Journal of Advanced Sciences and Mathematics Education
Volume 2, Issue 1, 29 – 37
e_ISSN: 2798-1606
DOI : 10.58524/jasme.v2i1.75

Élmu palak: Ethnomathematics exploration in mathematics at Sukabumi district high school

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Article Info

Article history:

Received: March 16, 2022
Revised: June 10, 2022
Accepted: June 28, 2022

Keywords:

Mathematics;
Ethnomathematics;
Élmu palak;
Repok.

Abstract

This study examines the arithmetic used by Sundanese people, especially in several regions in Sukabumi Regency, as a cultural heritage that can be used for activities in daily life using specific patterns. Some traditional societies in the Sunda region are still closely related to the beliefs adopted and passed down from their ancestors. This study aims to determine the mathematical material in the *élmu palak* count, especially in *repok counting*ing pattern (match count of matchmaking before marriage). The method used in this study is the ethnographic method with a qualitative approach and a gradually advanced research flow. The subjects used in this study are limited to five people from different sub-districts determined using purposive sampling technique. The study found that there are a variety of counting patterns, but in general, the calculation elements consist of the name and/or day of birth. Other than that, there is relevance to high school mathematics material, one of which is the material relations and functions, residual theorem, and modulo.

To cite this article: Rosinansis, R., Nurcahyono, N. A., & Lukman, H. S. (2022). *Élmu palak*: Ethnomathematics exploration in mathematics at Sukabumi district high school. *Journal of Advanced Sciences and Mathematics Education, 2*(1), 29 – 37.

INTRODUCTION

Mathematics is essential to learn because it has a unique characteristic to science, which has an abstract object, axiomatic and deductive thinking pattern, and is based on truth (Imswatama & Lukman, 2018). Besides, mathematics is originally from various cultures and can be a source of inspiration for students of its own culture (Darmayasa, 2018). According to Regulation of the Minister for Education Indonesia (Permendiknas) No. 23, 2006, national education is rooted in the values of Indonesia's national culture. This follows what Nurcahyono & Novarina (2017) conveyed, which revealed that customs and habits contain the importance of local wisdom that need to be preserved. The significant role of culture as the direction of educational development, taking noble cultural values and integrating them into subjects, has a strategic position in implementing learning. Therefore, education influences one's abilities (Maskur et al., 2020).

Education is a construction process of character and abilities to create certain circumstances or situations in social life(Rahmawati et al., 2021). However, In mathematics learning activities at school, teachers have not linked mathematics with culture or daily activities. As a result, the students cannot use mathematical concepts to solve everyday problems (Nugraha et al., 2020). In addition, we also still encounter various difficulties and challenges such as low motivation to learn math, difficulties in grasping and understanding complex mathematical concepts, codes, and values, attention and concentration deficits in class, and more, which negatively affect academic achievement (Fouze & Amit, 2018). This educational issue has always been an exciting topic of discussion among the wider community (Permanasari & Pradana, 2021; Rionanda et al., 2022). So, there needs to be a synchronization between mathematics learning and culture in the environment where students live and study. Mathematics and culture are two things that are strictly related and can be mutually explained through various cultures and activities in people's lives (Hermanto et al., 2019).

Mathematics has been integrated into various fields of life, including the culture of the community (Pradana et al., 2022). Society often does not realize that they have used mathematics in their culture (Huda et al., 2020; Komarudin & Permana, 2019; Wahyuni, 2021). Culture in a particular community or ethnic group accompanied by the growth of mathematical activity is often known as ethnomathematics (Muslimahayati & Wardani, 2019). Ethnomathematics represents a field of mathematics that studies different types of mathematics from other cultures (Yustinaningrum et al., 2018). Ethnomathematics utilizes mathematics concepts widely that are bound up with mathematics activity sort, covering activity

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agglomerates, get computing, measure, designing building or tool, play, determining the location and any other as it (Hirzi & Gazali, 2020). Ethnomathematics can act as a connecting bridge between cultural preservation and local wisdom with technological and artistic advances through science (Nur et al., 2020). This relationship can be seen from two perspectives: what mathematics is contained in cultural symbols or how mathematics is the basis for producing cultural symbols in society (Latif & Talib, 2021).

In Indonesia, the Sundanese is the second largest ethnic after the Javanese (Dhona, 2016). With all the greatness it has, it covers the community, region, and culture. Sundanese culture is one of the wealth of the Indonesian people that lives, grows, and develops among the Sundanese people. Some of the traditional society in the Sunda region is still gripped by the customs and beliefs of their ancestors (Nursalis et al., 2018), including the *élmu palak* or the science of calculating sacrifices found in *Naskah Palintangan* or *Paririmbon*. The text of this manuscript is familiar in the community, even though there are still differences in beliefs. It is one of the ancient manuscripts that is a legacy of ancient Sundanese cultural heritage.

However, this calculation pattern is a traditional cultural heritage that we respect. On the one hand, there are still those who take it seriously and are worth considering it is a sacred calculation that can give reality. While on the other hand, the calculation system uses primbon books or predictions that contain problems that cannot be trusted.

The interviews with one of the Sukabumi cultural observers revealed that *élmu palak* is a calculation to determine *repok. The* calculations can estimate the season using specific patterns, determining good times for agriculture, holding a prayer, building a house, holding a wedding, taking long trips, and many others that are sacred in their count patterns. The counting pattern Sundanese has long used as a cultural heritage inherited from generation to generation can not be separated from the pattern of calculating modern mathematics found and recognized by the world far from the Pasundan hemisphere.

Almost all aspects of life have relevance to mathematics, both of which have been studied using methods understood from generation to generation by their ancestors in the community or other things in such environmental activities. This is also referred to as ethnomathematics, namely the knowledge related to the pattern of life and the ways introduced, used, and developed from the ancestors of a particular group of people, with or without their knowledge. It has used science which is now called mathematical science. Then it can be concluded that mathematics can not be separated from a life that has been entrenched, not separated from mathematical patterns.

Research on the analysis of ethnomathematical forms in the calculation system has been carried out several times, including research by Sulaiman (2021) and Suraida et al., (2019), which analyzes the form of ethnomathematics in determining the auspicious wedding day of the Javanese people according to *neptu* and *weton*. Research by Kristanti et al. (2022) examines the application of ethnomathematics to the *Methik Pari* tradition. Suarjana et al. (2014) research aims to explore the repetition of a person's birthday using the Balinese calendar. In East Java, Sugianto et al., (2019) conducted research by analyzing local mathematical wisdom in the calculation of the traditional house building of the Ponorogo community. From several previous studies, no research describes the pattern of calculating *élmu palak* to determine *repok.*

This research aimed to describe the pattern of *élmu palak* counting in *repok* pattern and to find out their correlation with high school mathematics material, especially in Sukabumi Regency. This research was limited by focusing on one *élmu palak* counting pattern, namely the pattern of *repok counting*ing (match count of marriage mate before marriage). This study was limited to only five sub-districts in the Sukabumi Regency area.

METHOD

This study used ethnographic method with a qualitative approach and gradual research flow. Furthermore, Ethnography is a work depicting culture to understand other ways of life from an indigenous point of view (Sudarsi et al., 2019). The purpose of ethnography is to understand a picture of life from the perspective of the native population. This study used a stepwise research stream. There were twelve steps in doing ethnography (Windiani & Nurul, 2016). The researchers only used six core stages based on the problem-solving process, including:

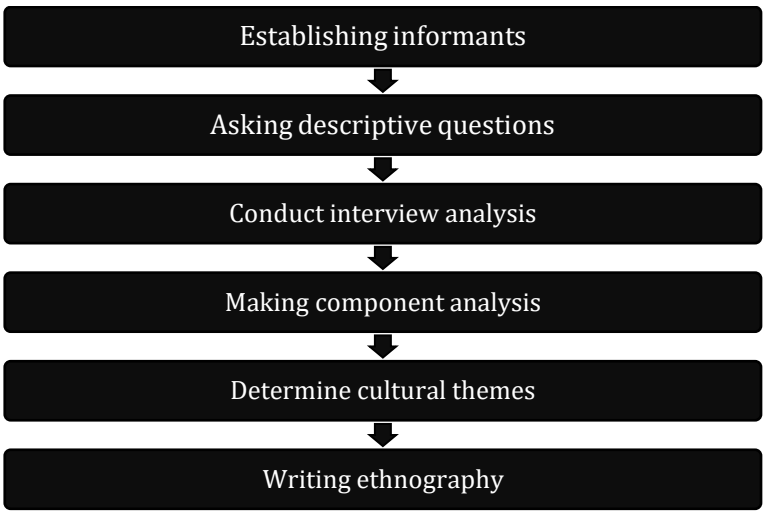

Figure 1. Stages Based on the Problem-Solving process in Ethnography

The subjects were selected using purposive sampling. The chosen subjects were the experts who can provide in-depth information about the *repok counting* in *élmu palak*. There were five experts from five different sub-districts in the area of the Sukabumi Regency. The subjects were experts called *pananyaan*. This is the list of names of research subjects.

Table 1. List of Research Subjects

Subject Code	Job	Education	Age	Gender	Expert
S1	Farmer	Primary School	64	M	*Élmu Palak*
S2	Security Guard	Primary School	53	M	*Élmu Palak*
S3	Teacher	Bachelor Degree	50	M	*Élmu Hikmat*
S4	Unemployment	Primary School	111	M	*Élmu Palak*
S5	Farmer	Bachelor Degree	66	M	*Élmu Palak*

Data analysis techniques were done by systematically compiling data obtained from the results of observations, interviews, and documentation, using triangulation techniques, component analysis, and analysis of cultural friends, according to the Spradley method. The data collection techniques were observation, interviews, and documentation. The instruments used were observation sheets and interview guidelines.

RESULTS and DISCUSSION

Repok counting in Pattern

Repok counting in pattern (match mate) determines the matching pair. There are differences of opinion between people who believe in the counting pattern because it is considered sacred. Besides being an ancestral heritage, it also has an essence for people who believe it. In addition, some people do not believe in the counting pattern because it is considered old-fashioned and inappropriate. Some say that if you believe in these counts, you are deemed to have parted with the Almighty God.

Based on five subjects met by researchers and some people around the home of the research subjects who also helped provide information about the beliefs and calculation patterns used, the results showed that 88% of the people believed in the calculation. On the other hand, 12% did not believe it. The data is accumulated from an average of 13 people encountered by researchers in each research subject environment. Of the 88% or 57 people who claimed to still use the arithmetic, only ten knew the repok counting pattern, giving uncertain answers and suggesting that the researchers directly ask *pananyaan*. Confidence about the pattern count is used to determine different repok in each region in Sukabumi Regency.

S1 Subject describes the *repok counting* pattern by using the count from *naktu* (literacy value used), the name of the prospective wife and prospective husband. *Thae naktu* uses *aksara cacarakan*, with the following pattern.

Table 2. *Naktu Aksara Cacarakan*

Aksara	Value	*Aksara*	Value
HA	1	PA	11
NA	2	DHA	12
CA	3	JA	13
RA	4	YA	14
KA	5	NYA	15
DA	6	MA	16
TA	7	GA	17
SA	8	BA	18
WA	9	THA	19
LA	10	NGA	20

After counting the *naktu*, the names of prospective husbands and wives are summed. Then, the results are divided by five. The remainder of the quotient is the most highlighted number. The remainder must fall to numbers 2 or 3. So that is said to be *repok*. But number 3 is better than number 2. The count is taken from *jangjawokan,* which shows the order of the remaining 1 to 5 or 0.

Table 3. The Meaning of *Jangjawokan Pancaka 5*

Remaining results	*Jangjawokan*	Meaning
1	*Sri*	Life in his household only survives with modest wealth
2	*Lungguh*	Trusted in holding positions in community life
3	*Dunya*	Have abundant assets
4	*Lara*	Always get sad and always fight in his household life
5 atau 0	*Pati*	Not long after marriage will be close to death

The following is an example of a *repok counting* that uses *naktu*, *aksara cacarakan*.
GANI PRESA WIBAWA and WULAN SUKMAWATI
In *aksara cacarakan*, the names come from the basic word:
17 + 2 + 11 + 8 + 9 + 18 + 9 dan 9 + 10 + 8 + 16 + 9 + 7.
74 + 49 = 123 divided by 5 = 24 remaining 3.

Based on the predetermined count, the remaining 3 indicate *Dunya*, meaning you will have worldly wealth. Thus, the two candidates suggest that they are matched and predicted will get earthly happiness. The S1 subject also explains other ways of determining *repok* that is by matching the *wedal* (day of birth) of both candidates with stipulated conditions, that is :

Table 4. *Repok* Based on *Wedal*

Prospective Husband *Wedal*		Prospective Wife *Wedal*
Monday	→	Thursday
Tuesday	→	Friday Saturday
Wednesday	→	Sunday
Thursday	→	Monday
Friday	→	Tuesday
Saturday	→	Tuesday
Sunday	→	Wednesday

Subject S2 describes the count pattern of *repok* by using the count from *naktu* name of prospective wife and prospective husband. The *naktu* used *aksara pegon* (Arabic) with the following pattern.

Tabel 5. *Naktu Aksara Pegon*

ط	خ	ز	و	ه	د	خ	ب	ا
9	8	7	6	5	4	3	2	1
ص	ف	ع	س	ن	م	ل	ك	ي
90	80	70	60	50	40	30	20	10
غ	ض	ذ	ظ	ث	ت	ش	ر	ق
900	800	700	600	500	400	300	200	100

How to count patterns of *repok* according to S2 Subject, that is by adding *naktu* from the names of the two candidates, then adding 7, which means that the couple is blessed for 7 days in one week. The results of the sum are then divided by 9, then the remainder of the quotient is then the benchmark for

the candidate pair to match or not. Among the remaining 1 to 9 or 0, the best remaining results are at number 7 then the other alternative is 8. The results of the remaining counts from 1 to 9 or 0 namely: (1) *Hamlun*; (2) *Sorun*; (3) *Jaujun*; (4) *Sirtonun*; (5) *Ashadun*; (6) *Sumbulatun*; (7) *Mizan*; (8) *Akrobun*; dan (9) *Qowasun.* There are several alternatives when the results are calculated from *naktu*. The name does not fall at 7 or 8; then it is added *naktu* days, then counted the same way. As for *naktu*, the days are as follows.

Table 6. *Naktu* Days

Days Name	***Naktu* Days**
Sunday	5
Monday	4
Tuesday	3
Wednesday	7
Thursday	8
Friday	6
Saturday	9

Here is an example of a *repok counting* using *naktu*, the name of *aksara pegon*.
GANI PRESA WIBAWA dan WULAN SUKMAWATI
900 + 50 + 200 + 60 + 6 + 2 + 6 dan 6 + 30 + 60 + 40 + 6 + 400
1.224 + 542 + 7 = 1.773 divided by 9 = 197 remaining 0.

Because the remaining number 0 is a bad result, it is added with *naktu* days. The example, if the couple's birthday is Wednesday and Saturday, the count becomes:

1.224 + 542 + 7 + 9 + 7 = 1.789 divided by 9 = 198 remaining 7.

Worldly and ukhrowi (afterlife) will be balanced. Based on the predetermined count, the remaining 7 means falling on the count *Mizan*, which means balanced. Based on the predictions of the knowledge, the couple will not feel troubled while living a married life.

S3 Subject describes the count pattern of *repok* using *élmu hikmat* counting by counting the number of letters of the two names of potential partners who will do the marriage then summed with *naktu* born of both. As for *naktu*, birth is as follows.

Table 7. *Naktu* Days at *Élmu Hikmat*

Days Name	***Naktu* Days**
Sunday	1
Monday	2
Tuesday	3
Wednesday	4
Thursday	5
Friday	6
Saturday	7

Wedding days can be known after the number of values of the name count and *naktu* born by adding up *naktu* days starting from number 1. The value of the number of names and *naktu*-born pairs must be equal to or less than the amount *naktu* days. The following is an example of a count of *repok* based on *élmu hikmat*.

GANI PRESA WIBAWA = 15
Born on Wednesday = 4
WULAN SUKMAWATI = 14
Born on Saturday = 7 +
= 40

Then counting *naktu* days must be more than or equal to the number of candidates.
1 + 2 + 3 + 4 + 5 + 6 + 7 = 28

Because the number 28 is still less than 40, the calculation method is done by adding up again, starting from 1.

28 + 1 = 29 + 2 = 31 + 3 = 34 + 4 = 38 + 5 = 43.

The Value of addition *naktu* days is already more than the value of the candidate count. The contract must be made on the day that it has *naktu* in the last addition, which is 5, is Friday. Because 43 has a value of 3 more than 40, then calculating the marriage contract is done by adding up the remaining count values *naktu* days with *naktu* that day.

3 + 5 = 8. Then the marriage contract is made at 8 o'clock.

The S4 Subject describes the *repok counting* pattern by using *naktu* birthday, marriage contract day, and contract time by adding up all of them then divided by 7, and the remainder of the quotient must fall to number 2. *Naktu*, the day used is the same as expressed by the S2 subject. The example of *repok counting* is as follows:

The birthday of a prospective husband is Wednesday = 7
The birthday of a prospective wife is Thursday = 8
The marriage contract will be held on Sunday = 5
The marriage contract will be conducted at = 8 +
= 28 : 7 = 4 remaining 2

The S5 subject describes the *repok counting* pattern by using the count from *naktu* name of prospective wife and prospective husband. *Naktu* used *aksara cacarakan* exactly as in S1 Subject, but S5 Subject reveals that on *aksara cacarakan* in Sunda has no script of *DHA* and *THA*. Hence, the literal value is not 20 but 18. After adding up *the naktu* name, then divided by 7, which is called *pancaka 7*. The meaning of the results of the remaining 1 to 7 or 0 is as follows:

Table 8. The Meaning of *Jangjawokan Pancaka 7*

Remaining results	*Jangjawokan*	Meaning
1	*Pisang punggel*	Have an unhappy *watek* and won't obtain happiness
2	*Tunggak semi*	A little fortune
3	*Lungguh gumuling*	Presumably, other people have no less life, so many are asking for help
4	*Satriya lumaku*	Like to move their house
5	*Pandita mukti*	Loaded in science
6	*Pandan waringin*	Lots of sustenance but many people take part in enjoying it
7 or 0	*Padaringan kebek*	Will not lack food

Among these counts, the best is when you have the remaining results for 3. If it does not add up to 3, the other better ones are 5 or 6.

Mathematical Number Patterns on *Repok countings*

The calculation pattern revealed by five subjects from five different sub-districts in the Sukabumi Regency area obtained data that these calculations can be related to patterns of mathematical numbers or mathematical formulas. There are three main categories of high school mathematics material, including the following.

(1) *Relations and Functions*

As explained by the S1 subject, there are alternatives in calculating *repok* by using birthdays. The mathematical pattern obtained in this case is on material relations and functions. These results are in line with research by Jumri & Murdiana (2019), which states that the Andun Dance in the wedding party of the people of South Bengkulu applies the material of relations and functions.

The relations from set A to set B are based on the *repok counting*ing pattern. If set A is the birthday of the prospective husband and set B is the birthday of the prospective wife, it can be seen as follows.

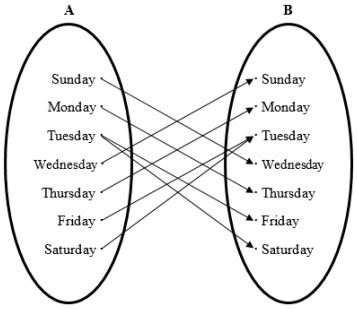

Diagram 1. A Mapping of B

It can be concluded that the alternative count *repok* using birthdays is not a function because one member of set A (domain) has more than one partner to members of set B (codomain).

(2) *Residual Theorem*

The repok counting pattern found that four research subjects gave a similar pattern. The mathematical pattern obtained in this case is in the material of the residual theorem, which can be described as follows.

- $x = \frac{a+b}{5}$, remaining 3 or 2
- $x = \frac{a+b+7}{9}$, remaining 7 or 8
- $x = \frac{a+b+m+n+7}{9}$, remaining 7 or 8
- $x = \frac{m+n+o}{7}$, remaining 2
- $x = \frac{a+b}{7}$, remaining 3 or 5 or 6

Where the x = quotient; a, b = *naktu* name; m, n, o = *naktu* days.

There are several differences in how to count *the naktu* name; some used *aksara cacarakan*, and some used *aksara pegon*. In the use of *aksara cacarakan*, there are also differences between the two versions. This can be said to be reasonable because there are differences in understanding and differences in sources. Besides, there are differences in *naktu's* name*. Naktu* days also have two versions of *naktu* days considered from books or manuscripts *paririmbon*, and *naktu* days based on the source of the book of *al-aufaq*.

Based on the explanation of each research subject, dividing numbers and the remainder of the quotient are criteria that are considered good, suitable, or can be said to get *repok*. In addition to definition differences, there are differences in dividers and the remaining results for those considered good. In addition, the differences in each remaining result provide an explanation that can predict good results for couples who will get married.

(3) *Modulo*

In *repok counting*ing, mathematical patterns exist in modulo material. These results align with Suraida et al. (2019) research, which states that the good or bad days of marriage can be determined using the modulo arithmetic formula. But the difference is, in this study, the concept used is the concept of modulo 5. The material is an advanced material from the residual theorem material studied at the high school and advanced levels. *Repok counting* pattern based on *ilmu himat* is as follows.

$$x \bmod 8\backslash\{0\}, \quad \forall \quad x = \sum a + \sum b + a_1 + b_1$$

Where the x = quotient; a = the name of the prospective husband; b = the name of the prospective wife; a_1 = *naktu* born of the prospective husband; b_1 = *naktu* born of the prospective wife.

The modulo results are used to determine a good day to carry out the marriage contract, and the remaining sum results are added to the day to determine the marriage contract time. The mathematical calculation pattern that has been determined and recognized, and used in a scientific way worldwide, is on the *repok counting*, which is used in one area in Sukabumi Regency. The calculation model is included in modulo 8 material without 0.

CONCLUSION

Based on the explanation in the previous chapter, this study concludes that the pattern of *repok* in *élmu palak* is one of the cultural properties still used in several regions in the Sukabumi Regency. The maintained trust can prove it in traditional arithmetic. The counting pattern of *repok* used in the research location has various count patterns. The calculation elements generally consist of the name and/or day of birth. The calculation is then analyzed so that mathematical number patterns are obtained, and general formulas can be made according to the mathematical material categories used at the high school level.

Therefore, ethnomathematics rules based on this research can be seen from the pattern of mathematical numbers in the count of *repok* used by Sundanese, especially in the Sukabumi Regency. High school mathematics material is relevant, one of which is the material relations and functions, residual theorem, and modulo. Not separated from the subject matter, there are basic calculations such as addition and inverse and multiplication and inverse. Even so, the pattern of counting of *repok* only applies to those who believe it. Therefore, it does not impose and cannot generalize in its entirety.

AUTHOR CONTRIBUTIONS STATEMENT

The creators of this study are RR, NAN, and HSL. RR analyzed the preliminary data, NAN made the instrument, and HSL tested the instrument.

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