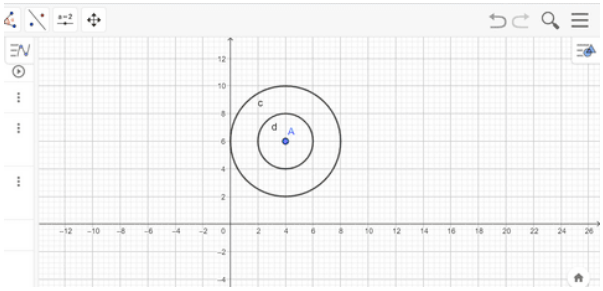

Figure 2. Circle using Geogebra

Through Figures 1 and 2 it can be understood the properties of a circle as follows : (1) a circle only has 1 side, (2) has no vertices, (3) has a central point, (4) the number of angles is 3600, (5) has symmetry fold and infinite rotary symmetry, (6) has a radius and diameter, and (7) has a circumference and area.
In Figure 1, for example, the diameter of Panggora is 36 cm, then it can be determined :

- Panggora's circumference is C. $C = \pi \mathrm{d} = \frac{22}{7} \times 36cm = \frac{792}{7} = 113{,}14cm$
- Area of Panggora is A. $A = \pi r^2 = \pi(\frac{1}{2}d)^2 = \pi\frac{1}{4}d^2 \rightarrow A = \pi\frac{1}{4}(36)^2 = \frac{22}{7}\frac{1}{4}(1296) = 1018{,}28\ cm^2$

2. Sarune Bolon

Sarune Bolon is a wind instrument that is useful for carrying melodies.

Figure 3. Sarune Bolon

Sarune Bolon is made of bamboo with holes at both ends with a length of 10-12 cm and a diameter of 1-2 cm. In Sarune Bolon there are 6 holes of different sizes (Dwi, 2020) [9]. In Sarune Bolon, it can be seen that there is a flat geometric concept, namely an isosceles triangle and a circle. There is also the geometric concept of a geometric shape, that is a cone. By using Geogebra it can be described as follows:

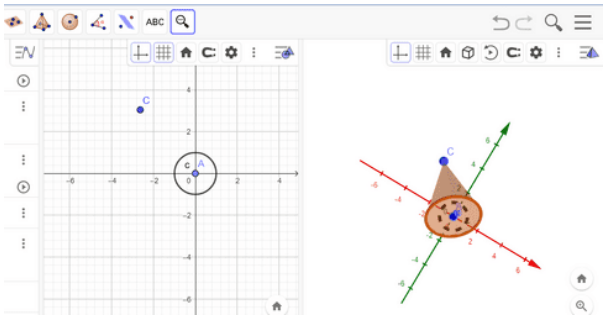

Figure 4. Cone using Geogebra

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Through Figures 3 and 4, the properties of a cone can be understood as follows : (1) having 2 curved sides, namely the base side in the form of a circle and the blanket side in the form of an isosceles triangle, (2) having 1 vertex (peak point), (3) having a line the painter, namely the lines on the conical blanket that are drawn from the apex (point of the corner) to the points on the circumference of the circle, and (4) have the volume and surface area of the cone.

In Figure 3, for example, the diameter of the Sarune Bolon is 2 cm, the height is 10 cm, then it can be determined:

- Volume of Cone (V) = $V = \frac{1}{3}\pi(\frac{1}{2}d)^2t = \frac{1}{3}.\frac{22}{7}.(\frac{1}{2}.2)^2.10 = \frac{220}{21} = 10{,}47cm^3$
- Cone surface area = $\pi rs + \pi r^2$

Before determining the surface area of a cone, it is necessary to determine the line of the cone painter, namely
$s = \sqrt{r^2 + t^2} = \sqrt{1^2 + 10^2} = \sqrt{101}$ = 10,049 cm.
Cone surface area = L = $\frac{22}{7}.1.(10{,}049) + \frac{22}{7}.1^2 = 31{,}58 + 3{,}14 = 34{,}72cm^2$

3. Garantung

Garantung is a Toba Batak musical instrument as a melody carrier.

Figure 5. Garantung

In Garantung there are 11 rectangular wooden slats that are hung on a resonator or sound storage container. The resonator or sound storage container is in the shape of a trapezoid. Each piece of wood in Garantung has a length of ± 28 cm. The Garantung beater has a diameter of ± 0.7 cm and a length of ± 22 cm (Pasaribu, 2013) [10]. Meanwhile, the size of the resonator container or sound storage is adjusted to the size of the wooden slats in Garantung.

On the wooden slats it can be seen that there is a geometric concept of a flat shape, namely a rectangle. By using Geogebra it can be described as follows:

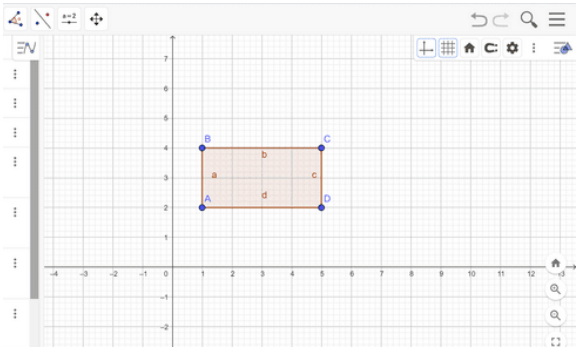

Figure 6. Rectangle with Geogebra

In the resonator container or sound storage, it can be seen that there is a geometric concept of a flat shape, this is called the trapezoid. By using Geogebra it can be described as follows:

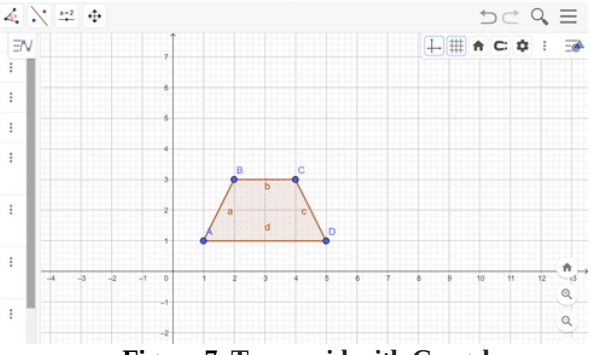

Figure 7. Trapezoid with Geogebra

In the Garantung beater, it can be seen that there is a geometric concept of a geometric shape, that is a tube. By using Geogebra it can be described as follows:

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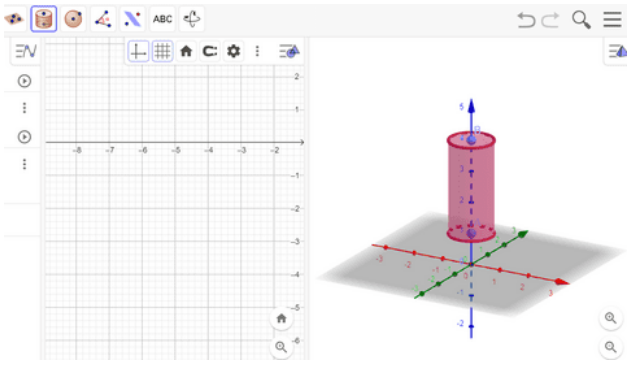

Figure 8. Tube with Geogebra

From the size of the Garantung bat, it has a diameter of ± 0.7 cm and a length of ± 22 cm. Suppose a diameter of 0.7 cm and a length of 22 cm can be determined.

Volume (V) = $\pi r^2 t = \frac{22}{7}.(0{,}35)^2.22 = \frac{22}{7} \times 0{,}1225 \times 22 = \frac{59{,}29}{7} = 8{,}47cm^3$

Tube surface area = $L = 2\pi r(r+t) = 2.\frac{22}{7}.0{,}35.(0{,}35+22) = \frac{44}{7}.(0{,}35).(22{,}35) = \frac{344{,}08}{7} = 49{,}15cm^2$

4. Taganing

Taganing is a Toba Batak musical instrument that is used in mastering the repertoire and playing melodies together with sarune. The drums in Taganing have different sizes and produce different sounds. The size of each drum in Taganing consists of (1) Taganing 1 with a diameter of 29 cm, height 81 cm, (2) Taganing 2 with a diameter of 24 cm, height 70 cm, (3) Taganing 3 with a diameter of 22 cm, height 55 cm, (4) Taganing 4 with a diameter of 19 cm, height 53 cm, (5) Taganing 5 with a diameter of 19 cm, height 53 cm, and Taganing 6 with a diameter of 16 cm, height 51 cm (Hadisukirno, 2013) [11].

Figure 9. Taganing

In Taganing, it can be seen that there is a geometric concept of a geometric shape, this is called a cylinder. By using Geogebra it can be described as follows:

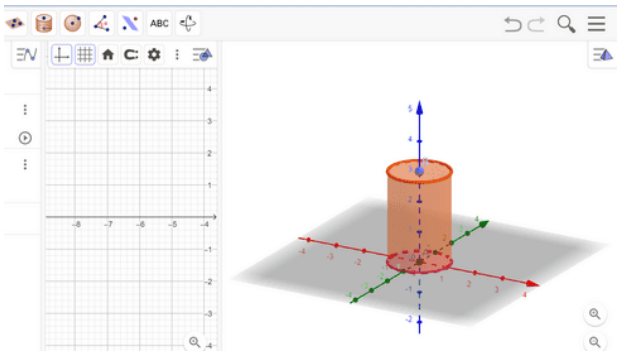

Figure 10. Tube with Geogebra

5. Gondang

The gondang (gordang) is a Toba Batak musical instrument consisting of a drum that is larger than the Taganing which acts as a carrier of both constant and variable rhythms (Juliano, 2022) [12].

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Figure 11. Gondang

In Gondang it can be seen that there is a geometric concept of a geometric shape, that is a tube. By using Geogebra it can be described as follows:

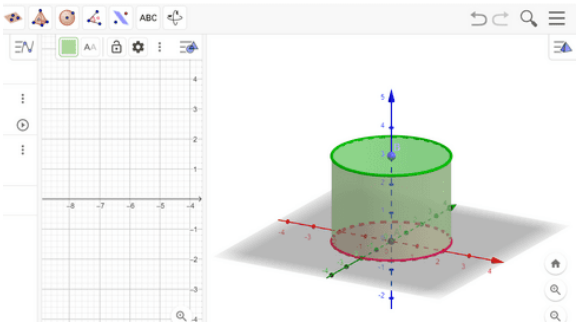

Figure 12. Tube with Geogebra

6. Sulim

Sulim is a Toba Batak traditional musical instrument consisting of a blow hole and 6 tone holes. Sulim is almost the same as the type of flute in other ethnic groups in general. The difference is only in the additional hole, namely between the blow hole and the tone hole. This additional hole has a sound color which is its own characteristic compared to other flute instruments (Matthewigt, 2018) [13].

Figure 13. Sulim

In Sulim, it can be seen that there is a geometric concept of a geometric shape that is called a tube. By using Geogebra it can be described as follows:

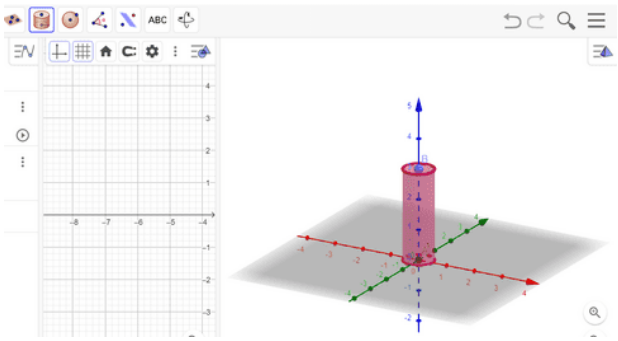

Figure 14. Tube with Geogebra

Previously, it was explained that in the Garantung, Taganing, Gondang and Sulim beaters there is a geometric concept, that is the cylinder. This can be observed directly from the shape and size of each of these Batak musical instruments and is also supported by visualization images from Geogebra so that students can understand the characteristics of the tube.

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4. CONCLUSION

The result of ethnomathematics exploration of the Gondang Batak musical instrument is that there are geometric concepts in the form of flat shapes and geometric shapes. The flat shapes in question are circles, triangles, rectangles, and trapezoids. The shape of the space in question is a cone and a tube. The concept of flat shapes and spatial shapes on the Gondang Batak musical instrument can be used to introduce mathematics through local culture so that learning is more meaningful. In addition, the Gondang Batak musical instrument, which is loaded with geometric concepts, can be used as a concrete and innovative learning medium.

5. REFERENCES

[1] Patri, S. F, D & Heswari, S. (2022). Etnomatematika dalam Seni Anyaman Jambi sebagai Sumber Pembelajaran Matematika. JIP : Jurnal Inovasi Pendidikan, 2(8), 2705-2714. Accessed at https://stp-mataram.e-journal.id/JIP/article/view/1150

[2] Rahma, N. (2013). Hakikat Pendidikan Matematika. Al-Khwarizmi: Jurnal Pendidikan Matematika dan Ilmu Pengetahuan Alam, 1(2), 1-10. Accessed at https://ejournal.iainpalopo.ac.id/index.php/al-khwarizmi/article/view/88

[3] Rosnawati, R. (2013). Kemampuan Penalaran Matematika Siswa SMP di Indonesia pada TIMSS 2011. Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA, Universitas Negeri Yogyakarta, 2(1), 203-213.

[4] Fajriyah, E. (2018). Peran Etnomatematika Terkait Konsep Matematika dalam Mendukung Literasi. PRISMA: Prosiding Seminar Nasional Matematika, 114-119

[5] Sitanggang, N. (2021). Eksplorasi Alat Musik Tradisional Khas Batak Toba. Jurnal PEKA : Jurnal Pendidikan Matematika, 4(2), 57-62. Accessed at https://jurnal.ummi.ac.id/index.php/peka/article/view/851

[6] Hikmah, R & Nengsih, R. (2021). Etnomatematika : Persamaan Garis Lurus dengan Media Geogebra. Jurnal Derivat , 8(2), 88-97. Accessed at https://journal.upy.ac.id/index.php/derivat/article/view/1972

[7] Jelatu, S., Sariyasa2, & Ardana I. M. (2018). Pengaruh Media Geogebra terhadap Pemahaman Konsep Geometri Ditinjau dari Kemampuan Spasial Siswa. Jurnal Pendidikan dan Kebudayaan Missio, 10(2), 162-171. Accessed at http://unikastpaulus.ac.id/jurnal/index.php/jpkm/article/view/167

[8] Dwi. (2020). 15 Alat Musik Tradisional Sumatera Utara (Artikel web). Accessed at https://tambahpinter.com/alat-musik-sumatera-utara-batak/#:~:text=10.%20Panggora,-Sumber%20foto%3A%20macamalatmusik&text=Menyerupai%20alat%20musik%20Faritia%20yang,kuningan%2C%20besi%20atau%20juga%20perunggu.

[9] Dwi. (2020). 15 Alat Musik Tradisional Sumatera Utara (Artikel web). Accessed at https://tambahpinter.com/alat-musik-sumatera-utara-batak/#:~:text=10.%20Panggora,-Sumber%20foto%3A%20macamalatmusik&text=Menyerupai%20alat%20musik%20Faritia%20yang,kuningan%2C%20besi%20atau%20juga%20perunggu.

[10] Pasaribu, S. R. B. (2013). *Pembuatan dan Fungsi Garantung, Salah Satu Alat Musik Tradisional Batak Toba* (Master thesis). Accessed at http://digilib.unimed.ac.id/16996/

[11] Hadisukirno. (2013). Taganing Batak (Artikel web). Accessed at https://www.hadisukirno.co.id/produk.html?id=Taganing_Batak

[12] Juliano, A. (2022). Mengenal Gondang Batak Toba, Alat Musik yang Dimainkan saat Suka maupun Duka (Artikel web). Accessed at https://www.merdeka.com/sumut/mengenal-gondang-batak-toba-alat-musik-yang-dimainkan-pada-saat-duka-maupun-bahagia.html

[13] Matthewjgt. (2018). Sulim/Seruling Batak (Artikel web). Accessed at https://budaya-indonesia.org/Sulim-Seruling-Batak