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REVUE EUROPEENNE D ETUDES EUROPEAN JOURNAL OF MILITARY STUDIES
Social Science Journal

Etnomathematics: System of Mangse and Determination of Ngandang Rowot on Rowot Sasak Calendar

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Abstract

This article aims to explore and examine the customs of the Sasak people of West Nusa Tenggara in determining the season and ngandang rowot (beginning of the year) in rowot Sasak calendar system. This is a qualitative research with an ethnographic research design. The ethnographic design adopted from Spradley. The research instrument consisted of an observation guide and an interview guide. Data were collected through participatory observation, in-depth/unstructured interviews, photographs, video recordings, document studies, and artifacts. Informants in the study were traditional elders and cultural experts who are members of Lombok Rowot Nusantara Institute who understand the determination of seasons and ngandang rowot (beginning of the year) using rowot Sasak calendar. This research suggested that Sasak people, especially those living in Batu Kuwur hamlet, Sukarara Village, Central Lombok have unconsciously used mathematical modeling to determine the season system and ngandang rowot (beginning of the year). The results of this study may be utilized as a basis for teaching mathematics in a way that is relevant to students' social and cultural lives.

Keywords: Ethnomathematics, System of Mangse, Ngandang Rowot, Rowot Calendar

Introduction

The Sasak are an indigenous group from West Nusa Tenggara with a rich cultural heritage. It is easy to locate and study many cultural practices and artifacts from this tribe, including traditional wedding rituals, songket weaving, residential structures known as bale, and handicrafts. The Sasak have undergone cultural acculturation along with the times. The majority of the Sasak live in a large area, making it difficult to perform an anthropological study of them. Studying the indigenous Sasak who have passed down their culture from generation to generation is one approach to conduct a study about them. The people of Batu Kuwur Hamlet, Sukarara Village were selected as the subject of the study because they still practice their ancestral culture and exhibit cultural traits unique to their community.

Unintentionally, the community's activities at Sukarara Village have been connected to the study of mathematics. When measuring traditional structures, planning celebrations,

planting crops, and dividing the seasons, they are accustomed to employing mathematics as a calculating tool. The mathematics used on a daily basis is a type of mathematics that is strongly tied to concepts, mental processes, and the value of mathematics itself.

Mathematics has its roots in culture and it can serve as an inspiration for students to discover new things (Risdiyanti & Prahmana, 2018; Rosa et al., n.d.; Utami et al., 2019). The art of reasoning, explaining, and displaying diverse concepts and ideas related to quantitative values in daily life as both a person and a part of society is described as procedural mathematics (Umbara et al., 2021). Numerous cultural products, such traditional house building and woven fabric designs, are examples of artistic inventiveness that include geometry (Supiyati et al., 2019; Sutarto, Ahyansyah, et al., 2021; Sutarto, Hastuti, et al., 2021)

Mathematics is influenced by historical, environmental, social, geographic, and cultural factors that occur as human beings grow and change throughout their lives (Prahmana et al., 2021; Rosa et al., n.d.; Utami et al., 2019). Ethnomathematics is a field of study that examines how mathematics and culture interact (Muhtadi et al., 2017; Risdiyanti & Indra Prahmana, 2020; Rosa & Orey, 2011; Supiyati et al., 2019). By relating mathematical content to students' sociocultural experiences, teachers can contextualize the teaching and learning of mathematics through ethnomathematics (Umbara et al., 2021). Due to the diversity of its cultures, Indonesia has the chance to reform its educational system for mathematics through culturally-based initiatives (Abdullah, 2017).

Many cultures in Indonesia can be explored to obtain the context of learning mathematics, including the culture in the Lombok area. An initial study revealed that there are several ideas, processes, symbols, and forms that involve mathematical activities in the daily life of the Sasak. Therefore, the researcher intends to explore the forms of mathematical concepts used based on an ethnomathematical perspective. The results of ethnomathematical studies on the Sasak indigenous people can enrich ethnomathematical studies such as research on the season system on the Sasak rowot calendar. In addition, exploration of cultural elements using an ethnomathematical point of view, especially in Sasak architecture such as residential houses (Bale), religious buildings (mosques), barns (Supiyati et al., 2019). Exploration of the geometric transformation of the Sasak Sukarara tribe weaving in an ethnomathematical perspective (Sutarto, Hastuti, et al., 2021). Exploration of Sasak culture can be used as a source of elementary school mathematics learning (Fauzi & Setiawan, 2020).

This study focuses on how the Sasak indigenous people employ mathematics in their daily lives, particularly in the mangse (season) system and predicting the emergence of rowot stars in rowot calendar. It is possible to investigate in depth the study of mathematical practice that is still upheld and practiced as a tradition, both in terms of identifying the fundamental principles of mathematics employed and in terms of identifying mathematical concepts and methods.

The Sasak tribe's practices for defining the mangse (season) system, predicting the emergence of rowot stars, and selecting auspicious days for holding gawe (celebrations), beteletan (cultivating crops) are the main topics of this study. Previous studies (Awaludin, 2019; Kohar, 2020; Wathoni, 2021) have not looked at the Sasak rowot calendar's season system from an ethnomathematical perspective and instead have focused on it from an astronomical standpoint. As a result, this study uses ethnomathematical studies to investigate the practice of calculating the seasons and establishing the start of the year (nganndang rowot). This study also shows how the Sasak Tribe's practices count as a singular and exclusive habit. A calculating activity is used to create predictions regarding an object's uniqueness and

exclusivity. The uniqueness and exclusivity is a calculation activity used to make predictions about an event. Based on this, this research will be guided by the following questions: (1) What is the procedure used by the Sasak tribe in determining the season and determining the beginning of the year (ngandang rowot)? (2) What mathematical concepts do the Sasak tribe use in determining the season and determining ngandang rowot that can be adopted into mathematics learning at school? The success of researchers in implementing ethnomathematics learning can strengthen the development of school mathematics learning curriculum. The application of ethnomathematical practices can recontextualize an approach that focuses on culture-based learning.

Methods

This qualitative study refers to the Spradley stages and uses an ethnographic design (1980). The culture of a community is described by ethnography (Milgate, 2006; Rosa et al., n.d.). This method seeks to identify and define the thought organization as a social action that can enrich education. The aim of ethnomathematics, which examines concepts, procedures, and techniques in a specific culture based on the original viewpoints of people of that culture, is aligned with ethnography. The goal of ethnographic research is to understand cultures that think, hear, talk, and act in unique and self-discoverable ways. The study's use of the term "ethnographic design" alludes to Spradley's (Lange, 1988). The ethnographic design flow is: 1) assigning informants, 2) interviewing informants, 3) making ethnographic notes, 4) confirming data, 5) analyzing ethnographic interviews, 6) classifying cultural themes, and 7) writing ethnography.

The study subject must satisfy a number of requirements in order to provide data relevant to the research problem: 1) Proficient in or understand the subject matter being studied, 2) Posses firsthand knowledge of the issue being researched and are currently or have previously been involved in it, 3) Posses good knowledge of a wide range of related topics, 4) Posses enough free time to provide answers, and 5) Communicate fully in both Sasak and Indonesian.

Based on these criteria, the researchers selected four informants: two traditional heads of Batu Kuwur Hamlet, Sukarara Village and two cultural experts who are members of the Rowot Nusantara Lombok Institute. In practice, researchers collect information from these informants. Interviews were conducted systematically based on the type of informants selected and could guarantee the validity of the research data because the clarification process could be carried out quickly to informants (Umbara et al., 2021).

An observation guide and an interview guide were used as the research tool. The purpose of the observation guide is guiding the participatory observations of different activities and other cultural elements as the subject of the research, particularly related to activities done during specific seasons and what natural events take place during that season. Unstructured questions were used in the interview guide to delve deeper into the necessary facts linked to the research objective, and the interview was videotaped. From April through June 2022, all of the researchers independently collected data using a handycam.

Participatory observation, in-depth/unstructured interviews, photos, videos, document studies, and artifact collection were all used to gather field data. Researchers can enter the community being researched through participatory observation and attempt to participate in suitable cultural activities as a member of the community. In this instance, the researcher engages with the local population while taking field notes and images while in the setting of

the research subject. Participatory observation involves the researcher watching what is being done, listening to what is being said, and creating an observation technique in order to collect the necessary data.

In-depth or unstructured interviews consist of questions that do not have a predetermined response alternative. This is done so that research subjects are more flexible and naturally provide the information needed and researchers can explore more detailed data. Interviews were conducted in conjunction with participatory observation in an intimate and informal setting.

The data analysis procedure in this study refers to Creswell (2013) which included 1) organizing the data, 2) reading the entire data, 3) describing and coding, 4) presenting and visualizing the data, and 5) making reports. At the time of organizing the data, the researcher organized a file of observation notes and interview transcripts. When reading the entire data, the researcher did a reflection. In the description and coding stages, the researcher makes a detailed description of the coding, creates a theme, and makes a broader meaning. Presentation and visualization of data includes making text descriptions, charts, and tables. The last stage of data analysis is to make a research report.

Results And Discussion

Mathematical Modeling of Mangse System in Lombok

The Sasak people pay close attention to a variety of natural occurrences in their environment while deciding the season. The findings demonstrate that they have developed a mathematical model of the seasonal system. Farmers can choose what kinds of crops to grow and when to harvest using this mathematical modeling. The implementation of the fragrance of nyale and the determination of ngandang rowot (the start of the year) on the rowot Sasak calendar are also timed using mathematical modeling. The Sasak Rowot Calendar divides a mangse year into two seasons: kebalit or summer, and ketaun or rainy season. The names of 12 mangse that redefine the kebalit and ketaun seasons are as follows:

Mangse Saq (The First Month)

It is around 40–41 days, falls in May, and usually marks the start of the Sasak Rowot calendar year, often referred to as Ngandang Rowot. Some trees' leaves begin to fall this month, signaling the beginning of their balding season. Farmers typically grow palawija (secondary crops) during this month. Additionally, chili plants thrive in this month.

Mangse Due (The Second Month)

It lasts about 23-24 days. Usually this mangse occurs in June, usually coincides with the appearance of the komaq flower. In this month, the air is hot during the day and cold at night. In this month, palawija plants usually start flowering and some have even begun to bear fruit.

Mangse Telu (The Third Month)

It lasts about 24 days. Usually this occurs in July, along with the emergence of disease dew for plants or known by the community as Adal Minyaq. In this month, the springs begin to decrease and farmers' secondary crops usually bear fruit.

Mangse Empat (The Forth Month)

It is about 25 days old and falls in August, usually coincides with the dryness of the spring or the receding of the well's water. In this month farmers usually plant tubers.

Mangse Lime (The Fifth Month)

It lasts about 35 days, falls in September along with the dryness of the springs or the receding of the wells which are thought to be due to being absorbed by tree roots or known as Taeq Aik Kayuk. In this month, usually the tubers planted have started to have young leaves.

Mangse Enem (The Sixth Month)

This mangse, which is in October, lasts around 33 days. The peak of summer officially begins this month. Unexpected rains usually occur, but they do not last all day. Small amounts of summertime drizzle are referred to as Rau Rampak, whereas summertime thunderstorms are referred to as Omber balit. Farmers typically begin setting up nursery for upland rice in this month.

Mangse Pituq (The Seventh Month)

It lasts around 41 days and falls in November. Intense heat or summer climax usually hit this month. This is marked by "Ngempok Waras" or the breaking of bamboo, especially those used as a rib on the roof of the house.

Mangse Baluq (The Eighth Month)

It lasts around 26 days and falls in December, marked by rainfall that falls quite abundantly that the community call it "the busy month". This means that in Mangse Baluq, farmers are very busy planting, fertilizing, regulating rice field water and other activities related to growing rice plants.

Mangse Siwaq (The Ninth Month)

It lasts around 24 days and falls in January. The intensity of the rain this month is still quite high and there is still a lot of lightning and wind, the air feels wet. Because insect development coincides with the growth of the rice plant, rice bugs start attacking in this month. As a result, farmers are encouraged to fumigate their fields to stave off pests.

Mangse Sepulu (The Tenth Month)

This mangse, which is in February, lasts around 24 days. The community of South Lombok marks it with the appearance of Nyale, which they refer to as the Bau Nyale tradition (catching sea worms). Because it is the first catch, Nyale on this prey is known as Nyale Tunggak. This month is used by farmers to sow secondary crops like corn, soybeans, or green beans.

Mangse Solas (The Eleventh Month)

This mangse is around 23 days and falls in March. This is typically characterized by a strong south wind that feels a little dry and blows unharvested rice plants to the ground. Planting heat-tolerant crops like sweet potatoes and cassava is what farmers prefer this month.

Mangse Due Olas (The Twelfth Month)

This is about 40 days and falls in April, marked by the disappearance of the Rowot constellation in the sky. There is no agricultural activity this month except for the harvest of the previously planted secondary crops. Farmers usually rest completely and don't go to the fields much, so this month is also known as the "month of suwung".

Table 1. Calculations in Determining Mangse on Pranatamangsa

No	Month	Calculation			Mangse
		Month	Number	Calculation	
1	January-April	January	1	$1 + 2(4) = 9$	Mangse Siwaq
		February	2	$2 + 2(4) = 10$	Mangse Sepulu
		March	3	$3 + 2(4) = 11$	Mangse Solas
		April	4	$4 + 2(4) = 12$	Mangse Dua Olas
2	May-December	May	5	$5 - 4 = 1$	Mangse Saq/sekeq
		June	6	$6 - 4 = 2$	Mangse Due
		July	7	$7 - 4 = 3$	Mangse Telu
		August	8	$8 - 4 = 4$	Mangse Empat
		September	9	$9 - 4 = 5$	Mangse Lime
		October	10	$10 - 4 = 6$	Mangse Enem
		November	11	$11 - 4 = 7$	Mangse Pituq
		December	12	$12 - 4 = 8$	Mangse Baluq

Based on Table 1, the determination of the mathematical model in calculating mangse is as follows:

For January to June season, the formula used is as follows:

$$\text{Mangse} = \text{The number of month (January} - \text{April)} + 2\,(4) \quad (1)$$

For July to December season, the formula used is as follows:

$$\text{Mangsa} = \text{The number of month (May} - \text{December)} - 4 \quad (2)$$

A detailed description of prey is described in Table 2. This table 2 describes prey as a guide for farmers. It can also be a reference and learning resource for students and teachers in Lombok, West Nusa Tenggara.

Table 2. Mangse System

No	Month	Mangse	Natural Sign
1	January	Mangse Siwaq	Tiwoq tengkong/ The appearance of mushrooms which are the local people's seasonal food
2	February	Mangse Sepulu	Nyale tunggak/ The appearance of Nyale (sea worms) along the south coast.
3	March	Mangse Solas	Nyale poto (poto last means) appears on the 20th of the solas month.
4	April	Mangse Dua Olas	Tenggale/ The end of mangse marked by the appearance of the Tenggale (Orion) constellation without Rowot (Pleiades)
5	May	Mangse Saq/sekeq	The appearance of a constellation/rowot
6	June	Mangse Due	The appearance of the Komaq flower
7	July	Mangse Telu	Adal minyak/dew considered harmful to plants
8	Augustus	Mangse Empat	Randu flower/the bloom of the randu tree (cotton) and a local plant called Boroq
9	September	Mangse Lime	Taeq aik kayuk/ Trees begin to absorb groundwater for sustainability needs his life until the spring dries up
10	October	Mangse Enem	Romot Bageq and Tumbuq/ The appearance of the young leaves of the tamarind tree along with the shift of the sun to the equator.
11	November	Mangse Pituq	Ngempog waras/ Due to the high heat, the bamboo split naturally, accompanied by the appearance of the Tembeoq (a local bird species) accompanied by weak winds and high tides.
12	December	Mangse Baluq	Tiwoq rembaong/ The leaves of the trees began to fall accompanied by the initial rain with sufficient rainfall.

Mathematical Modeling on Ngandang Rowot (Beginning of the Year) on Rowot Calendar

The Pleiades (Rowot) Star is a celestial body that is utilized as a reference for calculations in the Sasak calendar's own reckoning mechanism. This star's arrival is seen as marking the start of the year. The Hijri month pattern is Sha'ban-Sha'ban-Raamdhan-Ramadhan-Syawal-Syawal, and the Sasak Calendar's counting algorithm follows a 5-15-25 pattern. The idea behind this pattern is that if the Rowot constellation is predicted to appear on the fifth day of a specific Hijri month, it can be determined that the Rowot star will show 10 days later on the fifteenth day of the same month the following year. Up to the third year, which will show up on the 25th, this pattern holds. Rowot will resurface the following year after the third on the fifth of the following Hijri month.

Table 3. Determination of Ngandang Rowot (Beginning of the Year) in the Rowot Calendar

Year	Ngandang Rowot (Beginning of the Year)
2016	5 Sha'ban 1437 13 May 2016
2017	15 Sha'ban 1438 12 May 2017
2018	25 Sha'ban 1439 11 May 2018
2019	5 Ramadan 1440 10 May 2019
2020	15 Ramadan 1441 8 May 2020
2021	25 Ramadan 1442 8 May 2021
2022	5 Syawal 1443 6 May 2022

The Hijri month is modeled cyclically as shown in Figure 1 below

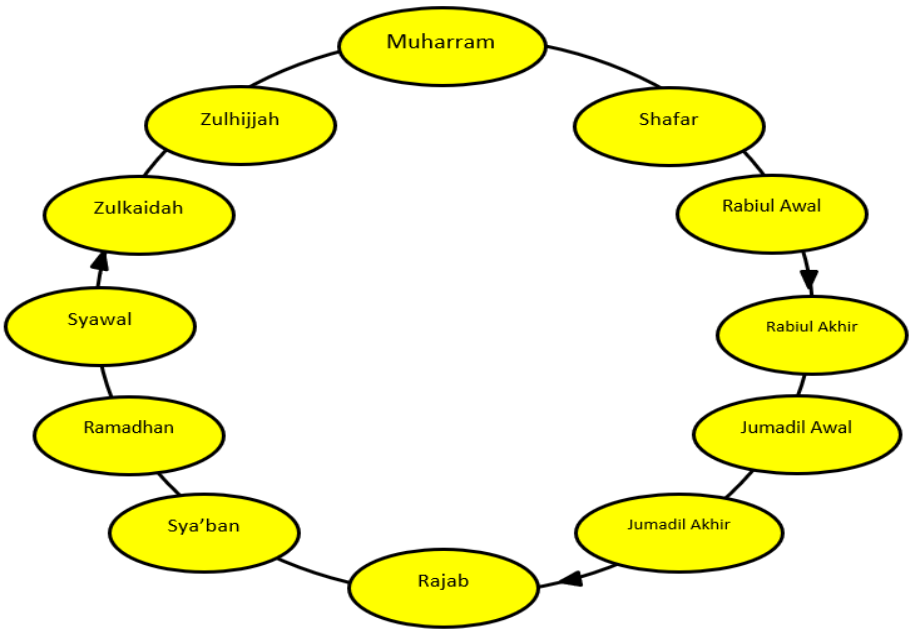

Figure 1. Cycle of the Hijri and Sasak Months

Because the calculation procedure at the start of the year employs numbers from the Hijri calendar, table 3 above shows the relationship between the Sasak Calendar (Rowot) and

the Hijri calendar. The determination of ngandang rowot (the beginning of the year) in Rowot calendar is always consistent with the month of May, which further demonstrates the link between the Gregorian calendar system and the Sasak calendar. This is supported by the author's discussion with one of the informants at the Rowot Nusantara Lombok Institute (Rontal) by the initial A. Based on Table 3, the determination of the mathematical model in determining ngandang rowot is as follows:

$$U_n = (n - 2016) + 1 \qquad ; n \geq 2018$$

Where n is a specific year

$$R = U_n(\mathrm{mod}3) + 1$$

$R = 1$ falls on the 25th
$R = 2$ falls on the 5th
$R = 3$ falls on the 15th

To determine the Hijri month of Ngandang Rowot, the formula used is as follow

$$y = (\text{particular year} - 2016) + 1 \qquad (1)$$

For example, what month does ngandang rowot fall in 2025?
Answer:

$$y = (2025 - 2016) + 1$$
$$y = 10$$

Because the Hijri month of ngandang rowot shifts every three years, ngandang rowot in 2025 falls on the month of Zulkaidah.

The findings of this study concur with those of previous studies on pranatamangsa, which show that the pranatamangsa system and the ceremony held on the day of birth and death follow a special mathematical pattern (Prahmana et al., 2021). The outcomes of the mathematical investigation into Sasak culture to establish mangse and ngandang rowot have added references and understanding that cultural considerations can be a source for studying mathematics. Similarly, Utami's research looks at Javanese practices surrounding market days from a mathematical perspective (Utami et al., 2019). A research (Sutarto, Hastuti, et al., 2021) shows that the wayang, subhnale, keker, four-star, and alang/lumbung motifs on sasak woven fabrics can be used as a source of learning material for geometric transformations such as the concept of reflection and translation or shift. The results of ethnomathematical exploration research on the mbojo culture show that: (1) On tembe (sarong) nggoli, there are mathematical concepts such as transformation geometry, an equilateral triangle, and a quadrilateral called a "rhombus"; (2) in the composition of the uma jompa, there is a mathematical concept such as the combination of a cube and a rectangular prism; (3) in commerce activity of mbojo tribal community, there is a mathematical concept such as the concept of measurement (Sutarto, Ahyansyah, et al., 2021). The exploration of barapan kebo and chicken shampoo in the people of West Sumbawa has become an innovation in mathematics learning, especially in geometry and measurement materials (Diena Frentika & Heru Tri Novi Rizki, 2020; Rizki & Diena Frentika, 2021).

The concept of local culture in learning mathematics can improve students' knowledge and reasoning (Widada et al., 2018). Ethnomathematics-based understanding affects problem-solving abilities by connecting real-world situations and cultural values that grow in society (Nur et al., 2020). To facilitate a meaningful understanding of mathematics, it is necessary to integrate culture in learning mathematics. The integration of mathematics and local culture is

an effective means to foster character and noble values in society. Cultural elements, especially Sasak culture, can be combined with elementary school mathematics materials such as the concepts of geometry, transformations, numbers, and measurements. Through ethnomathematics, teachers can contextualize the teaching and learning of mathematics by connecting mathematical content with students' sociocultural experiences. Through the study of ethnomathematics, mathematics can be rediscovered from different cultural roots of society, so that it can connect and revive students' critical reasoning and dialogue, and can foster democratic and tolerant character of students by embracing cultural differences and seeing it as an opportunity for mathematics education (Mauluah & Marsigit, 2019). Cultural values can impact both general education and mathematics education specifically (Fouze & Amit, 2018). The goal of this research is to help students comprehend mathematical concepts and how they relate as one of the goals of mathematics education in Indonesia. Mathematics education in Indonesia needs to place the subject in its social and cultural context.

Conclusion

A mathematical formula can be used to determine the seasons and ngandang rowot based on Sasak rowot calendar. According to Sasak culture, there are twelve seasons, and it is crucial for the Sasak people, especially for farmers to pay attention to them. This mangse system is used by farmers to decide what plants to plant, when to seed them, and when to harvest them. The computation of days based on rowot Sasak calendar must also be studied and paid attention to in order to calculate ngandang rowot (the start of the year). This study has revealed a rich modeling culture that could serve as a resource for learning pattern, modulo, and other mathematical concepts.

Acknowledgments

The researcher would like to express their gratitude to the informants who helped with this research, including the traditional elders of Batukuwur Hamlet, Sukarara Village, and cultural practitioners of Rowot Nusantara Lombok Institute. We also appreciate the monetary assistance provided by the National Competitive Basic Research grant from the Ministry of Education, Culture, Research, and Technology. Finally, we appreciate the help we received from Mandalika Education University, Hamzanwadi University, and Muhammadiyah University of Mataram to complete this research and publication.

Declarations

Author Contribution	Author 1: Making research tools, carrying out interviews and field observations, taking notes during observations, transcribing interview results, assessing interview results, and categorizing cultural themes in Lombok are all steps in the research process. Author 2: transcribing the results of the interview; analyzing interview results, Author 3: Visualization and Editing Together with Language, Proofreading
Funding Statement	This research was funded by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia through a National Competitive Basic Research grant.
Conflict of Interest	The authors declare no conflict of interest.
Additional Information	Additional information is available for this paper.

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