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An ethnomathematics study of the days on the Javanese Calendar for learning mathematics in elementary school

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Abstract. Ethnomathematics is a mathematical value that presents in a culture. Calendar as a system of time periods is ethnomathematics. The calendar has days, dates, months, and years. Likewise, the Javanese calendar has years, months, dates, days (7 cycles on a week), and also *pasaran* (5 cycles on a week at the Javanese). The use of days in the Javanese calendar can be used as contextual and enrichment material in learning mathematics. This study aims to reveal the ethnomathematics values on days of Javanese Calendar as mathematics learning material. It uses qualitative methods that follow the ethnomathematics study framework. We took data from the indigenous community at Yogyakarta, Indonesia. Data collection techniques use interviews with traditional elders, and document analysis of Javanese *Primbon* (the special of Javanese Book) and mathematics curriculum content. The data analysis is determined by relational ideas of the days on Javanese Calendar, and the mathematics curriculum content. The result shows the ethnomathematics value of the remainder and modulo associated with days in the Javanese Calendar. Based on the results, the days on Javanese Calendar can be incorporated in mathematics learning material. Elaborating the days on Javanese Calendar is the potential for connecting culture and mathematics in the classroom. The days on Javanese Calendar contain mathematics values, and close to students' thoughts, so it can be used in elementary school mathematics class to make learning mathematics more meaningful.

Keywords: Ethnomathematics, Javanese Calendar, Javanese *primbon*, remainder, modulo

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INTRODUCTION

Ethnomathematics is a study of mathematical value that exists in a certain culture. D'Ambrosio (Rosa & Orey, 2016) stated that ethnomathematics incorporates mathematical ideas and procedures as indigenous societies, groups of workers, professional classes, and groups of children of a certain age group. In other words, Ethnomatematics has an essential step in exploring and recognizing the different ways of thinking mathematics from a culture.

D'Ambrosio (1985) stated that ethnomathematics is the field of creating a bridge between anthropologists, cultural historians, and mathematicians. It can be understood that ethnomathematics can be explored through an anthropological study, historical studies, and continued through cultural interpretation from a mathematical point of view. Therefore, ethnomathematics studies can involve anthropologists, historians, mathematicians.

Furthermore, ethnomathematics from a culture can then be used in learning mathematics in schools. The use of ethnomathematics in class teaches students to connect culture and mathematics. The objectives of using ethnomathematics and cultural-based pedagogical approaches are relevant to the mathematics curriculum and intended to make school mathematics relevant and meaningful and also to promote the overall quality of students' educational experiences (Matang & Owens, 2014; Ogunkunle, Harcourt, Harcourt, George, & Ed, 2015; Rosa & Orey, 2010; Stathopoulou, Kotarinou, & Appelbaum, 2015; Unodiaku, 2013). Ethnomathematics also enriches mathematics by understanding and bridging the often perceived dichotomy between academic mathematics and daily life. The ethnomathematics perspective provides transformational space for students and teachers and enables them to think of diversity as good, valuable, and necessary to live in a globally interconnected world (Orey & Rosa, 2008).

Cultural products are various examples of ethnomathematics, i.e., artifacts (cutlery, jewelry, temples, etc.), rules, beliefs, ideas, calendars, and so on. A calendar is one of the cultural products of the local community which ensures the survival of the community. Counting and recording time on calendar constructions is an excellent ethnomathematics example (D'Ambrosio, 2006). The variety of local calendars that contain ethnomathematics enriches the application of mathematics in the world. The wealth of this mathematical application makes calendar systems as ethnomathematics can use in learning mathematics more meaningful and valuable.

The ethnomathematics example of the local calendar is on the Mayans calendar. The Mayans used two different calendars at the same time, i.e., the 260-day which combine from two independent cycles (13 cycles length and 20 cycles length), and the 365-day which was divided into 18 months of 20 days each and an extra period of 5 days. The calculations of the Mayans Calendar is in relation to their number system, and typical in various elementary texts to include the arithmetic of place value on various bases, modulus, geometry, and graph theory, which have natural contexts in courses, so can be used in the classroom (Katz, 1994).

Another example of a local calendar is a calendar from the Viking culture. Their calendar had in common included a seven-day week and an empirical lunar calendar, and in the 12th century was constructed a new system of recording time, which is called Misseri-calendar. Misseri-calendar was extended to measure the length of the year, which was divided into winter Misseri (six months), summer Misseri (six months), and the four extra nights were added at mid-summer, after the 13th week of the summer Misseri, which was therefore needed for the gathering (Bjarnadóttir, 2010).

The other example of a local calendar is Maya Calendar. The ancient Maya usually finds a calendar for each month that gives all the holiday one might ever care to know about; and also astronomical information, such as times of sunrise/sunset, moon-phase tables, and eclipses for the current year, coupled with meteorological information and the schedule of tides for major local harbors (Aveni, 2011). In addition, for the ancient Maya, numbers were more than their devices to tally units of time. Maya realm of timekeeping the duration between ritual events seems to have mattered as much as the times when events occur, and the day keepers of Maya codices are sequenced the intervals followed well-defined patterns, which reveal an array of motives for the Maya way of structuring time.

Mayans Calendar, Misseri Calendar, and Maya Calendar give examples of ethnomathematics from local calendars in the world. Ethnomathematics in local calendars also exists in Indonesia. Indonesia consists of various ethnicities, so it has a variety of local calendars, such as Balinese Calendar with a reusable calendar engine, *Pawukon,* and Saka calendar system. *Pawukon* system is an arithmetic calendar system which is in one year consists of 210 days and 30 *wuku* (week) in a year. Saka calendar system consists of 12 months called *Sasih*, which is corresponds to the number of months in the Gregorian calendar. Unlike the Gregorian calendar which has fixed 7 days in a week, the Balinese calendar system defines several divisions of the number of days in a week, including the three-days week quarter consist of *pasah*, *beteng*, and *kajeng*, scheduled as the day for traditional markets in the villages (Putra, Sukarsa, Githa, & Wijaya, 2019). Furthermore, ethnomathematics exists on the Calendar of Cirebon Kasepuhan Palace, Indonesia. Ethnomathematics of *aboge* (*alif*, *rebo*, *wage*) calendar as the determinant of the great days of Islam and traditional ceremony in Cirebon Kasepuhan Palace (Syahrin, Turmudi, & Puspita, 2016).

Additionally, ethnomathematics is also mentioned in the Javanese Calendar. It contains number theory and calendar construction with modulo (Nuraeni & Azizah, 2017). However, Nuraeni and Azizah have not discussed modulo and pattern number in determining of the days and *pasaran* on Javanese Calendar yet. In this article, we discuss ethnomathematics in deciding of the days and *pasaran* on Javanese Calendar and the proposal learning mathematics of it. Based on this, the research question is as follows:

a. How are the cycles different from the Javanese Calendar?
b. What is the characteristic of Javanese Calendar?
c. How are the ethnomathematics values on the Javanese Calendar?
d. How are the ethnomathematics values be used in elementary school mathematics class?

METHOD

Research Design

The method of this research uses a qualitative method to reveal ethnomathematics in Javanese Calendar. To conduct a qualitative method through ethnomathematics in Javanese Calendar, the design of this research follows the framework of ethnomathematics study from Alangui (2010), which is presented in Table 1.

Table 1. *The framework of ethnomathematics study*

Generic Question	Initial Answer	Critical Construct	Specific Activity
Where is it to look?	Cultural practices in the use of the Javanese Calendar in determining of the days and *pasaran.*	Culture	Conducting interviews with people who capable of determining the days and *pasaran.* Describing how were the rules of dating calendar that were used in determining the days and *pasaran.*
How is it to look?	Investigating qualitative and relational aspects of the determining of the days and *pasaran.*	Alternative thinking	Determining what qualitative and relational ideas are contained in the determining of the days and *pasaran.*
What it is?	Proof of alternative concept	Philosophical mathematics	Identifying criteria to justify the rules of external customs in determining of the days and *pasaran.*
What does it mean?	The significant value of culture, and mathematics	Anthropology	Describing the relationship between mathematics and culture: Write new mathematical concepts found in the determining of the days and *pasaran.*

Gathering Data

This research was conducted by interviewing informants. The informants are the Javanese traditional elders, who comprehend the Javanese traditions, especially about determining the days and *pasaran*. The criteria for the informants are described in Table 2.

Table 2. *The criteria for the ınformants*

Aspect	Criteria
Age	>70 years old
Work	Javanese Elder, where people ask about the determination of something in their life
Source of knowledge	Knowledge is taught by his ancestors, not from school

There were 3 informants in this study, namely Mbah Sri, Mbah Kalam, and Eyang Panji. All of the informants were over seventy years old. They are the Javanese elder and taught heritage from their ancestors. In this research, we deep interviews using Javanese. All questions were asked about the used Javanese Calendar on the determination days of the Javanese ceremony.

Furthermore, this research was carried out with document analysis from Javanese Calendar and Javanese *Primbon.* Javanese *Primbon* is the special book from Java which documenting the Javanese tradition such as matchmaking match before the wedding go on (*see* Utami, Sayuti, & Jailani, 2019). Javanese Calendar and Javanese Primbon are examined as supplementary and also triangulation data from Javanese elder's interviews.

The Data Analysis

This research is limited to the rules of dating calendar that were used in determining days and pasaran. The data analysis technique used in this study is taxonomic analysis. The taxonomic analysis is conducted to analyze the determining days and *pasaran*, and the values of school mathematics that can be taught.

RESULTS AND DISCUSSION

1. The cycles on Javanese Calendar

Organize time can be systemized in a period, which is known as a calendar. The calendar synthesizes the knowledge and behavior needed for the success of the stages of planting, and storing, and related to myths and rituals directed at the entity responsible for this success, which guarantees the survival of the community (D'Ambrosio, 2006). Therefore, the calendar is local to a community, although the internationally recognized calendar was the one proclaimed by Pope Gregorio XIII.

There are some kinds of the calendar. Every notion had created its calendar system which is systematically organized to record and mark various types of events, historical incidents, and other events that befall them, so various time calculation system variants have appeared (Widodo & Saddhono, 2012). If we classify it, there are two types of calendars systems, i.e., the theological and cultural calendar systems (Puryandani & Robiyanto, 2015).

The Javanese calendar system is considered unique because it combines Islamic, Hindu, Javanese, and Buddhist cultures and a little mix of western culture. Meanwhile, Sultan Agung (King of the Mataram kingdom) created a Javanese calendar which was a combination of the Saka calendar (from India) and Hijri calendar (the Arabic calendar) in 1555 in the Saka calendar (Widodo & Saddhono, 2012). The Javanese calendar, which was a combination of the Saka calendar and the Arabic calendar has *dina* (days) and *pasaran* (a cycle system).

The use of two-day cycles on Javanese with weekly cycles and a five-week cycle of *pancawara/ pasaran*. Days and *pasaran* in Javanese Calendar also have different characteristics and influences in daily life. The Javanese society believes in some of the special days and *pasaran* based on Javanese Calendar. There are some days that are considered sacred to do something.

Mystical values of some days are still upheld; for example, stock returns activity in the community in the economic field. Javanese Calendar affects the investors' risk aversion level (Hermin & Mahadwartha, 2018; Puryandani & Robiyanto, 2015; Renald, Kurniawan, & Robiyanto, 2018). The sacred days, i.e., *Kliwon* Friday and *Wage* Thursday, have a significant effect on the return of the Jakarta Composite Index (JCI) (Renald et al., 2018). It means that investors' behavior in Indonesia is influenced by superstition. The day of *Kliwon* Friday is often considered to be the most sacred as Friday the Thirteenth in Western culture.

Not only the sacred day of the Javanese Calendar but some days also influences various activities of the Javanese. Based on interviews conducted with Mbah Sri (one of the traditional Javanese elders) about the use of two-day cycles in Javanese society:

Researcher	:	*Menawi dinten pasaran wonten masyarakat mriki tesih dipun etang nggeh mbah?* (Is the *pasaran* day here still counted?)
Javanese Elder	:	*Nggeh tasih. Contonipun wonten ingkang pepanggihan-pepanggihan, contonipun pepanggihan trah saben minggu legi kemawon, saben minggu kliwon kewamon* (Yes, of course. For example, it is conducted on meetings, i.e breed meetings on *Legi* Sunday or on *Kliwon* Sunday) (interview, March 23, 2018).

It gives an explanation about a combination of two-day cycles and examples of the use of the Javanese Calendar in daily life. The other activities are spiritual activities, social gathering activities; villagers meeting activities considered the Javanese Calendar.

The activities of buying and selling activities in traditional markets are usually carried out on a certain day and *pasaran.* There are still many traditional markets in the Javanese community whose implementation consider to days and *pasaran*, such as *Pahing* Market in Kretek, Bantul, Yogyakarta; *Wage* Market in Godean, Sleman, Yogyakarta. The buying and selling activities in traditional markets, according to market days, are still carried out by the community.

The other example of the use of the Javanese Calendar in daily life is commemorating someone's death. The commemoration of someone's death used as a symbol in praying for people who have died. The remember is carried out on 7 days, 40 days, 100 days, one year, and 2 years from the death of (see on Supplementary File). Various Javanese community activities that use calendar show the importance of the Javanese calendar in Javanese society.

2. The Characteristic of Javanese Calendar

The Javanese calendar system combines Islamic, Hindu, and Buddhist cultures and a little mix of western cultures. The example of the Javanese calendar can be drawn in Figure 1. As a combination of Saka and Hijri calendar, time calculation in the Javanese calendar is separated by several cycles, i.e., weekly cycles, *pancawara* or *pasaran* cycle, the monthly cycles, the annual cycles of the year, and the eight-year. Weekly cycles consist of *Senen* (Monday), *Selasa* (Tuesday), *Rebo* (Wednesday), *Kemis* (Thursday), *Jemuwah* (Friday), *Setu* (Saturday), *Ngahad* (Sunday). *Pancawara* or *pasaran* cycle consists of *Legi, Pahing, Pon, Wage, Kliwon*. Monthly cycles of *mangsa* and *wulan* consist of *Sura*, *Sapar*, *Rabingulawal*, *Rabingulakhir*, *Jumadilawal*, *Jumadilakir*, *Rejeb*, *Ruwah*, *Pasa*, *Sawal*, *Dulkaidah*, *Besar*. The annual cycles of the year consist of *Alip*, *Ehe*, *Jimawal*, *Je*, *Dal*, *Be*, *Wawu*, *Jimakir*. Furthermore, there is the eight-year cycle which is called *windhu*.

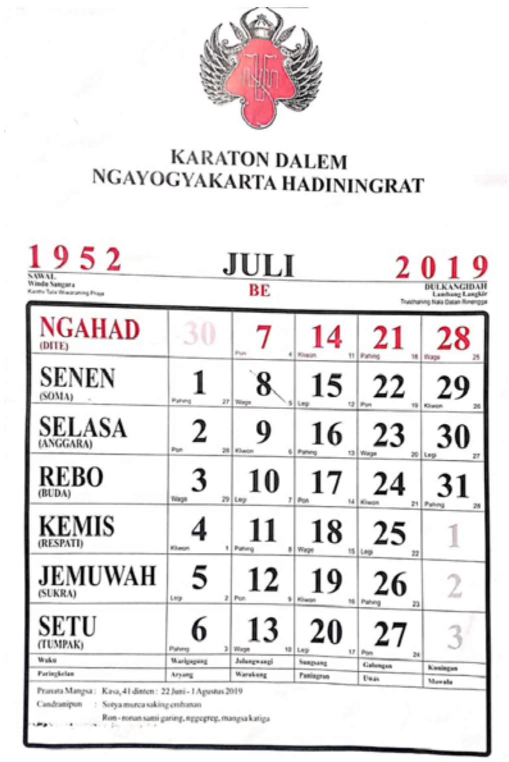

FIGURE 1. *Javanese Calendar*

In the daily life of Javanese, determination of the day in the Javanese calendar starts the rise of the moon (after sunset), such as in determining someone died. Based on interviews conducted with Mbah Kalam (one of the traditional Javanese elders) about the calculation of the day for someone who died on the 18th March at 3 am:

Researcher : *Mbah nek maghrib gantos niku misale maghrib melu 19? Ning gandeng wau enjing jam 3 melu 18?* (Grandpa, after Magrib changes, what does it

	mean after sunset is counted in the 19th? But, if it is 3 o'clock in the morning then counted on the 18th?)
Javanese Elder :	*Berati melu isuk. Nek bengi bar maghrib sudah ganti hari berikutnya* (It means morning. If after sunset, it has changed to the next day)(interview, March 18, 2019).

It means that the turn of the day in the Javanese calendar starts after sunset does not like the Gregorian calendar. As we know, the Gregorian Calendar is the recognized calendar in use around the world.

The determination of the day in the Javanese calendar is slightly different from the Gregorian Calendar. For example, 7 days from Sunday is Sunday, so 7 days from *Wage* Sunday in the Gregorian calendar is *Legi* Sunday. But, 7 days from *Wage* Sunday in Javanese Calendar is *Kliwon* Saturday (one day before *Legi* Sunday). In addition, the difference between Javanese Calendar and Gregorian Calendar is the Gregorian calendar consists of 364-365 days in a year (Rickey, 1985), while in the Javanese Calendar 1 year is 354-355 days (Purwanto, Chotimah, & Mustofa, 2018). These differences occur because of the Gregorian Calendar is Sun-based Calendar, while the Javanese Calendar uses a lunar or lunar calendar system (based on the rotation of the moon).

3. Ethnomathematics on Javanese Calendar

The construction of the Javanese Calendar has patterns that can be identified and contain mathematical values. Javanese can determine what even though they have not seen the Calendar to determine the days and *pasaran* of commemorating someone's death. The Javanese Calendar has a pattern; hence Javanese can determine even though they have not seen the Calendar. It is due to the characteristics of a calendar that has a pattern. Based on interviews conducted with Mbah Kalam (one of the traditional Javanese elders):

> "*Mangke niki kulo kandani, seko 7 dino tekan 1000 iso. Ono rumuse, 7 dino ki 7;2, 40 hari 5;5, 100 dino 2;5; 1 tahun 4;4; 1000 dino 6;5.*"
> (I'll tell you later about the commemoration of death from 7 days to 1000 days. There is formula for commemoration: the formula for 7 days is 2; 5, the formula for 40 days is 5;5, the formula for 100 days is 2;5, the formula for 1 year is 4;4, the formula for 1000 days is 6;5) (interview, 15 March 2019).

Mbah Kalam means that the determination of the example of determining the 7th day commemorate of the death of someone who died at the *Wage* Thursday is performed 7;2: (1) Thursday, (2) Friday, (3) Saturday, (4) Sunday, (5) Monday, (6) Tuesday (7) Wednesday, and *pasaran* (1) *Wage*, (2) *Kliwon*.

Next, the example of the determination of the 40th day of commemoration of someone's death, who dies on *Wage* Thursday is performed 5;5: (1) Thursday, (2) Friday, (3) Saturday, (4) Sunday, (5) Monday, and *pasaran* (1) *Wage*, (2) *Kliwon*, (3) *Legi*, (4) *Pahing*, (5) *Pon*.

The example of the determination of the 100th day of commemoration of someone's death, who dies on *Wage* Thursday is performed 2; 5: (1) Thursday, (2) Friday, and *pasaran* (1) *Wage*, (2) *Kliwon*, (3) *Legi*, (4) *Pahing*, (5) *Pon*.

The example of the determination of the 1st year of commemorating of someone's death, who dies on *Wage* Thursday is performed 4;4: (1) Thursday, (2) Friday, (3) Saturday, (4) Sunday, and *pasaran* (1) *Wage*, (2) *Kliwon*, (3) *Legi*, (4) *Pahing*.

The example of the determination of the 1000th day of commemorate of someone's death, who dies on *Wage* Thursday is performed 6;5: (1) Thursday, (2) Friday, (3) Saturday, (4) Sunday, (5) Monday, (6) Tuesday, and *pasaran* (1) *Wage*, (2) *Kliwon*, (3) *Legi*, (4) *Pahing*, (5) *Pon*.

Look at all the determination above starts on Thursday because in the afternoon it has entered into the next day. This is also the case with *pasaran* which is a start in *Wage*. The determination of the day to commemorate something is one day before the Gregorian Calendar.

The statement of the Javanese elder (Mbah Kalam) is in accordance with the Javanese *Primbon*. Look at the bottom row of document from Javanese *Primbon* (see on Supplementary

File), someone's who dies on *Wage* Thursday, so the commemorate of the 7th day is *Kliwon* Wednesday, the commemoration of the 40th day is *Pon* Monday, the commemoration of the 100th day is *Pon* Friday, the commemoration of the 1st year is *Pahing* Sunday, the commemoration of the 1000 days is *Pon* Tuesday.

Aside from the ceremony of commemorating someone dying, the ceremony is also done on babies born. For example, during the *selapanan* (one of the babies born ceremony) that was carried out at the age of 35 days. Calculations are also carried out on this celebration. Based on interviews conducted with Eyang Panji (one of the traditional Javanese elders):

Javanese elder	:	*Arep neng selapanan, yo nggon setu pahing kuwi. Maju sedinone le gawe bancakan* (If you want to celebrate 35 days of birth a baby who born on *Pahing* Saturday uses *Pahing* Saturday. But, the celebration is one day before)
Researcher	:	*niku kok le damel bancakan maju sedino eyang?* (Why the celebration is one day before?)
Javanese elder	:	*lha mengko nek neng setu pahing kuwi wis 36 dino je etungane* (If on *Pahing* Saturday, it is already logged in 36 days) (interview 24 Juli 2019)

It means that the making of *among-among* (various types of food arranged as a symbol of the celebration) to celebrate 35 days of a baby born is on babies aged 34 days. This can be understood as described above that Javanese Calendar uses the lunar calendar system so that the turn-on of the days begins in the afternoon. Making a*mong-among* for *kenduri* (celebration activities) is usually done in the afternoon or after sunset.

The determination of ethnomathematics value in days and *pasaran* on Javanese Calendar is presented as follows.

Ethnomathematics on Determining of 7th days

The determination of the 7th days is 7; 2. It means in the 7th (day) and 2nd (*pasaran*). 7th (day) on 7 days cycle in determining 7th days means 7 divided by 7 is 1, remainder 0, so we can write 7 = 7 · 1 + 0 and in the modulo arithmetic $7\ mod\ 7 = 0$. A similar, we can write 7 divided by 7 is 0, remainder **7**, so we can write 7 = 7 · 0 + 7 and in the modulo arithmetic $7\ mod\ 7 = \mathbf{7}$**.** Furthermore, 2nd (*pasaran*) on 5 *pasaran* in determining 7th days cycle means 7 divided by 5 is 1, remainder **2**, so we can write 7 = 5 · 1 + **2** and in the modulo arithmetic $7\ mod\ 5 = \mathbf{2}$**.**

Ethnomathematics on Determining of 35th days

The determination of the 35th days is 7; 5. It means in the 7th (day) and 5th (*pasaran*). 7th (day) on 7 days cycle in determining 35th days means 35 divided by 7 is 5, remainder 0, so we can write 35 = 7 · 5 + 0 , and in the modulo arithmetic $35\ mod\ 7 = 0$. A similar, we can write 35 divided by 7 is 4, remainder **7**, so we can write 35 = 7 · 4 + 7, and in the modulo arithmetic $35\ mod\ 7 = \mathbf{7}$**.** Furthermore, 5th (*pasaran*) on 5 *pasaran* in determining 35th days means 35 divided by 5 is 7, remainder 0, so we can write 35 = 5 · 7 + 0 and in the modulo arithmetic $35\ mod\ 5 = 0$. A similar, we can write 35 divided by 5 is 6, remainder **5**, so we can write 35 = 5 · 6 + **5** and in the modulo arithmetic $35\ mod\ 5 = \mathbf{5}$

In addition, the lowest common multiple of 7 and 5 is 35. In other words, the lowest common multiple is also included in determining 35th the days.

Ethnomathematics on Determining of 40th days

The determination of the 40th days is 5; 5. It means in the 5th (day) and 5th (*pasaran*). 5th (day) on 7 days cycle in determining 40th days means 40 divided by 7 is 5, remainder **5**, so we can write 40 = 7 · 5 + **5** and in the modulo arithmetic $40\ mod\ 7 = \mathbf{5}$**.** Furthermore, 5th (*pasaran*) on 5 *pasaran* in determining 40th days means 40 divided by 5 is 8, remainder 0, so we can write 40 = 5 · 8 + 0 and in the modulo arithmetic $40\ mod\ 5 = 0$. A similar, we can write 40 divided by 5 is 7, remainder **5**, so we can write 40 = 5 · 7 + **5** and in the modulo arithmetic $40\ mod\ 5 = \mathbf{5}$**.**

Ethnomathematics on Determining of 100th days

The determination of the 100th days is 2; 5. It means in the 2nd (day) and 5th (*pasaran*). 2nd (day) on 7 days cycle in determining 100th days means 100 divided by 7 is 14, remainder **2**, so we can write 100 = 7 · 14 + **2** and in the modulo arithmetic $100\ mod\ 7 = \mathbf{2}$**.** Furthermore, 5th (*pasaran*) on 5 *pasaran* in determining 100th days means 100 divided by 5 is 20, remainder 0, so we can write 100 = 5 · 20 + 0 and in the modulo arithmetic $100\ mod\ 5 = 0$. A similar, we can write 100 divided by 5 is 19, remainder **5**, so we can write 100 = 5 · 19 + **5** and in the modulo arithmetic $100\ mod\ 5 = \mathbf{5}$

Ethnomathematics on Determining 1st year of days

Remember if 1st year on Javanese Calendar is 354-355 days. The determination of the 354th days is 4; 4. It means in the 4th (day) and 4th (*pasaran*). 4th (day) on 7 days cycle in determining 354th days means 354 divided by 7 is 50, remainder **4**, so we can write 354 = 7 · 50 + **4** and in the modulo arithmetic $354\ mod\ 7 = \mathbf{4}$**.** Furthermore, 4th (*pasaran*) on 5 *pasaran* in determining 354th days means 354 divided by 5 is 70, remainder **4**, so we can write 354 = 5 · 70 + **4** and in the modulo arithmetic $354\ mod\ 5 = \mathbf{4}$**.**

Ethnomathematics on Determining of 1000th days

The determination of the 1000th days is 6; 5. It means in the 6th (day) and 5th (*pasaran*). 6th (day) on 7 days cycle in determining 1000th days means 1000 divided by 7 is 142, remainder **6**, so we can write 1000 = 7 · 142 + **6** and in the modulo arithmetic $1000\ mod\ 7 = \mathbf{6}$**.** Furthermore, 5th (*pasaran*) on 5 *pasaran* in determining 1000th days means 1000 divided by 5 is 200, remainder 0, so we can write 1000 = 5 · 200 + 0 and in the modulo arithmetic $1000\ mod\ 5 = 0$. A similar, we can write 1000 divided by 5 is 199, remainder **5**, so we can write 1000 = 5 · 199 + **5** and in the modulo arithmetic $1000\ mod\ 5 = \mathbf{5}$**.**

Determination of the 7th days, 35th days, 40th days, 100th days, 1st year, and 1000th days are related to mathematics division and remainders on modulo arithmetic:

> Let $b \neq 0$ be an arbitrary integer. Every other a will either be a multiple of b or fall between two consecutive multiples $q \cdot b$ and $(q+1)b$ of b. Thus one can write
>
> $$a = qb + r \qquad (1)$$
>
> Where r is one of the numbers
>
> $$0, 1, 2, \ldots, |b| - 1 \qquad (2)$$
>
> In (1) r is called the least positive remainder or simply the remainder of a by division with b, while q is the incomplete quotient or simply the quotient (Ore, 1948).

As an example, let us divide 40 by 7. We can write: 40 = 7 · 5 + **5. 5** is remainder of 40 by division with 7. Another commonly used notation is $a\ mod\ m = r$. In the arithmetic of modulo:

> Suppose that a is an integer and m is an integer more than 0, hence:
> $a\ mod\ m\ = r$, so that $a\ = mq\ +\ r$, where $0\ \leq\ r\ <\ m$

Therefore, 40 = 7 · 5 + **5** can write as $40\ mod\ 7\ = 5$.

4. Ethnomathematics Javanese Calendar in Elementary School Mathematics Class

The values of cultures related to mathematics indicate the existence of mathematics present in every culture. It means that culture enriched mathematical material, especially in applications mathematics in daily life. Diverse mathematical material can be used to support the preparation of varied learning activities.

Various studies show the positive influence of using ethnomathematics on classroom, i.e the use of indigenous knowledge calculations makes students spend less time and fewer mistakes in completing each assignment (Matang & Owens, 2014); learning using ethnomathematics approaches is effective in improving students' creative skills (Ogunkunle et al., 2015); the use of ethnomathematics allows students to understand mathematics with their own perceptions, which is called informal knowledge, and students are given the opportunity to renegotiate mathematical concepts and validate meaningful knowledge in several contexts (Stathopoulou et al., 2015); and the use of ethnomathematics-based teaching materials on the concepts of volumes of cylinders and hemispheres is effective in improving students' mathematics learning achievement (Unodiaku, 2013). Different mathematical activities of peoples all around the world enable students to develop respect for their own and other mathematical activities and products. A variety of forms in mathematical knowledge can be encoded differently from academic textbooks (Powell, 2009). Likewise, ethnomathematics in Javanese Calendar can use in learning mathematics.

Ethnomathematics on learning mathematics can be used by ethnomodeling. Ethnomodeling is a process of elaboration of problems and questions growing from real situations or systems taken from reality (Orey & Rosa, 2010). Ethnomathematics associated with ethnomodeling perspectives is possible to the development of understanding different ways of doing mathematics through dialogue and respect (Orey & Rosa, 2010). Learning mathematics with ethnomodeling can be designed by the determination of the 7th days, 35th days, 40th days, 100th days, 1st year, and 1000th days. The example of problems and questions that can be arranged from the mathematical sentences are:

Problem

Mrs. Marta gave birth to a baby girl on Legi Sunday on August 4, 2019. Mrs. Marta will be held 35th days' ceremony for her baby.

Question

When the baby birth 35th days' ceremony of Mrs. Marta's baby will be held?

To solve the problem and question above, we can check the Javanese Calendar or pay attention to the pattern of Javanese Calendar.

Furthermore, to facilitate the determination of the day in learning mathematics, pattern number can be arranged as a formula. Before arranging the mathematics formula, we convert the days as numerical. Determination of days can use modulo 7, and it can be recorded with numbers 0, 1, 2, 3, 4, 5, 6 by rules: Sunday = 0, Monday = 1, Tuesday = 2, Wednesday = 3, Thursday = 4, Friday = 5, and Saturday = 6. Additionally, to determination *pasaran* in Javanese Calendar can use modulo 5. *Pasaran* days can be recorded with the numbers 0, 1, 2, 3, 4 by the rule: *Pon* = 0, *Wage* = 1, *Kliwon* = 2, *Legi* = 3, *Pahing* = 4. Furthermore, to the determination of the 7th days is in 7th day and 2nd pasaran, we can record with numbers and change it to a mathematical sentence:

If the initial day is x, the day sought is y, the initial *pasaran* is a, and the *pasaran* sought is b, so:

$$y = x$$

$$b = a + 2$$

In the same way of determination of the 7th days, determining of 35th days is $y = x$, $b = a$; determining of 40th days is $y = x + 5$, $b = a$; determining of 100th days is $y = x + 2$, $b = a$; determining of 1st year (in Javanese) is $y = x + 4$, $b = a + 4$; and determining of 1000th days is $y = x + 6$, $b = a$.

Sometimes, the result of the calculation of "y" is the same or more than 7, and the count of "b" is the same or more than 5. Therefore, for this case:

if $y \geq 7$, so the result is reduced by 7 if $b \geq 5$, so the result is reduced by 5

After the calculation of the number, we can substitute for the initial equation. However, the celebration or the commemoration is one day before the determining day.

CONCLUSIONS AND SUGGESTIONS

The calendar has an essential role in determining the time of activities on Javanese society, i.e. spiritual, traditional market, social gathering, and village meeting activities. For determining the time of activities, in addition to weekly cycles, in the Javanese calendar known as Pancawara or, which consists of *Legi, Pahing, Pon, Wage, Kliwon*. We have shown that the remainder and arithmetic modulo are in the determination of days on weekly cycles and *pasaran* on the Javanese Calendar. In other words, ethnomathematics exists on Javanese Calendar.

Elaborating the days on Javanese Calendar is the potential for connecting culture and mathematics in the classroom. The days on Javanese Calendar contain mathematics values, and close to students' thoughts, so it can be used in elementary school mathematics class to make learning mathematics more meaningful. Hence, this ethnomathematics value has potential material as a context in mathematics learning, such as the context in making an ethnomathematical problem according to the remainder and arithmetics modulo.

CONFLICT OF INTEREST

Authors declare no conflict on interest in this writing.

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