Tapis Patterns in the Context of Ethnomathematics to Assess Students' Creative Thinking in Mathematics: A Rasch Measurement

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Abstract: Mathematics is employed in cultural activities in traditional and nontraditional societies. Ethnomathematics refers to mathematical ideas integrated into a culture. The culture can be used as a transformation effort to explore mathematical concepts in order to bring the mathematics closer to the reality and understanding of its people. Moreover, culture can be used as a groundwork for school mathematics. This study investigated ethnomathematics as geometry context illustrations of the patterns of Tapis Lampung in Indonesia. With an ethnographic approach and Rasch measurement that is to measure of persons and items on the same scale, this research is a quantitative study. Data were collected through test and documentation with tapis pattern results. It was discovered that the designs of the Tapis Lampung include geometric concepts that can be expressed as translations, rotations, reflections, and dilations. Moreover, students have different results of the creative thinking in mathematics. Each Tapis pattern also includes local values (i.e. sacred values, social stratification, history and understanding, creativity, inclusiveness, and economic value). Tapis Lampung can be used to disseminate and inform the world about Indonesian local wisdom and potentially as a source of contextual mathematics in rural schools and urban areas.

INTRODUCTION

Indonesia is a country with diversity in cultures and religions. Indonesia's population consists of indigenous people, descendants of Chinese, Egypt, India, and the Indo or Eurasian groups engaged in Indonesia and Europe. Indonesia has more than 500 ethnic groups and more than 600 languages (Roslidah et al., 2017). These must be maintained and managed by promoting the values of diversity so that no ethnicity stands as a closed and independent entity but rather interacts and interdepends on and mutually influence one another (Ewoh, 2013).

Lampung is a province in Indonesia, and it is strategically located. It lies at the southern end of the island of Sumatra, making it a gateway to the island of Sumatra. This makes Lampung the busiest due to migrants from various tribes. Therefore, Lampung people are not limited to Lampung in the Lampung province and those in Sumatra Island. Moreover, indigenous peoples of Lampung are divided into two Lampung customs and dialects, namely, Pepadun with O dialect and Paminggir (Saibatin) with A dialect. Papadun areas include Abung, Way Kanan, Sungkai, Tulangbawang, and Pubian, and the tribes under Paminggir include Paminggir Belalau/Ranau, Paminggir Krui, Pesisir Semangka, Pesisir Teluk, Pesisir Rajabasa, and Pesisir Melinting-Meringgai. The sixth customary entity inhabit the coastal West, South, and East Lampung. Thus, Lampung is diverse in culture.

Considering cultural diversity, transforming culture must be known to preserve national culture and cultural education (Nugraha, 2019). Regarding ethnomathematics, diverse cultures can be explored in education, especially in mathematics (Hartinah et al., 2019; Kieran et al., 2013). Despite its expansive scope, ethnomathematics is frequently confounded with ethnic or indigenous mathematics. In this article, I argue that ethnomathematics research should not be limited to the mathematical knowledge of culturally distinct people or people engaged in daily activities. The focus could be on academic mathematics, with an emphasis on the social, historical, political, and economic factors that have shaped mathematics into what it is today. With this background, ethnomathematics research has provided new and refreshing insights into the field of mathematics education, not only regarding ethnic or indigenous mathematical knowledge, but also regarding ethnomathematics approaches to mathematics and its education (Pais, 2011).

Mathematics is well-known in both traditional and nontraditional cultural activities of the societies (Kelly, 2018). Thus, this activities refers to cultural mathematics ideas and acknowledges that each culture and person develops unique ways and complex reasons to understand and modify their own realities (Presmeg et al., 2016; Rosa & Orey, 2017; Rubel, 2017). Furthermore, the ethnomathematics perspective is connecting mathematical concepts and local character value. These perspectives are contained in the 2013 Indonesian curriculum integrated the concept of education based on a character through culture, ethnicity, and values to promote by the Government of Indonesia (Suryadi et al., 2019).

Culture has many aspects that can be beneficially integrated into education. Cultural-based mathematics help students develop a greater interest in mathematics, enabling them to understand that mathematics extends beyond the classroom (Brown et al., 2019). Furthermore, because it investigates how mathematical ideas and practices are processed and used in daily activities, ethnomathematics shows how various cultural groups organize their realities (Brown et al., 2019; Rosa & Gavarrete, 2017; Rosa & Orey, 2016). Ethnomathematics is a dynamic, holistic, transdisciplinary, and transcultural field of study. Its evolution would benefit academic mathematics because it advances in a way that is much closer to reality and the agents immersed in reality (D'Ambrosio, 2020).

Furthermore, ethnomathematics can be seen as the process by which people from a particular culture use mathematical ideas and concepts to deal with quantitative, relational, and spatial aspects of their lives (Bender & Beller, 2018; Supiyati & Hanum, 2019; Widyastuti et al., 2021, p. 2). To describe the mathematical practices of identifiable cultural groups, d'Ambrosio (1985) coined the term ethnomathematics. It is defined as the study of mathematical ideas found in a culture. This perspective of mathematics validates and affirms all people's mathematics experiences by demonstrating that mathematical thinking is inherent in their lives due to the relationship between mathematics and culture (Balamurugan, 2015; Hannula, 2012; Pathuddin et al., 2021). In this context, mathematical development in different cultures is based on common problems encountered within a cultural context, according to an ethnomathematical perspective (Borko et al., 2014; Yuliani & Saragih, 2015).

Ethnomathematics have been widely researched in many countries worldwide. "Exploration of Ethnomathematics at the Margin of Europe – A Pagan Calendar" is one of the reported studies on ethnomathematics (Bjarnadóttir, 2010). In the study, in 930 in Iceland, researchers discovered a system for recording time, or a calendar influenced by the environment, specifically by observing celestial bodies, including the sun and moon. This is an example of empirical adjustment of mathematical models in which the length of the calendar year is adjusted to natural observations. d'Ambrósio, (2006) defined ethnomathematics as follows: "In the same culture, individuals provide the same explanations and use the same material and intellectual instruments in their daily activities." Nyoni (2014) reported that because a mathematics game known as "mutoga" in the local language of South Africa is played every day at home and in school, ethnomathematical epistemology can be implanted. Responding to curriculum and practice assessments, according to researchers, must be mediated by cultural pedagogy.

In Indonesia, few researchers still explore the mathematical concept in unique and rare patterns in traditional woven. However, some researchers have explored fabric patterns worldwide. Regarding the batik patterns, in Yogyakarta batik, the concept of geometry transformation is employed to make Yogyakarta's unique batik motif (Prahmana & D'Ambrosio, 2020). This research is an ethnography study, which shows moral, historical, and philosophical values. The author stated that the mathematics concept can be implemented for students who live in rural and urban areas. Additionally, previous studies have shown that mathematics basic concepts can be explored as Sundanese ethnomathematics (Muhtadi & Charitas Indra Prahmana, 2017). This study was focused on the activities of indigenous people and explored Sundanese culture. Unfortunately, the standards for the application of mathematical concepts in measuring the activity of mathematical rules have not been met. Furthermore, mathematics concepts can be described with ethnomathematics on Dayak Tabun traditional tools (Hartono & Saputro, 2019). This study focused on the aspect of motif as not only as geometry but also algebra and trigonometry concepts. Some researcher try to connect between local culture and students' official cognitive. As Pais (2011) argued that this resource, concerned in establishing a "bridge" between local and school knowledge, is prevalent in ethnomathematics research. This "bridging" of local and school mathematics knowledge is viewed as a way of valorizing students' cultures while also allowing students to gain a better understanding of formal mathematics through their own not yet formalized knowledge. Based on previous studies, this study investigates the local culture "Tapis Lampung" as an exploration ethnomathematics approach into the classroom to assess students' mathematical creative thinking. The Tapis Lampung will be explored in more detail in the literature review. Tapis Lampung was investigated as a geometry concept for the indigenes of Lampung, which is an ethnomathematics concept. Therefore, it is decided to develop an open-ended test supported by the Rasch measurement model in order to identify and assess the development of students' creative thinking in relation to grade level and gender (Soeharto, 2021). Rasch Analysis (RA) is a one-of-a-kind mathematical modeling technique based on a latent trait that achieves stochastic (probabilistic) conjoint additivity (conjoint means measurement of persons and items on the same scale and additivity is the equal-interval property of the scale) (Granger, 2008).

THEORETICAL BACKGROUND

Ethnomathematics approach

A fundamental change in mathematical instruction is required to account for the continuous change in the demographics of students enrolled in mathematics classes (Rosa & Orey, 2011). Numerous scholars have developed culturally relevant pedagogical theories that take a critical look at the teaching and learning process by incorporating cultural elements and values into mathematics (Fouze & Amit, 2017). It is required for the integration of a culturally relevant mathematics curriculum into the existing mathematics curriculum. From this point of view, it is critical for culturally relevant education because it proposes that teachers contextualize mathematics learning by connecting mathematics content to the student's culture and real-world experiences (Matthews, 2018).

According to the Rosa & Orey (2016) approach, culturally relevant mathematics should be centered on the sociocultural context, incorporating ethnomathematical concepts and ideas, and solving contextual problems from an ethnomathematics perspective. Additionally, ethnomathematics studies are increasingly being conducted, in which culture is linked to mathematical concepts and examples of the cultural context in mathematics are described (Barton, 1996, 2007). Following the recent Indonesian curriculum's emphasis on integrating culture into the curriculum, ethnomathematics may be a promising approach for assisting students in exploring their culture in order to generate mathematical concept ideas while also appreciating the cultures of others in a multicultural country (Peni & Baba, 2019). Additionally, schools must be established to teach the official knowledge while leaving the community's indigenous knowledge on its own (Pais, 2011). Therefore, including cultural aspects in the mathematics curriculum will benefit students in the long term; cultural aspects help students recognize mathematics as a part of everyday life, increasing their ability to make meaningful connections, and deepening their understanding of mathematics (Adam, 2004). This perspective was based on the numerous facets that the culture can be incorporated into the delivery of education to benefit students. The learners gain an understanding of how mathematics is used in everyday life, which improves their ability to make meaningful mathematical connections and broadens their understanding of all types of mathematics (Begg, 2001).

Tapis Lampung as Indonesian Traditional Pattern

One of the well-known and most respected cultural items is tapis. Tapis is an item of Lampung women's clothing; a shaped sarong made from cotton yarn woven with a motif or decoration material and silver or gold thread with embroidery. However, due to the increasingly modern times, Tapis Lampung can also be used as clothing for men (Figure 1). Tapis Lampung is rich in mathematical concepts, making it suitable as an alternative learning resource in teaching mathematics, especially material related to geometry (Figure 2). Geometric decorations found on tapis fabrics, in general, have firm contours with several line elements, such as straight lines, curves, zigzags, and spirals, and various shapes, such as triangles, rectangles, circles, kites, regular polygons, and geometric transformations.

Figure 1: Tapis Lampung in Wedding Ceremony

The nobility used Tapis Lampung in the past, but now, it is also used by ordinary people in Lampung. In the Lampung community, tapis is a source of income and a staple. It is a local commodity and source of revenue that needs to be preserved. The beauty of tapis is appreciated in the artistic forms spread on cloth sheets (Suherman et al., 2021). Current tapestry shapes show rhythmic regularity or pattern when closely observed. To create some forms of order on the rug, geometric transformations are employed. Euclidean geometry, in contrast, is used to identify forms made by human beings, including rectangles, circles, spheres, and triangles (Suherman et al., 2018). Thus, the structure of Tapis Lampung, which serves as a geometric representation of mathematical concepts, needs to be explored and made known globally.

We illustrate how cultural practices have been incorporated into mathematics education, with designs that adhere to the cultural geometry model, either explicitly or implicitly. These examples demonstrate the potential for Indigenous students to use their culture when designing and implementing school activities through the lens of the cultural geometry model.

Cultural Geometry: Integrating Ethnomathematics into Indigenous Students in the School

Mathematics constructed and evolved historically because of cultural norms or generally accepted and agreed upon practices. Consider how geometry developed during the Babylonian and ancient Egyptian civilizations between 5000 BC or 4000 BC to 500 BC (Muhtadi, 2017). Ancient civilizations made extensive use of visible geometry in their constructions, such as irrigation, flood control, swamp drainage, and large structures. In ancient Egypt, the geometry was used to define land boundaries along the Nile's banks because of flooding. Floods continue to strike the Nile's banks, erasing the boundaries of land owned by the indigenous community. Egyptians sought to redefine land boundaries while maintaining ownership of previously owned land. Later on, the Egyptians discovered a lengthy and extensive measurement system for community-agreed land boundary demarcation and for resolving the problem of tilled flooded land.

Additionally, the Babylonian and ancient Egyptian civilizations are regarded as the forerunners of the birth of the mathematical branches of knowledge, specifically geometry. The knowledge that appears first is cultural, such as experimentation, observation, assumption/estimation, or intuitive activities, which then evolved into standard and universal knowledge. Geometry then reaches a golden age during Euclid's (300 BC) era, when knowledge of geometry is constructed using an axiomatic system. Basic geometric shapes have been widely used as primitive concepts in previous community cultures (knowledge base, a concept which is not defined). The connections between these concepts resulted in the development of definitions, postulates/axioms, and theorems that comprise a deductive system. The deductive system is then accepted as mathematical knowledge, with geometry being classified as a subfield of mathematics.

Fundamentally, the development of human civilization is inextricably linked to the development of culture and mathematics. Nonetheless, because the method of obtaining it is unique, many people appear skeptical that culture cannot be separated from mathematical activity, but also cannot be considered separately or as a source of illumination for the development of mathematics today. In this context, culture encompasses a broad and distinct perspective, as well as being bound to the people's customs, such as gardening, playing, creating, and solving problems, as well as how to dress.

Integrating ethnomathematics into school mathematics for Indigenous students is viewed as significant because it demonstrates the existence of alternative forms of mathematics (Gerdes, 1985). However, the approach favored by these authors is:

An integration of the mathematical concepts and practices originating in the learners' culture with those of conventional, formal academic mathematics. The mathematical experiences from the learner's culture are used to understand how mathematical ideas re formulated and applied. This general mathematical knowledge is then used to introduce conventional mathematics in such a way that it is better understood, its power, beauty and utility are better appreciated, and its relationship to familiar practices and concepts made explicit. In other words, a curriculum of this type allows learners to become aware of how people mathematise and use this awareness to learn about a more encompassing mathematics (Adam et al., 2003).

Diverse perspectives on cultural traditions and practices enable a more nuanced understanding of how Tapis Lampung patterns become valued in general. As a result, while ethnomathematics has been hailed as a means of enriching students' understandings of mathematics through the use of contexts familiar to Indigenous students and enabling them to see themselves and their communities as mathematicians, concerns have been raised about how this integration may have unintended consequences. Even if Indigenous students gain mathematical insights through interaction with familiar cultural practices, the intrinsic value of the culture may be diminished if it is used merely to transmit mathematical ideas.

For many years in Indonesian educational discourse and on the school curriculum, indigenous culture was limited to the recognition of visual elements, such as signs, images, and iconography, that are immediately identifiable as representing indigenous culture and books of Indonesian myths. Cultural traditions and practices, on the other hand, should be valued in and of themselves.

Implementing the cultural geometry model in mathematics classrooms is challenging because all of the issues raised in each step must be considered concurrently. While mathematical concepts can contribute to cultural comprehension, if they are merely presented as representations of "Western mathematics," the possibilities for discussing Indigenous cultural artifacts and processes are likely to result in cultural imperialism (Bishop 1990). Rather than that, striking a balance between Indigenous cultural knowledge, including language, and mathematical cultural knowledge entails reflecting on the cultural geometry model's highlighted aspects.

Translation on tapis Lampung motif

According to Martin (2012), the mapping α is expressed as

$$\begin{cases} x' = ax + by + c, \\ y' = dx + ey + f, \end{cases}$$

This means that $(x', y') = \alpha((x, y))$ for each point (x, y) in the Cartesian plane, where $a, b, c, d, e, and\ f$ are numbers. A translation is a mapping having equations of the form

$$\begin{cases} x' = x + a, \\ y' = y + b, \end{cases}$$

Theorem: Given points P and Q, there is a unique translation taking P to Q, namely, $\tau_{P,Q}$.

Thus, if $\tau_{P,Q}(R) = S$, then $\tau_{P,Q} = \tau_{R,S}$ for points $P, Q, R, and\ S$. Note that the identity is a special case of a translation as $l = \tau_{P,P}$ for each point P. Also, if $\tau_{P,Q}(R) = R$ for point R, then $P = Q$ as $\tau_{P,Q} = \tau_{R,R} = l$.

An image that depicts the translation of geometric transformations, for instance, is the slope motif. Slope motifs are the most common type of motivation in Lampung society. For this reason, fabric tapestry is always created with slope patterns as a job by craft/art teachers for students in schools (Lampung Province). Movements on the slopes are often the key reason for filter manufacturing. This motif is red, black, and yellow at the back, and the carpet is golden to make it more beautiful and harmonious. The pitch motions are regarded as simple motifs.

The form shown in Fig. 2 also results in the combination of the basic forms in the previous figure with vertical lines. The motif of the path is a variation of the type of fundamental motif that repeats or changes. The repetition of the motif moves over the desired range of the filter fabric. The length should be between 2 and 3 meters when a shawl fabric is considered. The following form of the next motif is generated by translation vectors $T_1 = \binom{0}{-b}$ when a pitch is a motif positioned on the Cartesian axis. The fundamental form of the pathway movement is shown in Fig. 4 as a form of translation. If the form is shifted the $T_n = \binom{0}{-nb}$ vector formulas can be used to convert the form geometrically to show the slopes' motifs.

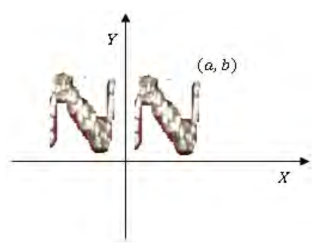


Figure 2: Cartesian coordinate of slop motif

Rotation on Tapis Lampung motif

Rotation is a transition in which a figure is rotated in a specific direction around a fixed point through an angle θ. In other words, a turning point around C by a directed angle θ is a turning point that sends every other C point to P so that P and P' have the same distance from the fixed C-point. A rotation with center C through an angle θ is usually denoted by $\rho_{C,\theta}$. It means that the image of any point P under $\rho_{C,\theta}$ is given as: $\rho_{C,\theta}(P) = \begin{cases} C, if\ P = C \\ P',\ if\ P \neq C, s.t. \overline{CP} = \overline{CP} \end{cases}$

Theorem. A rotation is an isometry.

For distinct points C and P, circle C_P is defined as the circle with center C and radius CP. Thus, $\overline{CP}$ is a radius of the circle C_P, and point P is on the circumference of the circle. Then, $\rho_{C,180} = \sigma_C$ follows that each transformation fixes point C and, otherwise, sends any point P to a point P' such that C is the midpoint of P and P' (Fig. 3).

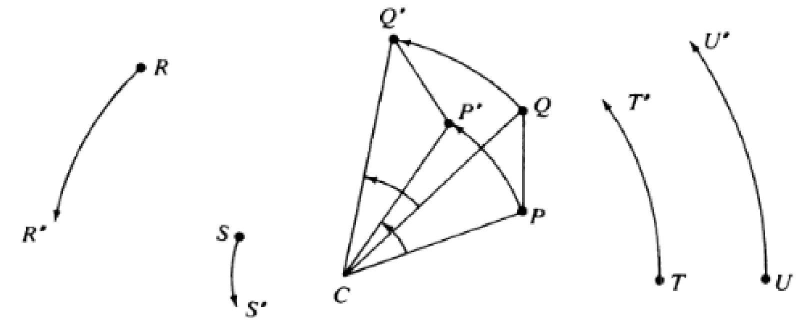


Figure 3: Rotation of illustration

To illustrate a rotation, the following is a motif of square on Tapis Gajah Meghem. If the image is rotated at angles of $90^0, 180^0$, 270^0, and 360^0 produces the original image. The rotation form of the basic shape in Fig. 10 are shown below.

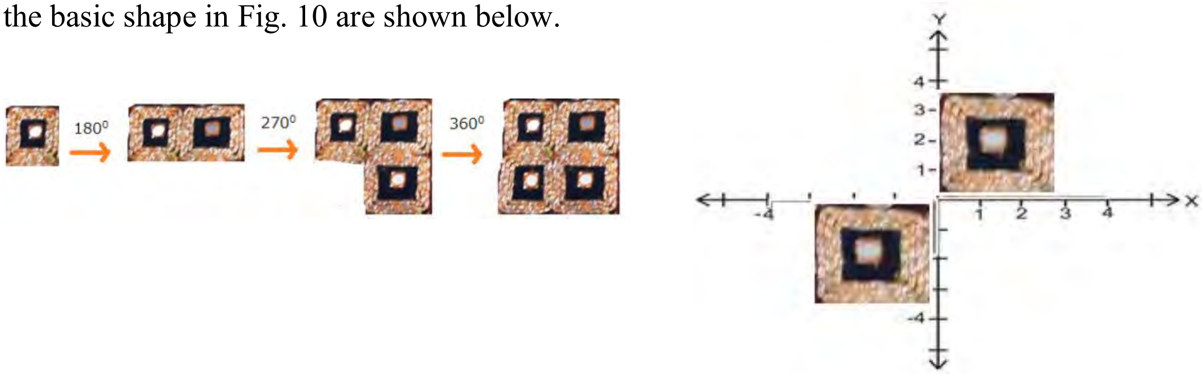


Figure 4: Rotation of Gajah Meghem motifs. The left figure was rotation on angle and the right figure was rotation on Cartesian coordinate

Reflection on Tapis Lampung motif

Given a line l and a point P, then, P' is a reflection image of P on the l if and only if $\overline{PP'}$ is perpendicular to l and $\overline{PM} = \overline{P'M}$, where M is the point of intersection of $\overline{PP'}$ and the l. In other words, P and P' are located on different sides of l but at equal distances from l. In this case, P' is said to be the mirror image of P and the l is said to be a line of reflection or an axis of symmetry. Reflection on l is usually denoted by S_l.

$$S_l(P) = \begin{cases} P, if\ P \in l \\ P',\ if\ P \notin \text{ and } l\ is\ the\ perpendicular\ bisector\ of\ \overline{PP'} \end{cases}$$

Theorem: An isometry is a collineation that preserves betweenness, midpoints, segments, rays, triangles, angles, angle measure, and perpendicularity.

Consider the symmetries of the rectangle in Fig. 5. The axes of the plane are lines of symmetry for the rectangle, and the origin is a point of symmetry for the rectangle. Denoting the reflection in the $x-$ and y-axis by σ_h and σ_v, respectively, we have that σ_h, σ_v, σ_o, and l are symmetries for the rectangle. Note that l is a line of symmetry for any set of points. Since the image of the rectangle is known once which of A, B, C, D is an image of A is determined, the four lines are the only possible symmetries for the rectangle.

This is a geometric illustration of an elephant's transformation on a ship. A nongeometric motif is a motif applied to the elephant tapis. Elephant motif, human motivation, human motif for boat riding, and link motifs are all elements of the form. Application composition is taken from a plant and combined to make it attractive to animal, handler, and human motifs on board boats and chains. The main motif is the elephant animal motif, which stands directly between the motifs of the operator and the person. The above motif is a vessel filter motif with elements, such as bamboo shoots, single boats, handlers, and elephants. The motif of the ship is a ship with freight and elephants in terms of its characteristics in the woven tissue. Reflections show the shape of the elephant motif on the ship. The form of reflection can be guided.

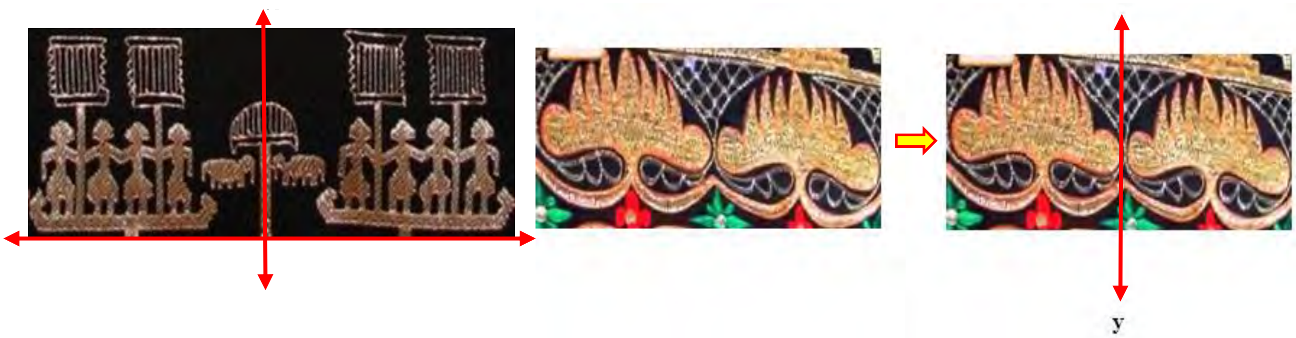


Figure 5: Reflection on the y-axis in the left side, Siger motif and reflection in the right side

There are also filters due to reflection beside the above motif. The remaining elements are siger. The picture above shows two Siger Lampung motifs that are the result of the y-axis reflection, the results are similar in images, reflected on both the x- and y-axis. The result of the reflection. Filters with Tajuk Berayun motifs are also available, as shown in On Tapis Pucuk Rebung, the Tajuk Berayun motif is usually used. It is placed on the motif edge of the swinging canopy ornament. The swinging headers are placed side-by-side. It is obtained from young bamboo plants. The application of this form element has the significance of fertility because fertile natural effects exist. The bamboo-shooting motif is closely connected to the social (value) and religious systems. This motif also depicts the relationship between humans and God, and people and the environment. Tapis Tajuk Berayun motifs (Fig. 6) are used for wedding, graduation, circumcision, and many others ceremonies. Geometrically, the Tajuk Berayun motif illustrates reflections. This is another motif that can illustrate a geometrical reflection.

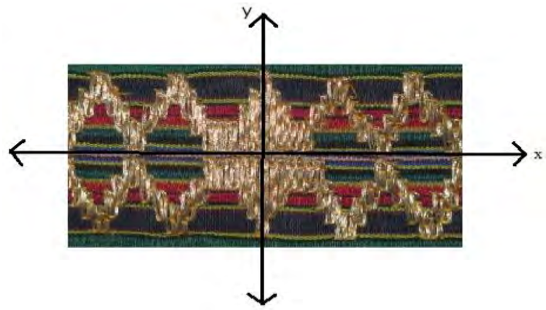


Figure 6: Tajuk berayun motif and reflection

Dilatation on Tapis Lampung

A transformation f is said to be a collineation if and only if the image of any line l under f is a line. In other words, for any point $P \in l$, the image $f(P) \in f(l)$. Furthermore, f is a dilatation if only if the image of any line l under f is a line parallel to l. That is, $f(l) \parallel l$ whenever f is colleneation, then f is said to be a dilatation.

Theorem: A dilatation is a translation or a dilatation

To show that there is a similarity in taking one triangle onto any similar triangle, suppose $\Delta ABC \approx \Delta A'B'C'$, as shown in Fig. 16. Let δ be the stretch about A such that $\delta(B) = E$ with $AE = A'B'$. With $F = \delta(C)$, then $\Delta AEF \cong \Delta A'B'C'$ by ASA. Since there is isometry β such that $\beta(A) = A'$, $\beta(E) = B$, and $\beta(F) = C'$, then $\beta\delta$ is a similarity taking $A, B, and\ C$ to $A', B' and\ C'$, respectively. If α a is similarity taking $A, B, and\ C$ to $A', B' and\ C'$, respectively, then $\alpha^{-1}(\beta\delta)$ fixes the noncollinear points and must be the identity. Therefore, $\alpha = \beta\delta$.

Dilation (multiplication) is a transformation that moves a geometry point, which depends on the dilation center and factor (scale). Thus, shades in a dilated geometry vary in size (small or big). The motif for Jung Sarat, for instance, is the motif for Mato Kibaw. The following motif can consider an extension. To achieve an attractive shape, the motif is enlarged. For the form shown in Fig. 7, the motifs are presented in part. The motif below can partially (separately) be considered as a group of Mato Kibaw motifs, originating from a square building with a white dot of fine zinc sheets at its center. The motifs below are of different sizes. If extended, this form produces a dilation or multiplication with a constant k to a partial shape, as shown in Fig. 18, which is considered a result of the positive real number k.

Mathematically, if k is a dilated factor, it applies to the following relationship. As a result, the shape of the Mato Kibaw motif is a dilated form of the center point of $O(0,0)$ by mapping.

$$[O, k]: P(x, y) \rightarrow P'(kx, ky)$$

The matrix of the equations is given as

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

Based on the analysis, another motif, a form of dilation or multiplication, can be displayed.

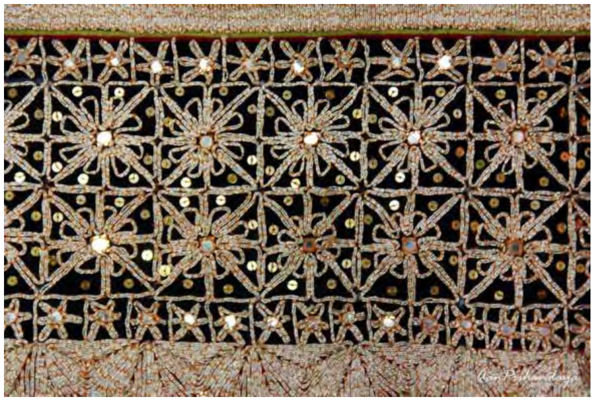


Figure 7: Flaura motif (Mato Kibaw)

METHOD

Participants

Participants were 157 secondary school students' (56% female), ages 12 to 14 years (M = 13.9; SD = .87). All students came from private and public school.

Procedure

An ethnographic approach was employed in this study (Gobo & Marciniak, 2011), aiming to provide an in-depth description and analysis of culture through intensive and prospective fieldwork research on culture (Huff et al., 2020; Person et al., 2013). This research focused on exploring culture while incorporating elements of Tapis Lampung as a symbol of users in a given culture. It gives insight into users' thoughts and actions, as well as the sights and sounds that they encounter during their activities. It clarifies the culture and symbolization of ethnomathematics. The framework stages are listed in Table 1.

Generic Question	Initial Answer	Critical Construct	Mastery Activity
Where should it look?	In the activities of making Tapis Lampung where there are mathematical practices	Culture	Interviewing indigenes who have the knowledge of Tapis Lampung or those who create Tapis motifs in Lampung.

	in it.		
How is it to look?	Investigating and exploring Tapis motif of the Lampung people concerning mathematics concept.	Alternative thinking and prior-knowledge	Determine what ideas are included in the making of Tapis Lampung in relation to mathematical concepts.
What is it?	Evidence (The outcomes of alternative thinking in the previous procedure)	Philosophical mathematics	Identifying the characteristics in the process of Tapis Lampung
What does it mean?	Significant outcomes of mathematics and culture.	Anthropolog y	Describe the relationship between the two mathematical knowledge and cultural systems. Describe the mathematical concepts in the activity of making Tapis Lampung for the Lampung people.

Table 1: Design of the Ethnomathematics research

Instruments

The instruments was about figural on the tapis patterns in the context of ethnomathematics. The ethnomathematical test items for testing creative thinking in mathematics. The figural test is about picture construction. This means that the participant starts with a fundamental shape and builds on it to make a picture (J. C. Kaufman et al., 2008). Scores are assigned based on classified responses that include elaborations score. Each response is further considered for its elaborateness and given either two or one points. Below is an example of figural test an ethnomathematics content in the table 2. Furthermore, the results of the items were presented in the table 3.

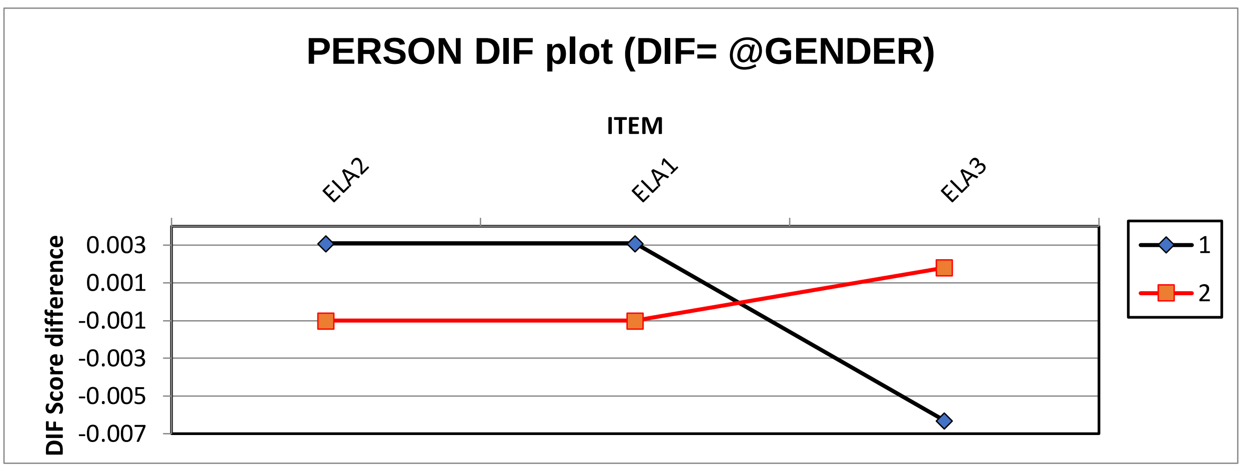
Questions	Picture
The pictures are part of Tapis Lampung with geometry motifs. a. Make a list of any flat shapes that you find in the Tapis Lampung motif! b. Draw any pictures from your findings using at least one flat shape that you found in number a. You can combine 2 or 3 or more flat shapes to create a unique image. Then name the image you have made.	

Table 2: An Example of Ethnomathematics-based Test

Item Measure	Test Group	
	Persons	Item
N	157	3
Measure	.53	.00
Mean	4.8	252.7
SD	.45	.68
SE	1.1	10.4
Mean Outfif MNSQ	.98	1.00
Mean Outfif SZTD	.05	-.23
Separation	.25	2.37
Reliability	.86	.85
Cronbach's Alpha	.86	

Table 3: The Summary of the Statistics Based on Pearson and Items

Based on Table 3, the reliability parameter in Rasch measurement for person and item are was .86 and .85, respectively. The statistics representing good reliability (more than 0.67) (Fisher, 2007). Furthermore, the Cronbach Alpha was 0.86. Rasch's measurements correspond to Outfit MNSQ in person ranging from 0.84 to 1.30 and Outfit SZTD ranging from -1.57 to 2.44. The item based on DIF is calculated for male (1) and female (2). There is no bias for item DIF has shown in the Figure 8.



Note: 1 = male; 2 = female; ELA1 = Item Elaboration no.1; ELA2 = Item Elaboration no.2; ELA3 = Item Elaboration no.3

Figure 8: The DIF item-based gender

Data Analysis

Data were collected through task and documentation. The objects observed include the steps in making Tapis Lampung, from the selection of tools to weaving the Tapis Lampung. As part of the documentation in this study, photographs of the task results by students of Tapis Lampung weaves were taken. To investigate the relationship between Tapis Lampung motifs and mathematical concepts, data were analyzed using Winstep software for Rasch measurement. This research is limited to the rules for determining the couple's matchmaking.

RESULTS

First, the 2-score items were examined using the Winstep format, one that compares the crossover, equal probability points "thresholds point'' using parameters of the partial credit model (Figure 9). The category probability curves of two items are demonstrated in Figure 9 (item 1 and item 3). The category probability curves indicate that items were like item 3 that equal to thresholds point. Therefore, the category probability has measure relative to item difficulty like item 1.

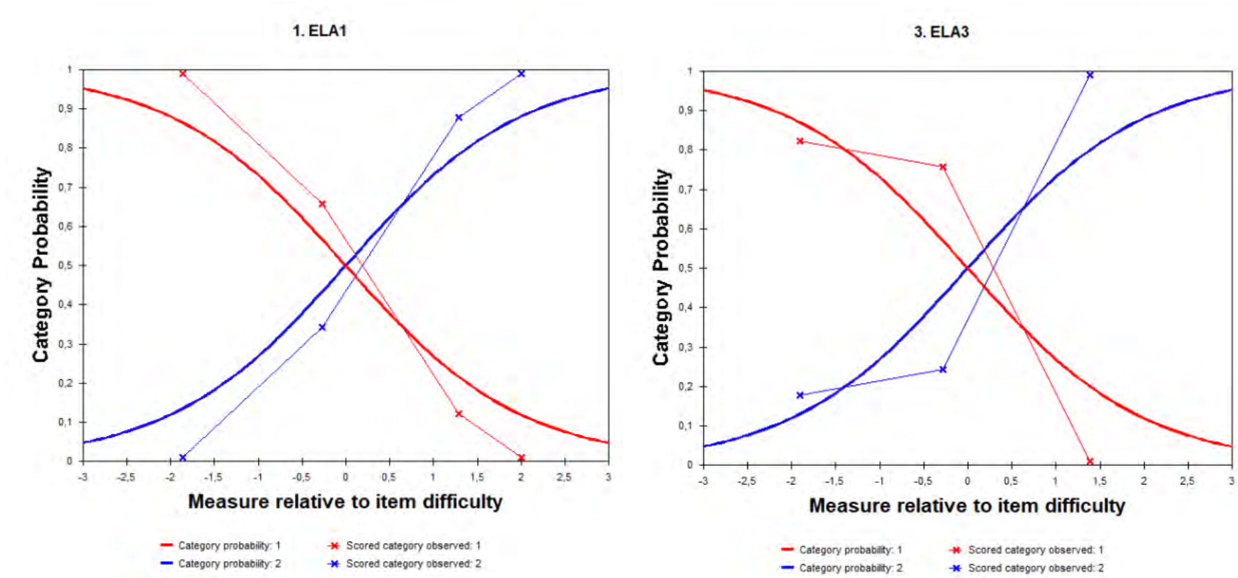
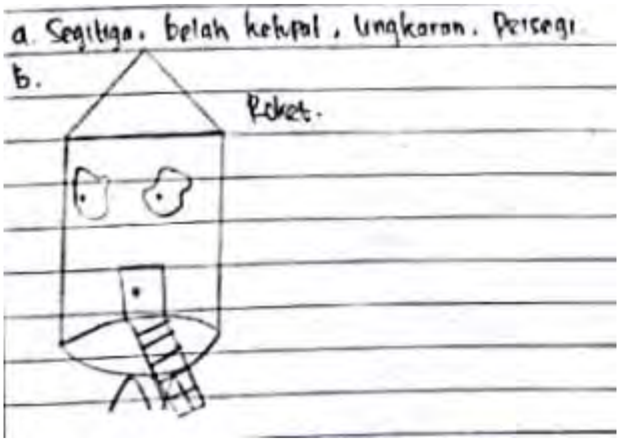
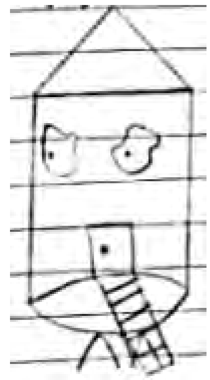


Figure 9: Category probability curves of the items 1 and 3.

Analysis of student answer patterns on creative thinking in mathematics in the context of Ethnomathematics has already presented. Further analysis was conducted to see how the pattern of answers of students with high statistical mathematical creative thinking (MCT) abilities, namely students with code 23MSMP and 116MSMP. The pattern of student answers can be seen in Table 4.

<table>
<tr>
<td>
</td>
<td>a. Triangle, rhombus, circle, square
b. Rocket
</td>
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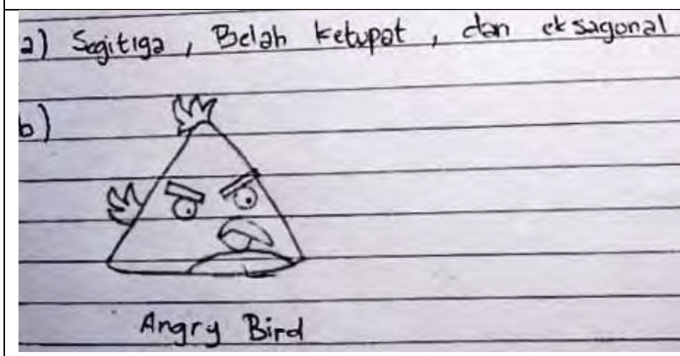
<tr>
<td>
</td>
<td>a. Triangle, rhombus, and heksagonal
b.

</td>
</tr>
</table>

Table 4: Students' Answer of Tapis Pattern

Based on students' answers to the code 23MSMP on test number 3, it could be seen that the students' extracted information about the questions. The students were listed of the Tapis pattern in four shapes: triangle, rhombus, circle, and square. Additionally, students can draw pictures using shapes that were seen on the pattern. The picture name is rocket. In contrast, students' answer with code 116MSMP was only 3 kinds of the shapes, triangle, rhombus, and hexagonal, respectively. Then, can draw the angry bird picture.

Multiple Analysis

The regression test is satisfied if the covariate and dependent variable have a linear relationship. The results of multiple regression for the analysis as below in Table 5. Based on Table 5, we can see that the table describes the variance percentage explained by the included independent variables. The statistics results have explained that the independent variables can explain 2.9% of variance in the dependent variable. The total variance explained is 2.9% if we consider only the independent variables that significantly contribute to the regression model, $R^2 = .29$, $p = .21$. That can expect of item test number 3 not seems to exert the strongest elaboration, on the other hand may have an impact on the developmental level of learning creativity. It is also influenced by ethnic students' which task characteristics may explain. Regarding the coefficients analysis, the ethnic score (t = 1.12, $p < .001$), is the significant explanatory variables. Whereas, the schooltype (t =1.9, $p = .06$), and living place (t = -56, $p = .58$) does not have a significant contribution to the regression model.

Independent variables	***r***	***ß***	***r·ß*·100**	***p***
Ethnic	.07	.09	.69	<.001
School type	.14	.16	2.31	.06
Living Place	.02	-.05	-.001	.58
Total variance explained			2.89	

Table 5: Results of multiple regression analysis for score no.3 as a dependent variable

Differential Item Functioning (DIS) based Gender

The DIF analysis confirmed that students with cross ethnic had fixed pattern of answer. This can be seen in the table 10 about DIF Measures. The students' have score different items in the own ethnic. In other words, the results of the DIF analysis in figure 10 conclude that although students have supportive demographic factors, such as gender, ethnic (i.e., Lampung, Java, Sundanese, Manado, Batak, Bugis, Munang, and others) in accordance with the given ethnomathematics-based test, they do not provide benefits for students in improving learning outcomes, especially those closely related to improving students' creative thinking in mathematics ability. However, it cannot be omitted that students' initial mathematical abilities also have their own role to support the development of other mathematical abilities.

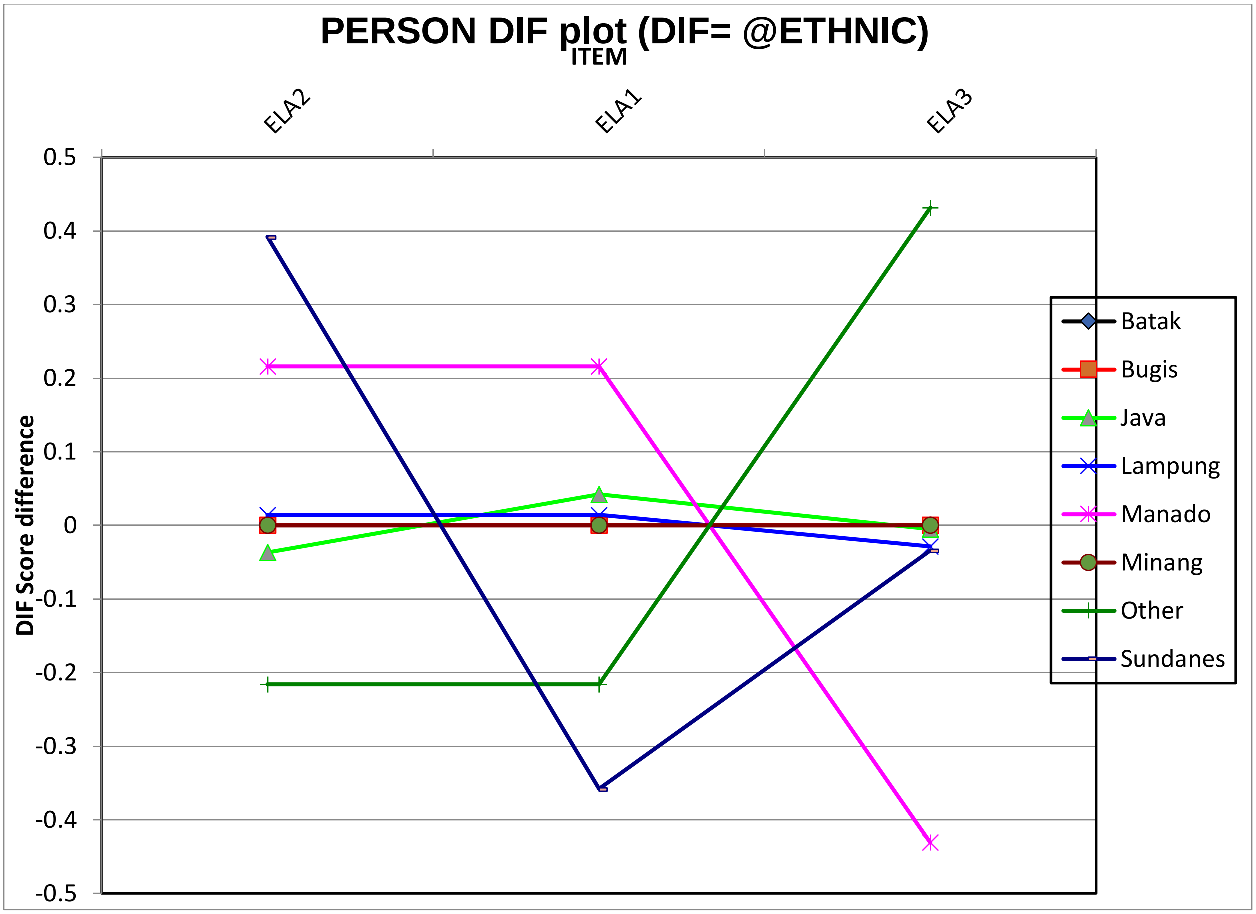


Figure 10: Person IF Students Answer on the Tapis Pattern Based Ethnic

DISCUSSION

Regarding the students answer, they can imagine to drawing the picture related to their own experienced. The picture based on the geometry pattern in the ethnomathematical context. The context has similar with the literature review about transformation geometry. Some examples of transformation geometry applications in the Tapis Lampung pattern are provided. The patterns on filtering motifs can have sacred values, social stratification, history and understanding, creativity, inclusiveness, and economic value (Matthews, 2018). For sacred values, traditional weaving cloth often indicates pure Lampung people in traditional ceremonies. The sacred value sources are motifs containing symbolic philosophical implications, such as constructions. Tapis woven fabric is regarded as a cloth with high symbolic value by the indigenes of Lampung. One of them symbolizes purity, which can protect the wearer from all external dirt. It is typically used in traditional and religious ceremonies to represent sacred values and functions. Ship decoration, for example, is a prominent feature of Lampung traditional tapis woven fabric. Ship shapes and colors also have different meanings. Red ship motifs represent sacredness and relationship with the upper world, whereas blue ship motifs indicate a relationship with the profane underworld. The third world is the middle, which includes humans and their natural environment, fauna, and flora (Nurdin & Damayanti, 2019).

For social stratification, traditional fabrics, usually owned by the local community, are maintained by indigenous Lampung families. Each cloth has a function, significance, and social status, such that some clothes are only allowed to be used by certain groups according to the social status of the ethnic groups. Tapis woven cloth is also an indicator of the social status of an individual (Isbandiyah & Supriyanto, 2019). Thus, a person's social status is known by looking at the woven tissue of the people by tapis. Members of the Lampung community wear tapis in traditional ceremonies, and each cultural group has different patterns and motifs of tapis. The patterns and motifs depend on the ceremony's purpose, and the tapis' patterns describe the users' position in the Lampung society's social hierarchy.

In the results, we found that the answer of students' creative thinking has different for each other. While they can answer the easy and difficulty of the item. We investigate in more detail using regression test to see whether independent variables (i.e., ethnic, school type, and living place) has effect on the creative thinking. Statistically, we found that only 29% of the creative thinking in mathematics contribute to the independent variables. Moreover, 73% was explained by other variables. Additionally, the item test was about figural on the tapis patterns in the context of ethnomathematics which can be seen that the figural covering of elaboration in more detail are fluency, flexibility, and the strategic retrieval and manipulation of knowledge may be among the more fundamental cognitive processes underlying g and divergent thinking (Beaty & Silvia, 2012; S. B. Kaufman et al., 2016). These skills appear to be more essential for mathematical creativity, which requires the application of reasoning and proofing ideation to an existing rational system and problem-solving (Huda et al., 2020). Practically, creative thinking in mathematics is needed to develop students' abilities. It can be understood by focusing on the responses of problem-solving students with out-of-the-ordinary thought processes and examining divergent production by determining the criteria of results (Haylock, 1997; Suherman & Vidákovich, 2022).

CONCLUSION

The Rasch Model analysis is important in checking for possible biases in student response patterns based on demographic factors. Rasch's analysis made it possible to further explore biases on demographic factors other than students' creative thinking in mathematics, gender, ethnicity, and student background. Other factors such as the level of affective factors and socio-cultural factors such as giving different results, can be explored further using the Rasch Model analysis by providing optimal analysis and students' results.

This study giving problems with ethnomathematics contexts was proven to help students' understanding to the problem presented. Tapis Lampung may be expressed by translations, rotations, reflections, and dilations as a geometrical example of transformation. The results of this study will help teachers prepare the most appropriate strategy for improving the mathematical concepts and students' skills, especially in local cultures. This will aid in effective teaching, learning, and assessment of mathematics. However, there is a need for further studies on the empirical use of geometry learning in mathematics.

This research has limited findings, where the ethnomathematics context presented uses the cultural context and tapis pattern in Lampung, Indonesia, and the number of the research subject is also small. Therefore, further research will continue by paying attention to the demographic-focused factors used and the existence of socio-cultural factors so that the findings obtained can provide significant results.

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