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Ethnomathematics of Pananrang in learning mathematics: Determining auspicious days in the Buginese traditional farming system

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Abstract

Background: Mathematics is closely related to daily human activities due to its evolution alongside cultural advancements. However, the subject is considered complex and distant from students' daily experiences. This results in a disconnect between mathematics education and real-life applications. Culture-based learning through ethnomathematics could bridge this gap and make mathematics learning more enjoyable.
Aim: This study aimed to explore the use of mathematical concepts in determining auspicious days for farming activities in the Buginese community.
Method: This study used a qualitative ethnographic approach.Data were collected through interviews with Pananrang experts to understand the process. Data analysis techniques are carried out through reduction, display, and conclusion. Data validity was ensured through time triangulation by verifying the information obtained from informants over multiple interviews.
Results: The results showed that the Buginese people utilized mathematical concepts such as addition, division, and modulo arithmetic in determining favorable days for agriculture.
Conclusion: This study found that Pananrang is the Buginese community's local wisdom used as a reference in the traditional agricultural system. Additionally, the results served as a valuable reference for contextual mathematics learning.

INTRODUCTION

Mathematics has been a part of human culture for centuries, and its development is closely related to cultural and social values (Wulandari & Puspadewi, 2016). However, it is often viewed as an abstract science disconnected from everyday life (d'Entremont, 2015; Supriadi et al., 2016; Wahyudin, 2018). This means the subject should be connected with real-life experiences and closely related to local culture to improve engagement and relevance (Dwidayati, 2018; Masamah, 2019).

In school, mathematics is often perceived as a complicated and abstract subject with many formulas (Acharya, 2017; Amran et al., 2021; Laurens et al., 2017). This is due to the formal nature of the subject, and it is disconnected from students' daily experiences (Supiyati & Hanum, 2019). Some students with the ability to solve math problems in real life struggle in class (d'Ambrosio, 1985). To address this, a culture-based approach to learning could help bridge the gap between mathematics in class and daily life (Brandt & Chernoff, 2015).

Ethnomathematics examines the connection between mathematics and culture, exploring how the subject is developed, shared, and specialized in different cultural systems (Zhang & Zhang, 2010). It enhances students' interest in mathematics by making the subject more

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contextual (Ogunkunle & George, 2015). Culture-based mathematics learning has been shown to improve students' understanding, critical thinking, and engagement (Herawaty et al., 2019; Kusuma & Dwipriyoko, 2021; Patri & Heswari, 2021; Widada et al., 2018; Widada, Herawaty, et al., 2019; Widada, Nugroho, et al., 2019). This suggests that ethnomathematics could inform the development of more engaging and context-rich learning designs. This could transform students' negative views of mathematics as an abstract and challenging subject into an easy and interesting one (Ramadhina et al., 2021).

Indonesia is the world's largest multicultural archipelago with a diverse array of ethnic groups (Anggraini et al., 2016; Hutagalung & Ramadan, 2022), providing great potential for the development of ethnomathematics. However, studies on ethnomathematics in Indonesia are uneven, with most are focused on Java Island. There is limited examination of ethnomathematics in other major islands such as Sumatra, Kalimantan, Sulawesi, and Papua (Muhammad et al., 2023).

Sulawesi Island in Indonesia is home to the dominant Buginese tribe (Pitoyo & Triwahyudi, 2017) whose culture is deeply ingrained in daily lives and they place high value on preserving their heritage. Despite this, exploration of the relationship between the Buginese culture and mathematics, known as ethnomathematics, is limited. Previous studies found that traditional Buginese cuisine could provide mathematical concepts for contextual learning, such as 2D, 3D, division, comparison, similarity, and congruence (Asma & Kadir, 2022; Busrah & Pathuddin, 2021; Pathuddin et al., 2021; Pathuddin & Raehana, 2019). Further studies on ethnomathematics explored the use of traditional Buginese games and farming tools, revealing geometric concepts that enhance students' learning (Akbar, 2021; Muslimin & Rahim, 2021). Subsequently, efforts have been made to incorporate Buginese culture in developing teaching materials based on ethnomathematics. These developments focus on geometry, which has been implemented to some extent in some schools (Fahira, 2021; Khatimah et al., 2022; Mania & Alam, 2021; Tando et al., 2022). Furthermore, studies on incorporating cultural context in geometry learning suggested that ethnomathematics could increase students' interest and critical thinking skills (Aras et al., 2022; Aras & Zahrawati, 2021).

Most ethnomathematics studies in Buginese culture have been confined to geometry. In contrast, this study aimed to examine other mathematical concepts as sources for students' learning. This study investigated the indigenous knowledge of the Buginese community's traditional agricultural system and its use in determining the ideal time for farming. Findings regarding the charateristics of the year and month for commencing agricultural activities among the Buginese Sidenreng Rappang community based on harvest results have been discovered (Pathuddin et al., 2023). This study continues the findings and offer some recommendations to the research. The objective is to contribute to preserving a rapidly changing and endangered culture through its integration into mathematics education.

METHODS

This study employed a qualitative approach with ethnography, which explores behavior, beliefs, values, practices, and attitudes within a social group to gain a deeper understanding of cultural relationships (Nur et al., 2021). It was conducted in Sidenreng Rappang Regency, a major agricultural center in South Sulawesi. Informant were selected based on their ability to provide relevant information and deemed experts in the traditional process of determining the best time for farming activities using *Pananrang*. In-depth interviews were conducted to gather further information and the results were recorded for analysis. Furthermoe, this study followed Miles and Huberman's data analysis method, namely reduction, display, and conclusion (Miles & Huberman, 1984). The reduction stage involved identifying relevant information, while unimportant data were discarded. The display stage involved presenting the reduced data and constructing a mathematical model based on the existing knowledge. Finally, conclusions were drawn from the data and models developed. Figure 1 summarizes the data collection and analysis process.

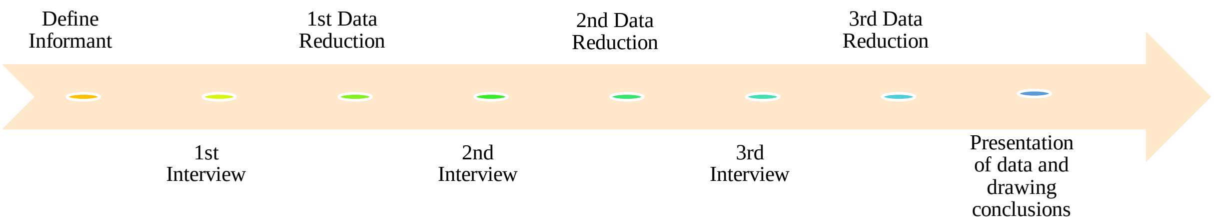

Figure 1. Stages of Data Collection and Analysis

Data validity was ensured through time triangulation by verifying the information obtained from informants over multiple interviews. The data collection from informants occurred over a span of five months, starting from the first to the second interview, followed by a four-month period from the second to the third interview. Time triangulation was chosen because the researchers left the urge to confirm with informant regarding the researcher's interpretation of previously obtained data. This is due to the data on recurring days with different characteristics in the seven Pananrang cycles, which highly increases the possibility of misinterpretation by the research team.

RESULTS AND DISCUSSION

The results were validated through the repeated confirmation of the same informant (*Pananrang*) across multiple interviews. *Pappananrang* is a term for individuals who are skilled in determining the optimal timing for agricultural activities in the Sidenreng Rappang Regency. Figure 2 depicts the documentation of conducting interviews with *Pappananrang* at different intervals.

(a) The first interview (b) The second interview

Figure 2. Documentation of interview

Determining Auspicious Day in Farming

The interview findings revealed the existence of seven different *Pananrang* cycles, each with a different number of days. The seven *Pananrang* cycles are: *Orong Porong, Wara-Wara, Tanrae, Manue, Watang Patae, Walue,* and *Tekkoe. Orong Porong, Wara-Wara, Tanrae, Manue, Watang Patae, Walue,* and *Tekkoe* are the seventh of these terms specifically used by *Pappananrang*. Every cycle consist of several day with different kinds of characteristics, which known with the terms namely *Galippusu, Puru, Kerre, Lesang Esso, Siesso, Siele, Congkilang,* and *Pallawangeng*. Table 1 presents the days and their specific characteristics for each *Pananrang* cycle.

Table 1. *Orong Porong*

Days	Characteristics of the Day	Farming Advice	Days	Characteristics of the Day	Farming Advice
1	*Galippusu*	Better not to plant rice	12	*Lessang Esso*	It is permissible to plant rice only in the afternoon
2	*Puru*	Better not to plant rice	13	*Siesso*	Allowed to plant rice all day
3	*Puru*	Better not to plant rice	14	*Siele*	Allowed to plant rice only in the morning
4	*Kerre I*	It is not recommended to plant rice	15	*Galippusu*	Better not to plant rice
5	*Lessang Esso*	It is permissible to plant rice only in the afternoon	16	*Puru*	Better not to plant rice
6	*Siesso*	Allowed to plant rice all day	17	*Puru*	Better not to plant rice
7	*Siele*	Allowed to plant rice only in the morning	18	*Kerre III*	It is not recommended to plant rice
8	*Galippusu*	Better not to plant rice	19	*Lessang Esso*	It is permissible to plant rice only in the afternoon
9	*Puru*	Better not to plant rice	20	*Siele*	Allowed to plant rice
10	*Puru*	Better not to plant rice	21	*Congkilang*	It is not recommended to plant rice except in the morning, but it should be avoided
11	*Kerre II*	It is not recommended to plant rice	22	*Pallawangeng*	It is not recommended to plant rice

The next *Pananrang* is *Wara-Wara* with 22 days, the same as *Orong Porong*.

Table 2. *Wara-Wara*

Days	Characteristics of the Day	Farming Advice	Days	Characteristics of the Day	Farming Advice
1	*Galippusu*	Better not to plant rice	12	*Lessang Esso*	It is permissible to plant rice only in the afternoon
2	*Puru*	Better not to plant rice	13	*Siesso*	Allowed to plant rice all day
3	*Puru*	Better not to plant rice	14	*Siele*	Allowed to plant rice only in the morning
4	*Kerre I*	It is not recommended to plant rice	15	*Galippusu*	Better not to plant rice

5	*Lessang Esso*	It is permissible to plant rice only in the afternoon	16	*Puru*	Better not to plant rice
6	*Siesso*	Allowed to plant rice all day	17	*Puru*	Better not to plant rice
7	*Siele*	Allowed to plant rice only in the morning	18	*Kerre III*	It is not recommended to plant rice
8	*Galippusu*	Better not to plant rice	19	*Lessang Esso*	It is permissible to plant rice only in the afternoon
9	*Puru*	Better not to plant rice	20	*Siele*	Allowed to plant rice
10	*Puru*	Better not to plant rice	21	*Congkilang*	It is not recommended to plant rice except in the morning, but it should be avoided
11	*Kerre II*	It is not recommended to plant rice	22	*Pallawangeng*	It is not recommended to plant rice

Table 3 illustrates the characteristics of the days within the *Tanrae* cycle. Of the seven *Pananrang* cycles, *Tanrae* has the largest number of days.

Table 3. *Tanrae*

Days	Characteristics of the Day	Farming Advice	Days	Characteristics of the Day	Farming Advice
1	*Galippusu*	Better not to plant rice	19	*Lessang Esso*	It is permissible to plant rice only in the afternoon
2	*Puru*	Better not to plant rice	20	*Siesso*	Allowed to plant rice all day
3	*Puru*	Better not to plant rice	21	*Siele*	Allowed to plant rice only in the morning
4	*Kerre I*	It is not recommended to plant rice	22	*Galippusu*	Better not to plant rice
5	*Lessang Esso*	It is permissible to plant rice only in the afternoon	23	*Puru*	Better not to plant rice
6	*Siesso*	Allowed to plant rice all day	24	*Puru*	Better not to plant rice
7	*Siele*	Allowed to plant rice only in the morning	25	*Kerre IV*	It is not recommended to plant rice
8	*Galippusu*	Better not to plant rice	26	*Lessang Esso*	It is permissible to plant rice only in the afternoon
9	*Puru*	Better not to plant rice	27	*Siesso*	Allowed to plant rice all day
10	*Puru*	Better not to plant rice	28	*Siele*	Allowed to plant rice only in the morning
11	*Kerre II*	It is not recommended to plant rice	29	*Galippusu*	Better not to plant rice
12	*Lessang Esso*	It is permissible to plant rice only in the afternoon	30	*Puru*	Better not to plant rice

13	*Siesso*	Allowed to plant rice all day	31	*Puru*	Better not to plant rice
14	*Siele*	Allowed to plant rice only in the morning	32	*Kerre V*	It is not recommended to plant rice
15	*Galippusu*	Better not to plant rice	33	*Lessang Esso*	It is permissible to plant rice only in the afternoon
16	*Puru*	Better not to plant rice	34	*Siele*	Allowed to plant rice
17	*Puru*	Better not to plant rice	35	*Congkilang*	It is not recommended to plant rice except in the morning, but it should be avoided
18	*Kerre III*	It is not recommended to plant rice	36	*Pallawangeng*	It is not recommended to plant rice

The fourth *Pananrang* in one cycle is *Manue* with 29 days.

Table 4. *Manue*

Days	Characteristics of the Day	Farming Advice	Days	Characteristics of the Day	Farming Advice
1	*Galippusu*	Better not to plant rice	16	*Puru*	Better not to plant rice
2	*Puru*	Better not to plant rice	17	*Puru*	Better not to plant rice
3	*Puru*	Better not to plant rice	18	*Kerre III*	It is not recommended to plant rice
4	*Kerre I*	It is not recommended to plant rice	19	*Lessang Esso*	It is permissible to plant rice only in the afternoon
5	*Lessang Esso*	It is permissible to plant rice only in the afternoon	20	*Siesso*	Allowed to plant rice all day
6	*Siesso*	Allowed to plant rice all day	21	*Siele*	Allowed to plant rice only in the morning
7	*Siele*	Allowed to plant rice only in the morning	22	*Galippusu*	Better not to plant rice
8	*Galippusu*	Better not to plant rice	23	*Puru*	Better not to plant rice
9	*Puru*	Better not to plant rice	24	*Puru*	Better not to plant rice
10	*Puru*	Better not to plant rice	25	*Kerre IV*	It is not recommended to plant rice
11	*Kerre II*	It is not recommended to plant rice	26	*Lessang Esso*	It is permissible to plant rice only in the afternoon
12	*Lessang Esso*	It is permissible to plant rice only in the afternoon	27	*Siele*	Allowed to plant rice
13	*Siesso*	Allowed to plant rice all day	28	*Congkilng*	It is not recommended to plant rice except in the morning, but it should be avoided

14	*Siele*	Allowed to plant rice only in the morning	29	*Pallawangeng*	It is not recommended to plant rice
15	*Galippusu*	Better not to plant rice			

In one cycle, the three *Pananrang* with 8 days are *Watang Patae*, *Walue*, and *Tekkoe*. The three *Pananrang* are also called *Pananrang Lautang*.

Table 5. *Pananrang Lautang* (*Watang Patae*, *Walue*, and *Tekkoe*)

Days	Characteristics of the Day	Farming Advice	Days	Characteristics of the Day	Farming Advice
1	*Galippusu*	Better not to plant rice	5	*Lessang Esso*	It is permissible to plant rice only in the afternoon
2	*Puru*	Better not to plant rice	6	*Siele*	Allowed to plant rice
3	*Puru*	Better not to plant rice	7	*Congkilang*	It is not recommended to plant rice except in the morning, but it should be avoided
4	*Kerre I*	It is not recommended to plant rice	8	*Pallawangeng*	It is not recommended to plant rice

Table 5 shows that the effective periods to start planting rice in *Pananrang Orong Porong*, *Wara-Wara*, *Tanrae*, and *Manue*are half a day on the fifth day (afternoon), one day on the sixth day (morning to evening), and half a day on the seventh day (morning). In *Pananrang Lautang*, rice is planted on half a day on the fifth day (afternoon) and half a day on the sixth day (morning). Days not recommended for planting are *Kerre*, *Congkilang*, and *Pallawangeng*. The number of *Kerre* depends on the number of days in one *Pananrang*, there is only one *Congkilang*(the day before the end of *Pananrang*), and one *Pallawangeng*(the day *Pananrang* ends).

Mathematical Concepts in Pananrang

Addition and Multiplication Concepts

The analysis showed a mathematical model that uses addition and multiplication concepts to determine the repeat of *Kerre* day, a day forbidden for starting farming activities. The model obtained is:

$$H_2 = H_1 + 7n \;\; \ldots\ldots \; (1)$$

H_2 : repeated day
H_1 : present-day
n : *Kerre-n* $(i - 1)$

Example:
When *Kerre* I falls on the fourth day of *Wara-Wara*, determine when the starting day of *Kerre* II and *Kerre* III.

Solution:
First, calculate the day of the entry of *Kerre* II. Suppose *Kerre* I fall on the fourth day, using Equation (1) obtains:

$H_2 = H_1 + 7n$
$= 4 + 7.1$
$= 11$

This means that *Kerre* II would fall on the 11th day.

Second, calculate the entry day of *Kerre* III.

$H_2 = H_1 + 7n$
$= 4 + 7.2$
$= 4 + 14$
$= 18$

The result indicates that *Kerre* III falls on the 18th day.

The Concept of Division

The analysis showed that determining the day's characteristics involves the division concept. The mathematical model obtained for determining the number of *Kerre* days in one *Pananrang* is:

$$K = \frac{d_n - 1}{7} \quad \ldots\ldots (2)$$

K : the number of *Kerre* days
d_n: the number of days on n^{th}*Pananrang*

Example:

1. The number of *Kerre* on *Orong-Porong*:
   $$K = \frac{d_1 - 1}{7} = \frac{22 - 1}{7} = \frac{21}{7} = 3$$
2. The finding shows that *Orong Porong*has 3 days, including *Kerre* I, II, and III. The same applies to *Wara-Wara*, which has the same number of days as *Orong Porong*.
3. The number of *Kerre* on *Tanrae*:
   $$K = \frac{d_3 - 1}{7} = \frac{36 - 1}{7} = \frac{35}{7} = 5$$

The result means that *Tanrae* has 5 days, including *Kerre* I, II, III, IV, and V.

4. The number of *Kerre* on *Manue*:
   $$K = \frac{d_4 - 1}{7} = \frac{29 - 1}{7} = \frac{28}{7} = 4$$

The finding implies that *Manue* has 4 days, including *Kerre* I, II, III, and IV.

5. The number of *Kerre* on *Watang Patae*:
   $$K = \frac{d_5 - 1}{7} = \frac{8 - 1}{7} = \frac{7}{7} = 1$$

The result means that *Watang Patae* has only *Kerre* I. This could also be applied to *Walue* and *Tekkoe* because they have the same number of days as *Watang Patae*.

The Concept of Modulo Arithmetic

Modulo arithmetic also determines the next day in one *Pananrang* as follows.

$$r = t \bmod 7 \quad \ldots\ldots (3)$$

r : remainder
t : the number of the next days

Example:
When today is *Kerre* in *Orong Porong*, which restricts farmers from planting rice, what about the next ten days?

Solution:
Using Equation (3) obtains:
$r\ = 10\ mod\ 7 = 3$
The remainder of the calculation results is 3, implying the next 10 days after *Kerre* are *Siele*. Therefore, the next 10 days are an excellent time to plant rice, provided these activities are performed in the morning. Based on the13 previous description, the application of mathematical concepts in farming activities can be summarised as shown in Figure 3.

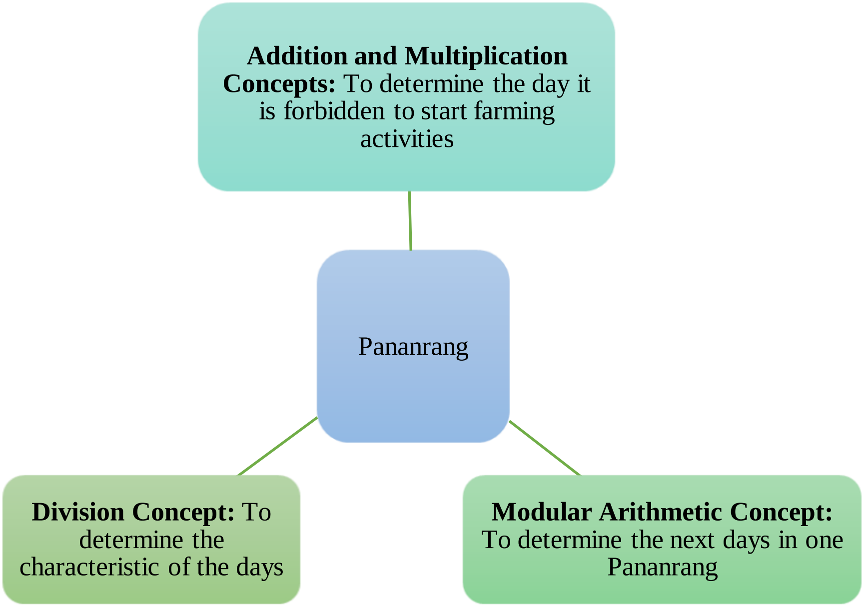

Figure 3. Mathematical Concepts on Determining Auspicious Days for Farming Based on *Pananrang*

Sidenreng Rappang Regency, where most of the Buginese people live, is one of South Sulawesi Province's agricultural areas. For Buginese farmers, the first thing to know before starting farming activities is the time. It is important because maximum results will not be obtained if the planting process is done at an inopportune time, no matter how well the plant seeds are planted or how good the maintenance of the plants. Therefore, *Pananrang* plays an essential role in their farming activities.

The findings in this research highlighted the use of mathematical concepts in *Pananrang*as a traditional farming system reference in the Buginese community to determine the best time for starting farming activities. The mathematical concepts used include addition and multiplication to determine the repeat of *Kerre* day. The division concept is used to determine the day's characteristics, and modulo arithmetic are used to determine the next day in one *Pananrang*. Furthermore, these findings suggested that *Pananrang* could be a contextual mathematics learning resource. The integration of cultural elements in teaching mathematical concepts could make learning easier for students as it is related to their surroundings. This makes ethnomathematics a potential approach to help students explore their culture and gain insights from mathematical concepts.

This study found that mathematics is a ubiquitous aspect of life regardless of cultural traditionalism. The findings facilitated transforming the use of mathematics from a traditional to a formal context by being incorporated into classroom learning. This supports previous studies that ethnomathematics has been effectively applied by various ethnic groups in Indonesia and should be more widely promoted. For instance, the Cigugur indigenous people in West Java have utilized sequential pairs, relations, addition, and comparison, as well as modulo and congruence in determining cardinal directions to bring good luck (Umbara et al., 2021b). Mathematical concepts such as numbers, sets, relations, congruence, modulo, and mathematical models have also been used to predict favorable farming days (Umbara et al., 2021a). Additionally, an ethnomathematics investigation of the Baduy community's calendar system found several mathematical concepts (Arisetyawan & Supriadi, 2020). These included the arithmetical concept modulo in determining the auspicious day for starting work and traveling. The analysis also identified the algebraic concept for determining the auspicious day to marry (Eliza & Pujiastuti, 2022; Sopiah, 2020).

Ethnomathematics studies showed that various indigenous communities in Indonesia, including the Javanese and Sundanese, have used mathematical modeling to determine seasons, birth dates, auspicious days for events, agriculture, and searching for lost objects. These mathematical concepts include addition, division, modulo, line segments, and arithmetic sequences (Agustina et al., 2016; Ami, 2021; Fitriani et al., 2019; Imswatama &Setiadi, 2017; Maryani et al., 2022; Nisa et al., 2019; Prahmana et al., 2021; Setiadi & Imswatama, 2017; Suraida et al., 2019; Zahira et al., 2022). The realm of Ethnomathematics unfolds in the intricate scheduling of cultural events and daily routines within Yosomulyo Village, employing the modulo arithmetic system (Agustina et al., 2016). Delving into Sundanese traditions, the theoretical frameworks of arithmetic sequences and modulo arithmetic intricately weave into the fabric of determining auspicious wedding dates and evaluating the harmony between bride and groom (Ami, 2021). In the realm of Javanese calculations, the utilisation of mathematical concepts like modulo 5 and 7 guides the prophecy of propitious wedding dates, while modulo 4 governs the selection of auspicious dates for diverse activities such as house construction, relocation, circumcision ceremonies, and maternity moments (Fitriani et al., 2019).

The sacred ritual of traditional Javanese weddings in Purworejo navigates through the realm of modular arithmetic for the calculation of propitious days (Imswatama & Setiadi, 2017). Further exploration uncovers mathematical underpinnings within the traditional wedding customs of Pulo village, where modulo arithmetic, addition, division, and line segmentations converge to delineate auspicious timings (Maryani et al., 2022). Meanwhile, in Lembur Balong Village, a tapestry of modulo arithmetic and arithmetic sequences unfolds across wedding ceremonies, agricultural endeavors, and quests for lost treasures (Nisa et al., 2019).

Yogyakarta's rich cultural tapestry unfolds mathematical modeling potentials, facilitating the comprehension of mathematical topics such as patterns, modulo operations, and numerical intuition (Prahmana et al., 2021). The intricate calculations involved in determining traditional Javanese and Sundanese "weton" find foundation in the remainder theorem (Setiadi & Imswatama, 2017). From the determination of propitious wedding days in Javanese traditions to assessing the compatibility of betrothed couples, mathematical patterns perpetually manifest through numerical systems, arithmetic operations, set theories, and remainder divisions (Suraida et al., 2019; Zahira et al., 2022). The traditional Balinese calendar system also contains mathematical concepts (Suarjana et al., 2014).

The findings complement previous studies on the use of mathematics in culture among certain ethnic groups in Indonesia. The study on the Buginese tribe adds new knowledge to ethnomathematics because it is a richly cultural group not widely explored. Therefore, these findings provide valuable insights for enriching educational resources for students in Indonesia.

CONCLUSIONS

This study found that *Pananrang* is the Buginese community's local wisdom used as a reference in the traditional agricultural system. The results showed that addition, multiplication, division, and modulo arithmetic concepts are employed to determine good and bad days for planting rice, as well as to find the next day in one *Pananrang*. These findings could inspire teachers to incorporate culture to make mathematics lessons more meaningful and engaging. This study only constructed mathematical models based on the data obtained. The models have also not been implemented in education. However, the findings could serve as a reference for future studies in developing teaching materials based on the ethnomathematics of Buginese *Pananrang* culture.

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AUTHOR CONTRIBUTIONS STATEMENT

HP has contributed in conceptualising the research, the writing of original draft, editing, templating, and visualising the research data. Meanwhile, K has contributed in editing, validating the data and reviewing the formal analysis.

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