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Ethnomathematical Insights into Rumah Gadang's Building Form and Ornaments

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ABSTRACT

Ethnomathematics integrates cultural contexts into mathematical learning, enriching students' comprehension of mathematical concepts and their applications. This study explores the embodiment of ethnomathematical concepts within the architecture and ornamentation of Rumah Gadang in Luhak Tanah Datar, a traditional dwelling renowned for its intricate designs. Employing a qualitative research method, this investigation utilizes interviews, participatory observation, and document analysis to examine the contributions of two craftsmen. The primary objective is to elucidate the mathematical principles manifest in the structural and decorative elements of Rumah Gadang, with a focus on identifying specific mathematical ideas and concepts that are applicable to educational settings. Findings reveal that the architecture and decorations of Rumah Gadang incorporate various mathematical concepts, including counting, measuring, locating, designing, playing, and explaining, which are expressed through numbers, shapes, lines, geometric transformations, trigonometry, angles, and symmetry. This research not only highlights the presence of intricate mathematical ideas in traditional architecture but also suggests the potential of these findings to serve as valuable educational resources in teaching mathematics. Additionally, these insights provide a foundation for further ethnomathematical studies related to Rumah Gadang.

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1. INTRODUCTION

The era of modernization has led to many improvements in society. The rise in information technology tools makes society, especially students, compete to keep up with the times. This technology makes students engrossed in the virtual world and it seems they forget the real things around them, including cultural knowledge and other historical relics, of course this is a legacy that they must also preserve (Salsabila, 2021; Syukur, 2023); This situation is caused by a lack of understanding and application of the importance of knowing national culture and local culture. Basically, education and culture are things that cannot be separated in everyday life, especially mathematics learning Abdullah, (2018) states that mathematics is a form of a culture, that has actually been integrated into all aspects of people's lives. Mathematics is a science that lives and develops in society, but often people are not aware of it. As stated by Abdullahi et al., (2021), Mathematics is actually used by everyone in their daily activities. Thus, it can be seen that mathematics is a science that has an important role in human life,

because mathematics has an influence on technological development. Apart from that, mathematics is a science that bridges other sciences. As stated by a German mathematician named Carl Friedrich Gauss, mathematics is the queen of the sciences (Abdullahi et al., 2021). Mathematics is one of the basic sciences, which is increasingly being felt its interaction with other fields of science, such as economics and technology. The role of mathematics in this interaction lies in the structure of knowledge and equipment used. Mathematics is still widely used today Various fields such as industry, insurance, economics, agriculture, etc many social and technical fields.

In addition, Zaenuri & Dwidayati (2018) also state that in essence, mathematics is a symbolic technology that grows on skills or cultural and environmental activities. The idea of culture must be integrated into mathematics learning. Implementing ethnomathematics into learning can help students see the creativity and beauty of learning mathematics (Putra et al., 2021);(Izah, 2021). Thus, the assumption that mathematics has nothing to do with culture is wrong, because mathematics is a science that is integrated in all aspects, including cultural aspects. Therefore, mathematics and culture cannot be separated. This connection between mathematics and culture is called ethnomathematics

Learning that can bridge between culture and mathematics is ethnomathematics. Ethnomathematics is defined as the use of a teacher's close and direct environment in teaching mathematics (Jemamun, 2023);(Harahap, 2019). In the learning process, ethnomathematics has been proven to be able to improve students' mathematical abilities, motivate students, and overcome student boredom and difficulties while studying mathematics (Nova & Putra, 2022). According to Muyassaroh & Dewi (2021), Ethnomathematics has a role to support and facilitate students' mathematical literacy skills, including that Ethnomathematics can construct mathematical concepts based on students' knowledge regarding the sociocultural environment around them. Ahmad, (2022) states that an effort to instill knowledge of culture in students can help them understand themselves and their peers, this can also help them develop knowledge about culture and increase their social interaction as a living society and will never be separated from culture.

In the process of integrating culture into learning mathematics, it is better if it starts from the culture that exists in the surrounding environment. This will make it easier for students to understand and interpret mathematics learning because the contextual problems given are close to students. One of the beauties of Minangkabau culture which can be used as a reference in learning mathematics is the traditional house. A traditional house is a building that has cultural characteristics and characterizes the life of the local community (Abdulghani, 2020);(Putra, 2020). The Minangkabau traditional house is Rumah Gadang. Rumah Gadang is a house left by ancestors in the Minagkabau area, West Sumatra. This house has many elements of uniqueness and uniqueness, including the roof which has a shape resembling a buffalo horn, which is oval and curved in shape, the shape of the building resembles a ship, carvings that have meaning, under the house which has various functions, and so on.

From the preliminary study, we found elements of ethnomathematics in the Rumah Gadang design, such as carvings and building shapes. Where there are mathematical concepts such as angles, symmetry, geometry and transformation. This in in line with Fitriza, (2018), who said there are four concepts that can be obtained based on the ethnomathematics exploration of Rumah Gadang, namely lines and angles, flat shapes, circles, and transformations. This is also reinforced by the results of the study Rahmawati & Muchlian, (2019), who said that mathematical concepts are the result of activity in making patterns that can be expressed from the motifs of the Rumah Gadang wall carvings including the concepts of circles, straight lines and curved lines, symmetrical, reflection, dilation, translation, and rotation.

The problem that will arise if the introduction of the Rumah Gadang as a cultural heritage is not carried out to students is that over time, this Rumah Gadang will be threatened with extinction. Moreover, nowadays very few young people know the carving techniques and meaning of the carvings on the Rumah Gadang. Many things can be found in the Rumah Gadang regarding ethnomathematics which are related to mathematics learning. For this reason, an ethnographic study related to Rumah

Gadang is needed. Thus, this study aims to find and know the various mathematical ideas and mathematical concepts contained in the construction of Rumah Gadang.

Various previous studies related to ethnomathematics on building forms and house ornaments. Like research conducted by Sari et al., (2018), whose research focus is on ethnomathematics in the culture of the Ogan Komering Ulu Traditional House, South Sumatra. Study by Yuningsih et al., (2021), The focus of this research is Ethnomathematics Exploration in Lengkong Traditional House Design. Next is research by Maharani, (2018), whose research focus is on Ethnomathematics in the Panjalin Traditional House. The next research conducted by Tyas et al., (2022) whose research focus is on Ethnomathematical Studies on the Building Structure of the Riau Selaso Tumbling Kembar Traditional House.

From the results of research conducted by several previous researchers, it is known that many ethnomathematic elements are found in the design of Rumah Gadang. So that students will feel that mathematics learning is directly connected to real life, which can make students more motivated and interested in learning mathematics, besides that they will feel that learning is more meaningful. This is in line with opinion of Fauzan, (2020), who said that the elements of ethnomathematics in Rumah Gadang are very likely to be an interesting context for learning mathematics, because in the design and architectural philosophy of Rumah Gadang there are various mathematical concepts. What distinguishes the research conducted by researchers from previous researchers is the subject of the research itself. The subject of this research is the tuo craftsman, Rumah Gadang in Luhak Tanah Datar. Meanwhile, the research subjects from Sari et al., (2018), Yuningsih et al., (2021), Maharani, (2018), dan Tyas et al. (2022), Traditional houses located outside the region of West Sumatra. Based on the description above, the researcher is interested in conducting research on ethnomathematics in the form of buildings and Rumah Gadang ornaments in Luhak Tanah Datar, West Sumatra province, Indonesia.

2. METHODS

This study employs a qualitative research methodology, defined by Sugiyono (2020) as an approach conducted against a naturalistic backdrop. It aims to delve into social issues by providing clear, comprehensive, and complex descriptions through verbal articulations. Manab (2015) further elucidates that qualitative research is a systematic endeavor to gather, categorize, describe, and interpret data obtained from interviews, observations, and documentary analysis. This methodological approach facilitates an in-depth understanding of the phenomena under study by focusing on contextual detail.

The specific focus of this investigation is ethnomathematics, utilizing the qualitative research framework to explore mathematical concepts embedded in cultural artifacts. According to Fraenkel (2012), ethnographic research involves documenting or describing the daily experiences of individuals through observation and interviews, capturing the perspectives of relevant participants within their authentic environments. This study is situated in various locales within Tanah Datar, including Pagaruyung, Malalo, Rambatan, Balimbing, Lima Kaum, Sungai Tarab, Pariangan, and Padang Magek.

Participants in this research include informants and participants such as artisans, workers associated with the construction of the Rumah Gadang, and caretakers of these traditional houses. These subjects are selected based on their deep understanding of the Rumah Gadang and the significance of each carving found therein.

Data collection for this ethnographic study utilizes a triangulated approach to ensure a thorough examination of the mathematical concepts inherent in the architecture of the Rumah Gadang. The research team conducts observational visits to various Rumah Gadang sites within Tanah Datar Regency, aiming to directly assess the architectural elements and spatial arrangements that embody mathematical principles. Concurrently, interactive interviews with 'tuo' craftsmen, the traditional builders of the Rumah Gadang, are conducted to glean insights into the planning and construction processes and how ethnomathematical concepts are integrated. Additionally, there is a systematic collection of textual materials and cultural artifacts, including documents that detail the philosophical

foundations of Minangkabau traditional houses and their architectural plans. This documentation is crucial for supporting and validating the findings derived from both observations and interviews, providing essential historical and cultural context to the study.

Data analysis in this study is structured into a cohesive process that begins with data reduction and codification, where activities include summarizing, prioritizing key elements, and identifying themes and patterns as highlighted by Sugiyono (2019). This is followed by data presentation, which involves organizing the condensed data in a manner that enhances its interpretability and ease of understanding. The final stage entails drawing conclusions from the analyzed data to elucidate the ethnomathematical elements observed in the Rumah Gadang. Utilizing Bishop's (1997) framework, the identified ethnomathematical aspects in the Rumah Gadang of Minangkabau are classified into six mathematical ideas: counting, measuring, locating, designing, playing, and explaining. These categories are instrumental in illustrating how indigenous knowledge systems seamlessly integrate mathematical thinking into their cultural practices.

3. FINDINGS AND DISCUSSION

Ethnographic research was conducted to see what mathematical ideas exist in Rumah Gadang, where these mathematical ideas contain mathematical concepts that can be taught in the process of learning mathematics. The mathematical ideas obtained are as follows:

3.1. Counting Idea

This idea has to do with associating objects with numbers. At Rumah Gadang, it is found that the number of rooms and the number of stairs are always odd. To determine the number of pillars used in the Rumah Gadang, it can be determined by multiplying the number of spatial pillars by the number of linear pillars used where each is added by one so that the formula is obtained $Bt = (tr + 1)(tl + 1)$

Description:

Bt = Number of Pillars of Rumah Gadang

tr = Number of space Pillars

tl = Number of Bollards

In the idea of counting, there is a mathematical concept in Rumah Gadang, namely the concept of numbers, where the concept of numbers can be taught in the learning process. In the learning process the teacher provides pictures of the shape of the Rumah Gadang stairs which have many different steps such as 3, 5, 7, 9 and so on, where the students observe the pictures to be able to group them and find odd number patterns, with this the students Later you will be able to understand the concepts of odd numbers.

3.2. Measuring Idea

This concept pertains to the activities of comparing, predicting, and calculating attributes in terms of their value and utility. At the Rumah Gadang, numerous instances of measuring ideas are evident. For example, the determination of stair lengths employs the principles of trigonometry, as demonstrated in the subsequent analysis. This application underscores the sophisticated integration of mathematical concepts in the architectural design of these traditional structures.

Figure 1. Stepladder of Rumah Gadang

Apart from that, the floor height also has the idea of measuring, where the floor height, for Koto Caniago, has the same floor height, while for Koto Piliang, the floor on the edges is raised, so it has a different floor height.

In the idea of measuring, there is a mathematical concept in Rumah Gadang, namely the concept of trigonometry, where the concept of numbers can be taught during the learning process. In the learning process the teacher provides a picture of the shape of the Rumah Gadang stairs, where students observe the shape of the Rumah Gadang stairs, which resembles a right triangle and paint a sketch of the shape of the stairs. After painting it students can determine the length of the sides of a right triangle using the phytaqoras theorem. With this, students will be able to understand the concept of trigonometry.

3.3. Locating Idea

Relating to the topographic activity of an object or spatial abilities. Initially the Rumah Gadang building in the Luhak Tanah Datar area was oriented/facing towards Mount Marapi which was believed to be the area of origin of the ancestors of the Minangkabau people. The Rumah Gadang should not face the sun because if it faces the sun, the Rumah Gadang will easily become rotten, so the Gadang Rumah Gadang extends from north to south and vice versa.

Apart from that, the Rumah Gadang must be on tribal land. In this locating idea there is the concept of a perpendicular line, where in the process of learning mathematics the teacher will give points that are on the west and east which correspond to the rising and setting of the sun and the north and south points according to the layout of the Rumah Gadang. Students will try to connect these points so that two lines will be formed that are perpendicular to each other, as shown in the following picture.

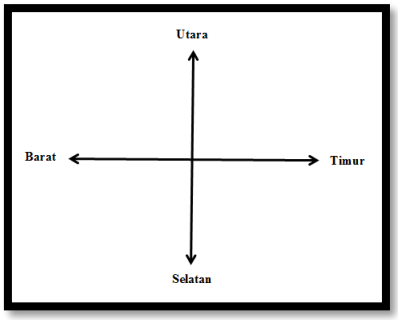


Figure 2. Garis saling tegak lurus sesuai dengan arah mata angin

From the picture above, students will try to determine the concept of a perpendicular line, such as the size of the angle.

3.4. Designing Idea

Related to the activities of design, abstraction, geometric, symmetry, comparison, similarity, congruence and zooming in and out with the scale of an object. On the roof of the Rumah Gadang, there is a gonjong shape that displays balance where the right side is a reflection of the left side and vice versa.

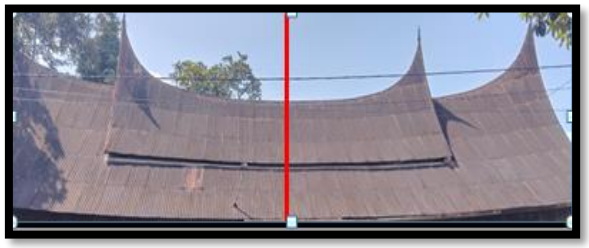


Figure 3. The roof of Rumah Gadang

In the milestone section you can see the shape of the milestone which is the shape of an n-sided prism, such as an 8-sided or 12-sided and the milestone section but has the same slope and is parallel

Figure 4. Pillars of Rumah Gadang

In the underside, similar and congruent building forms are also found and there is also the concept of geometric transformations such as reflection (reflection) as shown below:

Figure 5. Under area of Rumah Gadang

Apart from that, there are many mathematical concepts found in the design of Rumah Gadang, both in terms of the shape of the building and its ornaments, such as the concept of flat shapes, trigonometry, transformations and lines.

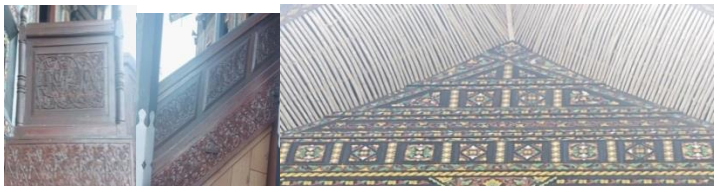


Figure 6. Carving of Rumah Gadang on a flat surface

In the picture above, it can be seen that there is an application of flat wake concepts such as triangles, squares, rectangles, parallelograms and so on

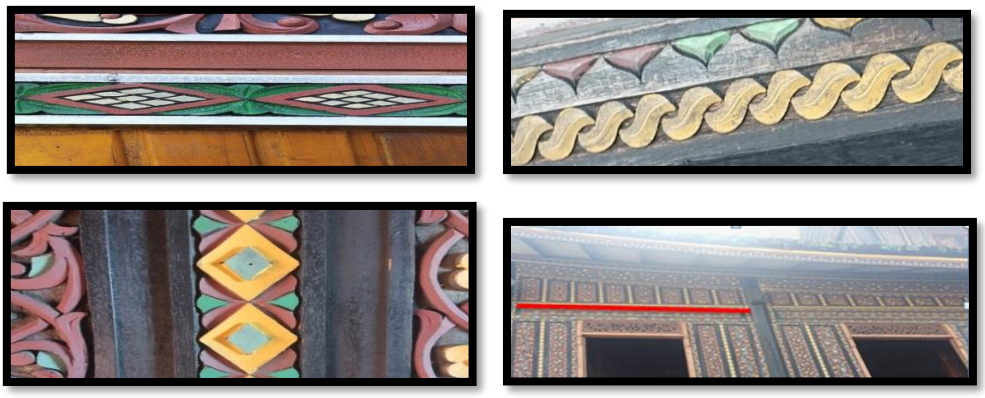


Figure 7. Carving of Rumah Gadang using the Concept of Transformational Geometry

In the picture above, it can be seen that the concepts of transformation geometry are applied, namely reflection, translation, rotation, and dilation.

Many mathematical concepts can be found in Rumah Gadang's designs, including flat shapes, lines, and geometric transformations. In the process of learning mathematics later the teacher can provide pictures of building shapes and Rumah Gadang ornaments to students, for example in the geometry transformation material for the reflection (reflection) section, the teacher gives pictures of the carvings of the *saik ajik* motif as follows

Figure 8. Ukiran Rumah Gadang motif saik ajik

Students will then sketch the saik ajik carving motif into a Cartesian graph like the following image

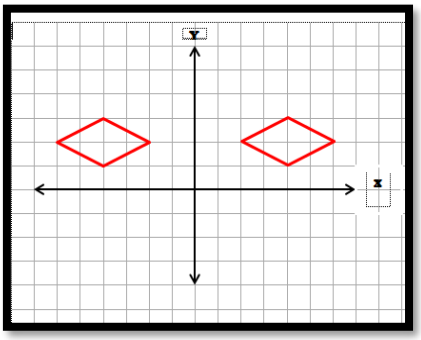


Figure 9. Sketsa ukiran motif saik ajik

After sketching the carving, students pay attention to the shape of the flat building in the left and right images, where there are similarities in size, shape and distance to the y-axis which is the mirror line. From this, students can understand the concept of reflection.

3.5. Playing Idea

Relating to rules or procedures in an activity. At Rumah Gadang, you can find many playing ideas, such as installing rafters, building ladders, building the side and back walls, and making the roof.

Figure 10. Rafter of Rumah Gadang

The rules for installing the rafters for the roof show that the wood used as *lae* is bamboo and wooden rafters with a thickness of 4-6 cm. *Lae* is arranged horizontally, where the bamboo wood is arranged parallel to the distance of about 1-3 fingers. The rafters are stacked vertically, so there is an intersection with the *lae*. The rafter spacing is estimated at 0.5 m - 1.5 m, where the number of rafters used must be an odd number.

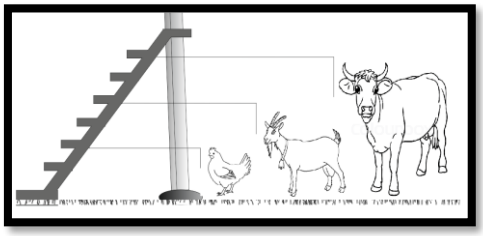


Figure 11. stepladder sketch of Rumah Gadang

The rules for building ladders can be seen from the use of pits. Kolong is usually used as a cage for livestock, both chickens, goats, cows and buffalo. The usefulness of this pit affects the size of the ladder, where the height according to the philosophy cannot exceed 2m or is estimated to be 1-2m.

Figure 12. Back Wall of Rumah Gadang

The rules for installing the side and rear walls using woven bamboo must follow the customary philosophy, where the woven must be made of a four-four system, namely four vertical and four horizontals where there are parallel and perpendicular lines.

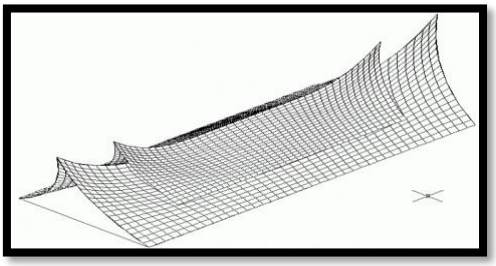


Figure 13. Roof Sketch of Rumah Gadang

The idea of designing Rumah Gadang can also be seen in the use of the concept of fractal geometry, where fractal geometry in architecture means repeating shapes at different scales. It looks like the shape of the building. One of them is on the roof which is a repetition of the oval shape, where the lower part looks bigger than the top.

In the idea of playing, you can find many mathematical concepts in the Rumah Gadang, including odd numbers, lines and fractal geometry. In the mathematics learning process, the teacher provides a picture of the shape of the roof of a Rumah Gadang where the roof of the Rumah Gadang has repeated shapes at different scales. Students observe the picture and try to paint again using a different scale given by the teacher. With this, students will be able to understand the concept of fractal geometry.

In the line material, the teacher provides a picture of the form of installation of lae and rafters on a Rumah Gadang, where students pay attention and analyze that the lae are arranged parallel, so that students can determine the concept of parallel lines, namely lines that have no intersections but have the same slope. Meanwhile, regarding the relationship between rafters and lae, students see the installation of lae and rafters on a Rumah Gadang which are perpendicular to each other, so that students can analyze and discover the concept of perpendicular lines, namely lines that intersect each other and form a right angle (90) degree.

3.6. Explaining Idea

This discussion relates to the cognitive aspects involved in conceptualizing and explaining architectural elements. The selection of Tonggak Tuo, the main supporting pillars for the Rumah Gadang, is based on specific criteria: the pillars must grow in flat areas, stand straight, and have few branches, as these characteristics are believed to indicate strength. Moreover, the construction of the Rumah Gadang is not merely functional; each element of the work carries its own meaning and philosophy. For example, the walls of the Rumah Gadang are traditionally woven in a four-four system, aligning with the Minangkabau philosophy of 'kato nan ampek' (four-word adages), which emphasizes wisdom and communal values in everyday life. In teaching mathematics, this cultural practice can be illustrated by showing students how the wickerwork is installed on the walls of the Rumah Gadang, enhancing their understanding of geometric patterns and cultural context. The following image provides a visual representation of this intricate process.

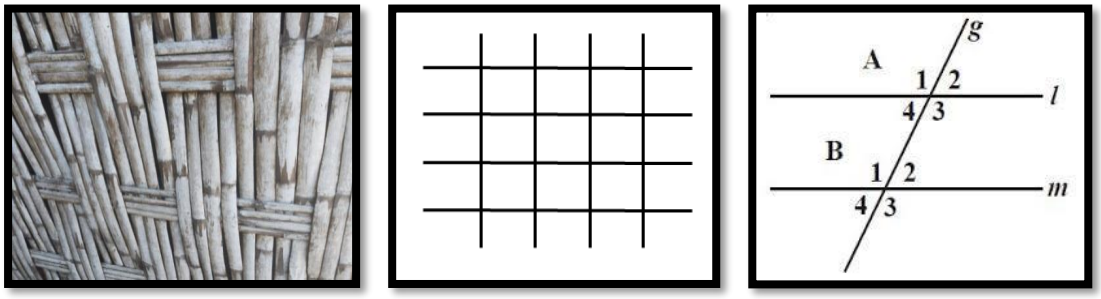


Figure 14. The back wall of the *Rumah Gadang* and its sketch

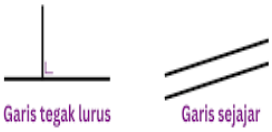
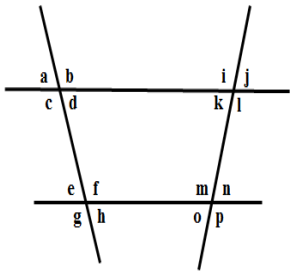
Students observe and analyze and determine the angles of parallel lines cut by transverse lines, namely straight angles, facing angles, opposite angles, one-sided angles, oblique angles and opposite angles. Examples of opposite interior angles have the same angle measure as <A4 = < B2, <A3 = < B1.

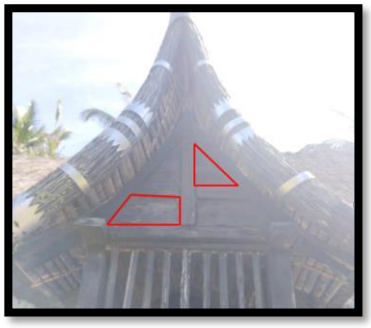
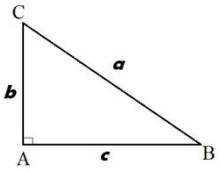
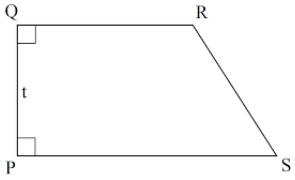
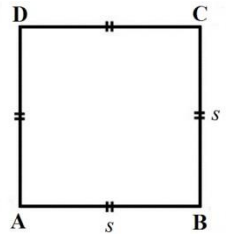
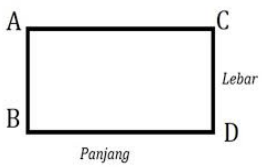
3.7. Ethnomathematics Implementation in Mathematics Learning

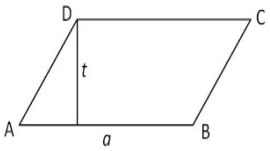
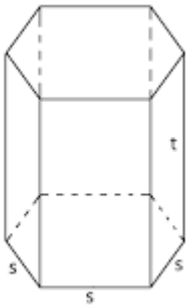
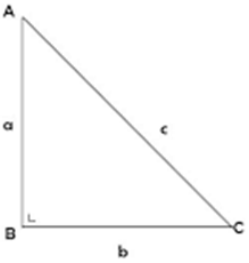
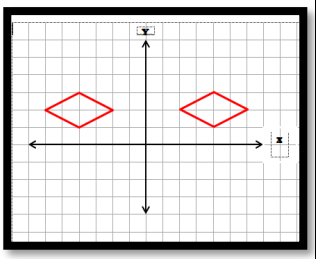
Based on the mathematical ideas obtained in the shape of the building and the ornaments of the Rumah Gadang, there are mathematical concepts that can be used as references in learning mathematics. The mathematical concepts contained include the concepts of numbers, lines, angles, shapes and shapes, congruence and congruence, symmetry, geometry, trigonometry and transformation. In the following, the ethnomathematics of the Rumah Gadang will be presented, which is associated with the mathematical concepts obtained at the Rumah Gadang, in the following table:

Table 1. Ethnomathematics and Learning Implementation

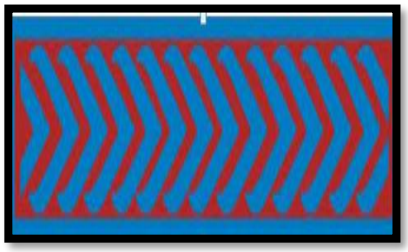
No	Name, Description and Figure	Math Concept	Implementation in Learning
1	Stepladder of Rumah Gadang	The odd number pattern is 1, 3, 5, 7, 9, 11, ... Rumah Gadang always has odd numbered steps, such as 3,5,7,9,11,…The odd number pattern formula is un = 2n-1	Identifying and determining the pattern of odd numbers

			
2	Installation of lae and rafters on the Rumah Gadang 	 Parallel lines have the same slope and will not intersect. Perpendicular lines are lines that intersect and at their point of intersection form a right angle of 90°. The gradient formula for parallel lines m_1 = m_2 The formula for the gradient of a perpendicular line m_1 x m_2 = -1	1. Identifying the concepts and properties of parallel and perpendicular lines 2. Determining the slope or gradient (m) of parallel and perpendicular lines
3	Rangkiang of Rumah Gadang 	 A straight angle has a sum of 180⁰, for example <a +<b = 180⁰ Angles with angles have a measure of 90⁰ Opposite angles have the same measure, for example <e =<h Opposite angles have the same measure, for example <a =<j	Analyzing relationships between angles as a result of two parallel lines cut by a transverse line Understanding and defining angular relationships straightened, gleaming, opposite, opposite, one-sided and opposite

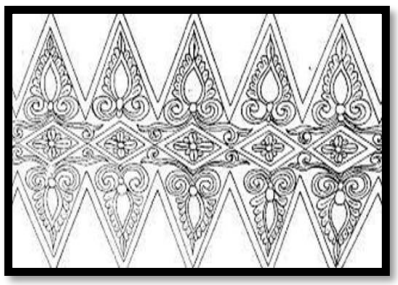
		One-sided exterior angles have a sum of 180^0, for example <o+<i= 180^0 One-sided interior angles have a sum of 180^0, for example <k+<m= 180^0 Opposite interior angles have the same measure, for example <c =<f Opposite exterior angles have the same measure, for example <j=<o	
4	The front of the Rumah Gadang has a triangular and trapezoidal flat shape  Doors of Rumah Gdang that have flat, square and rectangular shapes  The carvings located at the level of the Rumah Gadang are in the form of parallelograms	Triangle  Area = (base x height)/2 = (c x a)/2 Circumference = a + b + c Trapesium  Area = (number of parallel sides x height)/2 = ((PS+QR)x h)/2 Circumference = PS + PQ + QR + RS Rectangle  Area = s x s Circumference = 4s Rectangle  Area = length x width	1. Identifying the various wake up flat 2. Determining the circumference and area of flat shapes.

		Circumference = 2p + 2l  Area = a x t Circumference = AB +BC +CD + AD	
5	The pillars of the Rumah Gadang are in the shape of a trapezoid in terms of n 	 Surface area = 2 base area + blanket area Volume = area of base x height	Determining the area and volume of an n-sided prism
6	The Rumah Gadang has the shape of a right triangle 	 Determine the side lengths of a right triangle using the phytaqoras theorem: $a = \sqrt{(c^2 - b^2)}$ $b = \sqrt{(c^2 - a^2)}$ $c = \sqrt{(a^2 + b^2)}$	Determining the side lengths of a right triangle using the Phytaqoras formula
7	Reflection on the carving of saik ajik	Reflection 	Solving contextual problems related to geometric transformations (reflection, translation, rotation, and dilation)

Translation on Bada Mudiak carving



Rotation of the carvings of the Pucuak Rabung



Dilatation on the carved carvings on a flat shape which is located on the front wall of the Rumah Gadang

The rhombus above is reflected about the y-axis, Reflection formula on the -y axis: (x,y) then (-x, y) translation

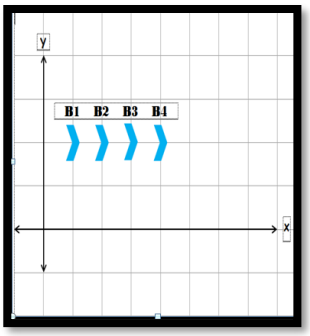
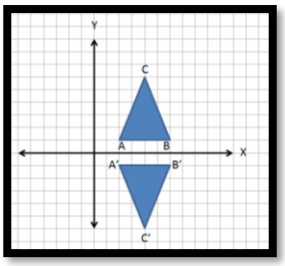
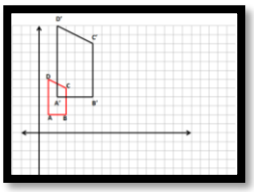


Figure B1 has shifted to B2, B3 and B4
The formula for translation:
(x',y') = (a,b) + (x,y)
Information:
x', y' = image point
x,y = origin
a,b = translation vectors
Rotation



Triangle ABC is rotated clockwise with a rotation angle of 180°.
The formula for a rotation of 180°:
(x, y) then (-x, -y)
Dilation



The trapezius above is magnified by 2 scales, the dilation formula at the center (0,0) and the scale factor k: (x, y) then (kx, ky)

Based on the table above, the mathematical concepts that exist in the form of buildings and Rumah Gadang ornaments can be taught in mathematics learning, so that students besides attracting students' interests and motivation to learn, later students also interpret and understand mathematical concepts and culture. This is because students immediately know the implementation of mathematics in the lives of students. An example of the concept of trigonometry is when students are required to determine the length of a Rumah Gadang ladder in the form of a right triangle. Students can pay attention to the levels of the Rumah Gadang and find its length using the Pythagorean theorem. This can help students understand the concept of Phytaqoras theorem, but students also know its use in life and cultural values.

Discussion

Ethnographic Research (Mathematical Ideas contained in the Rumah Gadang)

Based on the research's results, it was found that there were mathematical activities. According to (1997), there are six activities that humans do that are very important in the development of mathematical ideas, namely counting, locating, measuring, designing, playing, and explaining. In the preparatory activities and process of making Rumah Gadang, there are six activities in the development of mathematical ideas, where from these mathematical ideas there are mathematical concepts in Rumah Gadang. This is in line with the research results Dewita et al., (2019) In house ornaments there are geometric concepts such as the use of flat shapes such as squares, rectangles, circles, ellipses and n-shaped shapes.

Counting, counting or associating objects into numbers. The counting activity is a mathematical activity that emphasizes the relationship to the question "how much" and answering this question often uses body parts or surrounding objects that are used as measuring tools (Riswati, *et al*: 2021). The size of the rumah gadang is based on the use of non-standard units, using body parts as units, namely cubits, fathoms, spans, tampok or fingers. The number of rooms and stairs always has an odd value, namely 3, 5, 7 and so on. If you find it is even in the number of stairs used, the tuo craftsman will try to add or subtract the steps. From this, the tuo craftsman already knows the concept of even numbers and odd numbers (2n and 2n-1). Apart from that, the tuo craftsman also knows how many pillars are used to make a Rumah Gadang by multiplying the number of rooms plus one by the number of poles plus one or by the formula

Bt = (tr + 1)(tl + 1)

Description:

Bt = Number of Pillars of Rumah Gadang

tr = Number of space Pillars

tl = Number of Bollards

Measuring, related to the activities of comparing, predicting and contrasting as well as calculating qualities related to value and usefulness. Measuring activities are the dominant activity carried out by tuo craftsmen in the process of designing and building a Rumah Gadang. Starting from predicting, determining the size of the carving on the post to form an n-facet, determining the correct slope of the post so that the left and right slopes are the same (parallel). Apart from that, it can be seen that the size of the stairs can be determined using Phytaqora's theorem. According to Rahmawati, (2019), In the levels/stairs of a Rumah Gadang, trigonometry concepts/rules are used to determine the length of the levels/stairs of a Rumah Gadang. The size of the floor height depends on what kind of tribal Rumah Gadang it is made of and the size of the room according to your wishes, where some rooms get bigger towards the edge and some get smaller towards the edge.

Locating, relating to the topographic activity of an object or spatial abilities. The idea of locating is the activity of determining location, namely determining the position of a certain point/object (Fitriyah, 2021). Initially the Rumah Gadang buildings in the Luhak Tanah Datar area were oriented/facing towards Mount Marapi which is believed to be the area of origin of the Minangkabau people's ancestors, but there are some that do not directly face Mount Merapi. The Rumah Gadang

should not face the sun because if it faces the sun, the Rumah Gadang can easily become rotten. Apart from that, the Rumah Gadang must be on tribal land.

Designing, related to design activities, abstraction, geometric, symmetry, comparison, congruence, congruency as well as enlargement and reduction with the scale of an object. On the roof of the Rumah Gadang there is a gonjong shape which displays balance where the right side is a reflection of the left side and vice versa. The part of the pillar formed by an n-sided prism, such as an 8-sided or 12-sided prism, depends on its use. Apart from that, there are many mathematical concepts found in the design of Rumah Gadangs, both in terms of building shape and ornaments, such as the concept of flat shapes, trigonometry, transformations and lines.

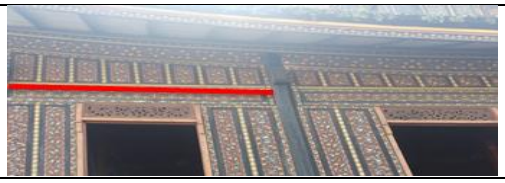
Playing, related to the rules or procedures in an activity. Tuo craftsmen follow certain rules in the process of building a Rumah Gadang. Starting from taking wood in the forest with the criteria for trees that will be used as pillars. Next, soak the posts in a mud pool, then carve the posts. In the activity of carving pillars, tuo craftsmen have rules to obtain pillars that are faceted, so that they are beautiful and comfortable to lean on. The rules and methods of the tuo craftsman for each luhak in carving the pillars have been explained above. After assembling and erecting the pillars, the craftsman carries out the roof work, with several rules such as, the number of rafters must be odd, the distance between the rafters and the rafters is ½-1 meter, as well as the distance between the rafters and the rafters is 2-3 fingers. Most craftsmen choose to work on the floor first before working on the walls and doors of the house. The back wall uses bamboo material which is woven in a four-by-four system. After that, a ladder is made, with an odd number of steps. Ended with work on the interior and exterior ornaments of the house. The Rumah Gadang is ready to be occupied, marked by an event of *Manaiki Rumah*

Explaining, related to cognitive aspects in the conceptualization and explanation of the concept. Where the selection of tuo poles is based on those that grow in flat places and stand upright and do not have many branches because they are believed to be very strong. Apart from that, in the process of building a Rumah Gadang, it is not just built, but every work carried out has a meaning and philosophy, for example, in installing the woven walls of the Rumah Gadang at the back, why must it be woven in a four-by-four system, this is in accordance with the philosophy of the Minang people who must know kato nan ampek. This also agrees with Patri & Heswari, (2022), Explaining activity is an explaining activity, where in the process of making woven mats and hats, there are several stages which are included in the explaining aspect, namely explaining the stages of making woven mats, such as crossing activities from the right, left, top and bottom.

Ethnographic Research (Mathematical Ideas found in Rumah Gadang related to the concept of transformation geometry)

The mathematical ideas contained in the Rumah Gadang which are related to the topic of transformation geometry can be seen in the shape of the building and the ornaments in the Rumah Gadang. This is in line with the findings Rahmawati Z & Muchlian, (2019), that the Minangkabau people's Rumah Gadang uses geometric elements in its construction which is a form of mathematical implementation, which includes geometric transformation concepts such as translation (shift), rotation and reflection). The concept of transformation geometry found in Rumah Gadang can be seen in its shape and ornaments in the following table:

No	Pictures	transformation Topic
1		Reflection

2		translation
3		Rotation
4		Dilation

4. CONCLUSION

This ethnographic research at the Rumah Gadang has revealed the integration of mathematical concepts within its architecture and carvings, encompassing counting, locating, measuring, designing, playing, and explaining. The structural elements and decorative carvings of the Rumah Gadang illustrate various mathematical principles, including lines, angles, planar shapes, symmetry, geometry, trigonometry, and transformations. These findings underscore the potential of these concepts to serve as effective educational resources in the teaching of mathematics. Based on the results of this study, it is recommended that educators incorporate the ethnomathematical aspects of the Rumah Gadang into their teaching methodologies. This approach not only enriches the learning experience by connecting mathematical theory with cultural architectural practices but also helps in preserving and promoting indigenous knowledge systems. Furthermore, future researchers are encouraged to develop educational tools and resources that leverage Rumah Gadang's ethnomathematics, thereby broadening the application of cultural elements in mathematical education and research.

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