Ethnomathematics Journal
Volume 1, No. 1, March 2020 (25-29)
Online: http://journal.uny.ac.id/index.php/ethno

Ethnomathematics study in calendar system of Baduy tribe

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ARTICLE INFO

Article History
Received:
23 October 2019;
Revised:
4 May 2020;
Accepted:
4 February 2020

Keywords
Ethnomathematics;
Baduy calendar

ABSTRACT

The aim of this research is to study ethnomathematics in the calendar system of the baduy tribe. The study of ethnomathematics in our research used ethnography methods. We found a unique pattern in baduy calendar that the first day in the previous month + 2 days after the first day of the previous month equals to the first day in the next month, in which, it is the reason why baduy people who have no mathematical knowledge from the formal school can predict, for an example, the first day in the next months.

INTRODUCTION

The diversity of cultures in Indonesia is actually an interesting object to study, especially when it is connected to education. Mathematics frequently taught at school as knowledge with no relation in real activities. According to Bishop in Septianawati (2017), mathematical ideas can be developed and founded from the surrounding environment. People may be living in different cultures, but they can be doing the same thing. Some of the activities which is done by humans are the factors that can push to develop mathematical ideas. Such activities include counting, locating, measuring, playing games, designing, explaining, and so on.

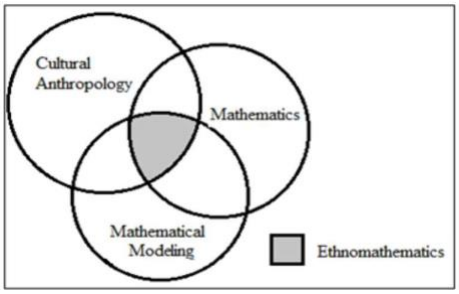

Figure 1. Ethnomathematics Diagram (Rosa & Orey, 2013)

Today, there are many studies that connect mathematics and culture. According to Hadi (2005), mathematics is a form of human activity that is developed through the exploration of various problems in the real world. In which, the real world here is defined as everything beyond the theory of mathematics, such as daily activities, the surrounding environment, even its connectivity to other subjects as a starting point in the learning process. Scientists have collected empirical data about mathematical ideas and other ideas from cultural groups both literally and non-literally (Pica, Lemer, Izard, & Dehaene, 2004). Of course, it has a wide impact on the philosophy of mathematics education, and also in mathematics itself.

Ethnomathematics in the picture above is actually an intersection between cultural anthropology, mathematical modeling, and mathematics itself (Rosa & Orey, 2013). The first stage when we study in ethnomathematics research is to dig the way thinking of the community we are exploring, and then after the data were collected, we have to describe it into mathematical modeling with appropriate mathematical concepts. The research area in the Baduy community has been widely carried out by several researchers in the world (Ichwandi & Shinohara, 2007; Iskandar, 1991; Matang, 2006). But, only some of the researchers who focus on the study of ethnomathematics in the Baduy tribe. Some researchers who had explored ethnomathematics in baduy are (Karnilah, Turmudi, & Juandi, 2012; Arisetyawan, Suryadi, Herman, & Rahman, 2014). The research focused on religion, language, technology, and the sciences system of the baduy tribe.

METHOD

The method we used in this research is an ethnographic method. The data were collected by using ethnography principles such as; observation, interviews, documentation, field notes, voice, and video recording. We also use descriptive-analytical methods are generally chosen in qualitative method because they can systematically describe the facts and characteristics of objects and subjects that are studied appropriately.

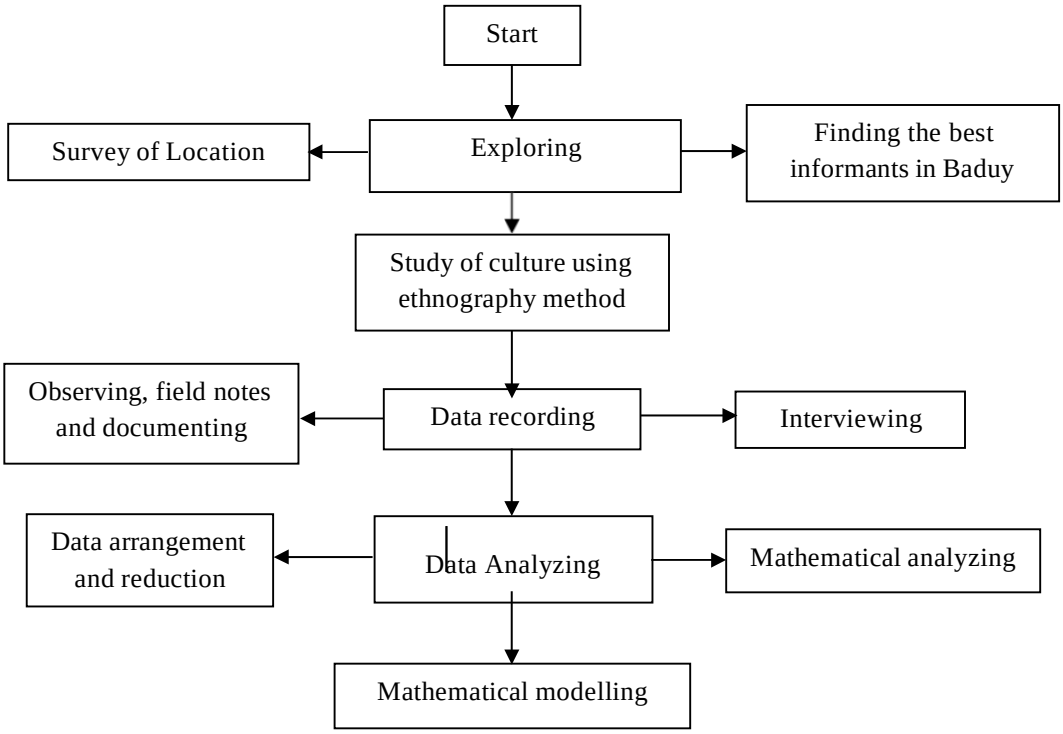

Figure 2. Flow Chart of Research in Baduy

In addition, it is also a research method that emphasizes to obtain the information about the status or symptoms at the time of research, provides an overview of phenomena, also further explains the relationship, and will uncover mathematical ideas. This research was conducted at the baduy tribe, located in leuwidamar, Lebak, the province of Banten. In this research, the primary sources were Mr. Syarif and Mr. Jama (The citizens of outer and inner baduy) as the main informants. Ethnomathematics have the same connection with the ethnography in the research procedure, including experience, ask questions, and cross-check (Wolcott, 1992).

FINDINGS AND DISCUSSION

Calendar baduy has a unique duration if we compare it with the International calendar that widely accepted as a standard calendar in the world. Although both of them use the position of the sun as the base on counting to determine how many days in a month, but the number of days is different. To understand the name and duration in days of the baduy calendar, we arrange it into the table below. Although baduy people have their own calendar system, they still use the international calendar in some conditions. For example, when they must explain their customary activities based on their own calendar to the researcher or people outside baduy like the question such as what the corresponding month is in the international calendar.

Table 1. Corresponding Months Between Baduy Calendar with International Calender

Month	Names of Baduy Calendar	Days	The International Calendar
1	Sapar or Kapat	30	April-May
2	Kalima	30	May-June
3	Kanem	30	June-July
4	Kapitu	30	July-August
5	Kadalapan	30	August-September
6	Kasalapan	30	September-October
7	Kasapuluh	30	October-November
8	Hapit lemah	30	November-December
9	Hapit kayu	30	December-January
10	Kasa	30	January-February
11	Karo	30	February-March
12	Katiga	30	March-April

From the table above, we see that every day every month always be the same in duration. It actually has a specific reason why calendar baduy only uses 30 days for all months. How baduy people can explain the 5 days differences with the international calendar that commonly about 365 days? Base on Mr. Syarif's explanation. He said, "aya anu dina diwagekan mun nangtukeun dina awal taun, kudu aya perhitungan husus, ngan nu ieu teu kabeh urang Kanekes (Baduy) bisa ngitungna, intina mah dicocokeun jeung musim melak pare engkena". (there are a number of days must be removed when we determine the first day in a new year, it has a specific formula that not all baduy people knew about it, the point is that it is connected with the growing season of paddy later.

Although the baduy calendar uses the position of the sun like an international calendar as based on counting days for every month, one year always be equals to 360 exactly. This systemic calendar makes baduy people who do not have any mathematical knowledge from the school, and also do not recognize about writing and reading culture (because they are prohibited going to school by the customary law), they can remember daily activities based on their calendar.

Ethnomathematics in The Calendar of Baduy

Let's start focusing on this calendar system below, we are not necessary to use all months in the baduy calendar just to determine the first day in every month. We can use 2 months for an example, months kanem and kapitu. Actually, we can use 2 other months as long as they are sequentially like sapar and kalima, kalima and kanem and so on. Our purpose is to find mathematical

modeling for predicting the first day in the next month. We use the model of calendar baduy based on Kurnia and Sihabudin (2010). From the figure above, we remember again the definition of modular arithmetic from the discrete of mathematics (Syahrin, Turmudi, & Puspita, 2016).

> *"Suppose a and m are integer, with m> 0. Operation a mod m (read as "a modulo m") gives a remainder when it is divided by m. In other words a ≡ b (mod m) such that a = mq + b, with 0≤ b <m".*

The first day in month kanem on 2072, according to the baduy calendar goes to Tuesday. Thus, how to determine the first day in month kapitu is as follows: because there are seven days in a week, and after the seven days is a repetition to the first day, then the modular arithmetic from the definition above can be applied to this calendar system. Given in figure 1, the first day goes to Saturday. We are numbering all days in a weeks as follows, because Saturday is the first day, we then write Saturday = 0, Sunday= 1, Monday = 2, Tuesday = 3, Wednesday = 4, Thursday = 5, Friday = 6. Since the baduy calendar has duration 30 days for every month. So that, to determine what the first day in the next month, we can write the formula as follows:

$$30 \equiv 2 \bmod 7$$

In which, the remainder from that modulo is 2. It corresponds to Monday that in the next month (kapitu) is the first day. Our prediction using the concepts of modular arithmetics matches with the first day in figure 2. Generally, to determine the first day in month-1, month-2,..., and month – n with safar as the first month in baduy calendar, we can use the same principle as we did before. It means, the month safar corresponds to 0, month kalima corresponds to 1 and so on. But, we have to change the corresponding between the numbering and the days before. We can not use Saturday = 0 as the first day because we take safar as the first month. We need to know what the first day in month safar. Let's back to see what the first day in safar 2071. From Arisetyawan (2015), we have the first day in month safar is Tuesday. And then, Tuesday corresponds to 0, Wednesday corresponds to 1,...., and Monday corresponds to 6.

To determine what the first day after month safar randomly, we can use the modified formula is as follows:

$$30 + 2k \equiv 2 + 2k \bmod 7$$

$$\text{with } k \in Z^{+} \cup \{0\},\ 2 + 2k \in Z_7 \text{ and } n = k + 1,\ n \in Z_{12}$$

If we choose $k = 2$, then $n = 3$, it means, we determine the first day in the third month (*Kapitu*). We have $34 \equiv 6 \bmod 7$ that corresponds to Monday. It is the same with previous result.

The Use of Modular Arithmatics on Mathematical Instruction

These are the concepts that the teachers can share to their student in the classroom when they use a calendar system of baduy tribe or any other object to study in the classroom which contents modular of arithmetics: 1.) The algorithm that determines the day of the week as in module 7; 2.) The algorithm that determines the month of the year as in module 12; 3.) The algorithm that determines the day of the year as in module 360.

Based on Awodeyi (2017), the content of modular arithmetic covers: 1.) Division of numbers with remainders; 2.) Integer modulo n, where n is a number- particularly, when n=7, 12, or 360; 3.) Congruence relation; 4.) Properties of modulo arithmetic; 5.) Congruent classes; 6.) Residue systems; & 7.) Reduced residue system modulo n. Although all the topics may not be within the scope in any level of curriculum for Mathematics both in primary or junior/senior high schools. But, some of the subtopics should necessarily be taught in schools for the inherent values to society and also, to serve as the foundation for algebra at the tertiary level.

CONCLUSION

The number of days in the baduy calendar always be 30 days every month. The first day from the previous month and the next month follows the rule: the first day in the previous month + 2 days after the first day of the previous month equals to the first day in the next month. For example, if the first day of this month is Friday, and then the first day of the next month must be Sunday. Although baduy people do not recognize the writing and reading culture, we conclude that this pattern of their calendar makes baduy people who do not know any mathematical knowledge from the formal school can predict the first day in their calendar easily.

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