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The use of ethnomathematics at arfak (west papua, indonesia): the representation of lines on rumah kaki seribu construction

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Abstract. This current study is at aim to identify the mathematical concept of Arfak tribe concerns with lines in daily life. The method used in this research is ethnography. The result has shown that the sense of sight is involved so as to determine the lines. It is used as a result of limited sources.

1. Introduction

Ethnomathematics is a terminology for describing the numerical lexicon that correlate to certain culture in certain place. Culture proper is defined as the customs of human beings found at the place where indigenous people live in, group of profession, students from various group of age and particular social group [1]– [8]. From the explanation above, it can be concluded that mathematics term likely to be found on human beings' surrounding in which they share the same thought with each other. The meaning of ethnomathematics has been differently proposed by dissimilar scholars. Zaslavsky proposes ethnomathematics as social mathematics that is applied in social life[7], [9]–[11]. D'Ambrosio defines ethnomathematics as spontaneous mathematics which the method is used in certain culture[7], [9]–[11]. Then, Posner calls it as informal mathematics used by students outside of school[7], [9]–[11]. Carragher et al and Kane state that verbalmathematics is a cognition obtained from one generation to another generation[7], [9]–[11].

Gerdes mentions as non-standardmathematics, the mathematics practice that overlap the laws and provision found on the field of mathematic[7], [9]–[11]. He also adds that ethnomathematics can be defined as hidden mathematics, a practice which is not realized by the people at their culture. Last, Mellin-Olsen in Gerdes says as general mathematics in which it is always involved in every activity of human being [7], [9]–[11]. Arfak Ethnomathematics is mathematics in popular culture Arfak. Arfak tribe is a community who live at the mountains of Arfak County portion of the province of West Papua Indonesia Country. Arfak tribe inhabit the hinterland lies at an elevation of + 2000 m above sea level and it has extreme temperatures to temperature in Equatorial regions, i.e. the temperature around 5oC – 9oC (Ob served data).

Due to the extreme temperatures the Arfak Culture still has not been much affected by the culture from outside. Mathematics in Arfak culture is interesting enough to explore, i.e. the transformation of the geometry in Noken Papua [12], shifting the triangular shape at Home knot of Rumah Kaki Seribu [13], numeral on society arfak [14]–[16], numbers on a community such as gesture Arfak [15], operation numbers in the Commerce society arfak past [17], and the Numerical Society Arfak has similarities with Abacus [16]. The Arfak tribe builds up their house by using wood, tree bark and leafage in order to adjust to the extreme natural condition. This house is best known as Rumah Kaki Seribu [13].

Figure 1. Rumah Kaki Seribu

In Figure 1, Rumah Kaki Seribu is made of wood. Moreover, the roof, wall and floor are considered flat field. Then, there are several certain methods to figure out the flat shape of roof, wall and floor, which are foundation point method, poles method and equal rights of high floor or roof. Departing to these methods, the new knowledge about how certain tribe draws lines may be able to expose. This current study is aimed to explore and identify the geometry patterns contained in Rumah Kaki Seribu. There are various the materials used by the Arfak tribe in building the house, such as deciding the wood, straightening the point of foundation and wall and determining the high of foundation. Thus, the exploration results will be analyzed by using the concept of mathematics.

2. Research Method

Ethnographic was used in this study. The subjects involved in this study were the indigenous people categorized as the tribe leader, public figure, students, educated people and villagers. The subjects were involved in order to collect the data concerned with the custom and habit. Later, the researcher would validate the data by asking the villager. Then, the collected information would be given to the experts so as to acquire logical reasons.

3. Finding

The lexicon of lines in Hatam language is different from that used by mathematics. Below are the interview results with interviewee.

R : How do you say lines in Hatam language?
S : It is cik
R : How about straight?
S : It is sreng
R : And curved?
S : Koi
R : And unstraight?
S : Duwi

Departing to the above results, it can be said that the meaning of each lexicons is different. Cik means line, sreng means straight, koi means curve, and duwi means un-straight.

The wood used in Rumah Kaki Seribu House represents the lines. It is because the wood are selected based on the straight line. The example is given below.

Figure 2. The Woods Used as Material

There are several ways in selecting the wood. The researcher interviews the subject to find out the answer.

R : How did you select the wood?
S : We selected the wood based on the straight line.
R : How did you do that?
S : We held the wood, then we looked the tip.
R : So, how did you decide whether it was straight or not?
S : If you could not see the tip of the wood, it meant straight. Otherwise, if you could see the tip, it was curved. You need to place the wood horizontally at first.

The way people see the straight is by looking the wood horizontally. They looked the shape from top and bottom of the wood. Look at the illustration below

Figure 3. Illustration in Determining the wood

The place where Arfak tribe builds up their house is unique. It is because the contour of the land is situated on the slope of mountain. Then, there are massive number of survival trunks of logging. Moreover, the trunks are not removed from the land. As a result, that special methods are needed in order to decide the point of foundation and the rectitude of floor. Therefore, the needs of special skills are necessary. These special skills are aimed to build the required shape of the house, such as foundation monotony and vertical measurement.

Figure 4. Arfak Village

In order to explain the method of determining the foundation point, the researcher conducts an interview.

R : How do you find out that the lines are straight?
S : We set a single foundation at first, then the others will observe.

The subject explains that determining the monotony of foundation is done by one person. Thus, he stands up in the end of the lines. The sense of sight is needed in this step. This activity is illustrated with the picture below.

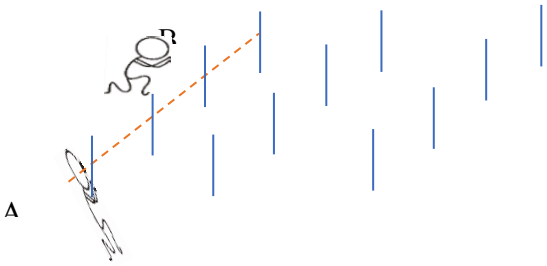

Figure 5. Illustration in Determining Lineage Lines Arrangement

The foundation monotony of *Rumah Kaki Seribu* house is considered necessary. It is because the monotony determines the balance of the floor. This balance is used as a comfort requirement for the villagers. Figure 6 explains the frame of *Rumah Kaki Seribu* house. The followings are the results of interview.

R : The floor is flat, how do you design it?
S : The foundation must be balanced. If the height of wood is different, you need to keep digging up the hole. If it is still the same, the wooden floor must be propped up, so on.
R : How do you determine that the floor is already flat?
S : There will be someone who stands up in the end of the floor.

Figure 6. The Frame of Rumah Kaki Seribu House

Subject explains that there will be one of them who observes the height of foundation. The people maximize the sense of sight in this step. Picture 7 is the illustration from subject's explanation. The one (A) who is involved in this step has responsibility to decide the height of each side meanwhile the other (B) will set the foundation.

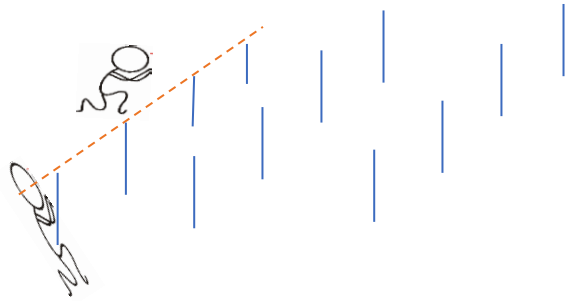

Figure 7. Illustration on Determining the Height of Foundation

The selection of wood and the determination of the foundation mentioned above is done by using the sense of sight. It is explained as follows.

R : I have asked some villagers, they say that they determine the straightness of wood, foundation and so on by using sense of sight. What does it mean?
S : All is done by the sense of sight.

R : So, how do you differentiate whether the wood is straight or not?
S : It is straight if you cannot see the tip of wood horizontally.
R : For example, the wood is curved. How do you prove it?
S : Try to see the tip of the wood horizontally. If you are able to see the tip or the center of the wood, it means curved.

The subject explains how the villagers determine the rectitude by using sense of sight. A single wood is categorized straight when it is seen from the tip, the wood will be seen as a point. This point means the tip of the wood. For the detailed information, look at the figure 8. In the figure, it is seen that every set of objects is in a straight line when it is viewed from the tip of an object. The object is seen as a point and the other object covered by one point.

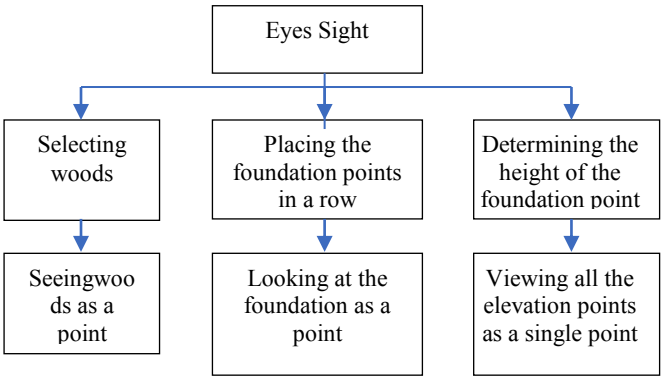

Figure 8. The mathematical Concept of Arfak Tribe

4. Discussion

The arfak community ensures that a curve is considered to be straight or not by the sense of sight. This is derived from community activities in determining the rectitude of wood, the position of the foundation points, and and the consistency of foundation height. In ensuring the straightness of those three aspects, the villagers look at the tip of the object from another side. The results will be seen as a straight when each object is considered as a point. The function of sense of sight is to receive any responses in the shape of flash. Something is visible because it emits light or reflects light from its source to eyes [18]. Therefore, an object can be seen when the light arrives at the eyes. The light comes from a particular object which reflects to another sources.

The movement of light shares the same function as lines. Light is one of the longitude waves, then it will move and take a straight line from the source to the object [18]. This concept is line with Euclid postulate which says that the movement of light is in between the straight lines. According to Dhabi and Kharki, the movement can be explained through figure 9.

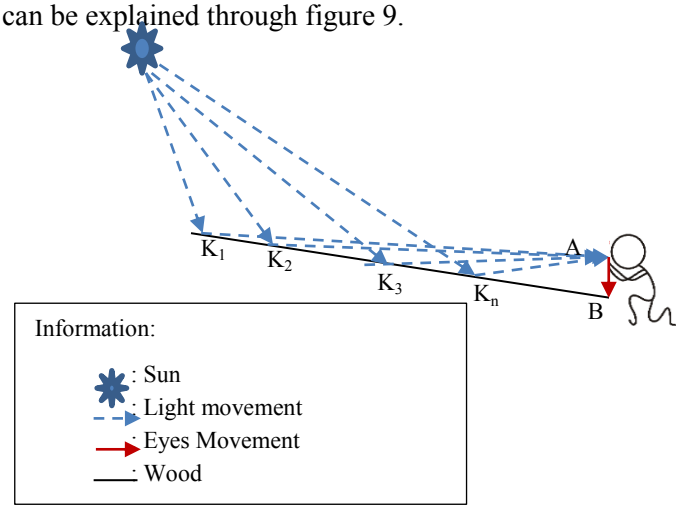

Figure 9. Illustration of Light Movement

Based on the figure 9, the villagers of Arfak drive their eyes from point A to point B. Wood is straight if the light taken from point K1, K2,…., Kn, to point are coincided. In Euclid geometry, it is said that two points will be combined into one point. Those are K1 with A, K2 with A,…., and Kn with A. The movement of eyes drives from A to B, so the lines of KiA becomes KiB in which i=1, 2, …, n is located in one line

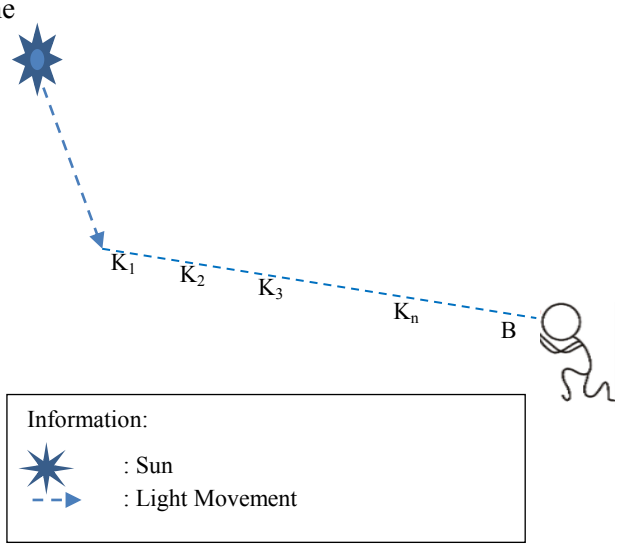

Figure 10. Illustration of Concept of Lines

The movement of light from K_1 to B creates line segment (Figure 10). In order to ensure the wood from point B and K_1 is in the straight line, every point of the wood must be located at the line segment. As a result, each point of K_i with i=1,2,3,….. is right at line segment K_1B.
From the traditional way in determining the wood, there are mathematical concepts used by the tribe, namely lines and line segment. Lines known by the villagers are the set of points found on light. Figure 11 explains how the villagers attain the lines.

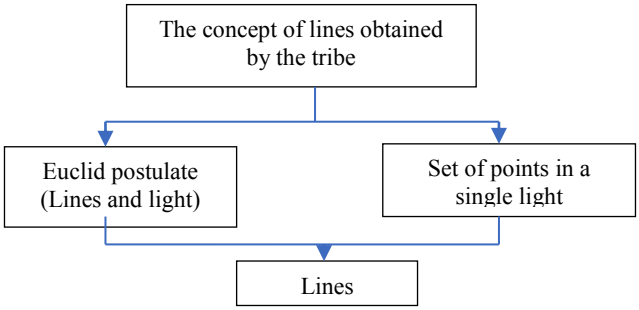

Figure 11. Mathematical Concept in Determining Lines

Arfak villagers do not use sort of media, such as rope, although it has been widely spread by them. Haryanto proposes that Arfak tribe has identified rope as one of the materials to craft noken (woven bag)[19]. Moreover, rope is also known by the villagers to tie up some objects, such as the use of rattan rope in house knot of Rumah Kaki Seribu[20]. Those ropes have mass, so the longer the ropes are, the more bent it will be. This action is caused by the gravity. The objects with less mass are well-considered to determine the lines, for example light. It is because there is no mass at light. Furthermore, Einstein states that light is made of particles and better known as photons. Likewise, Theory of Relativity proposed by Einstein explains that photons are particles without mass [21]– [26]. From the prior statements, it can be said that there is mass contained in light. Therefore, Light cannot

be deflected by gravity. Then, the choice of light as a media is the right way to determine the lines as the light cannot be deflected.

4.1. Ethnomatematics and School Mathematics Knowledge

Knowledge of lines in school mathematics is the most basic knowledge of geometry. This knowledge is given in schools at the most basic level, namely in grades 1 to grade 3 of elementary school. This knowledge is common in schools using a ruler. This can be seen when students recognize the first line is that students represent lines in the form of images. In drawing the line, students are given a bar like in Figure 12. In the picture students are not explained why they use a ruler

Figure 12. Ruler

The way to explain the reasons for using a ruler can be done by using Euclid's postulate as shown in Figure 11. The way that students practice is as shown in Figure 13 below. Students see from one end of the picture in Figure 13 A and the results obtained by students is that one side of the line will look like a point (black dot) in figure 13 B.

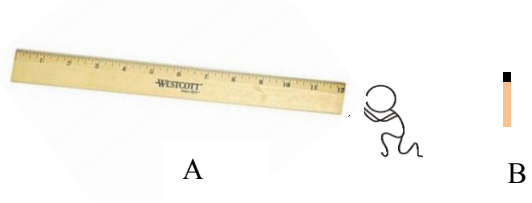

Figure 13. Students in Recognizing the Concept of Lines Through Ethnomatematics

Students' knowledge of the line is then associated with knowledge of the properties of light. In this way, students will get the line concept with the Euclid postulate.
Knowledge of lines by students is intuition [27]. Because this is intuition, students cannot explain their lines and characteristics. Therefore, by connecting the Ethnomathematics with school mathematics, the lines can be known by students empirically and theoretically. Students' knowledge of lines will be analytical and not intuitive.

5. Conclusion

Based on the above results, the researcher concludes that the concept of lines obtained by arfak society can be seen by determining the rectitude of wood, the position of the foundation and the height of the foundation. Moreover, the sense of sight is needed in these contexts. This concept is in line on which Euclid postulate that the light movement of light is in a rectitude. Thus, the use of sense of sight is as a way of determining the line compared to other media in accordance with Einstein's opinion dealing the mass of an object.

The concept of math in each cultural heritage of certain tribe may be varied from others since the needs are also various. Hence, the Ethnomathematics is adopted based on the surroundings.
The use of Ethnomatematics in school mathematics will change students' knowledge from intuitive to analytical. This produces mathematical concepts that students can better understand.

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