Ethnomathematics study: Formalizing mathematical representation in the *Marosok* trading tradition in Minangkabau

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Abstract. Ethnomathematics studies mathematical ideas in various cultural activities practiced by ethnic, social or professional groups. This research was carried out as part of the exploration and inventory of ethnomathematics to reveal mathematical representations and formulate a system of calculations used in the *Marosok* trading tradition by the Minangkabau tribe in West Sumatra. The *Marosok* buying and selling tradition is the tradition of shaking hands with "*marosok*" or touching fingers covered with cloth (cover), between sellers and buyers with the aim of obtaining price agreements in buying and selling livestock using nonverbal communication. Qualitative approaches and ethnographic methods through the principles of data collection such as field notes, unstructured interviews, and documentation studies were used in this study. The findings of this study show that mathematical representations of finger symbols and gesture in the *Marosok* tradition contain basic numbers one, two, three, four, five and two and a half as well as two types of operations, namely addition and subtraction. This mathematical representation is used to obtain other numbers needed in livestock buying and selling transactions using a certain formula.

1. Introduction

Mathematics can be seen as a science that also contains humans and culture [1]. This view allows us to study mathematics through a cultural perspective, to describe and reveal the diversity of mathematical practices that differ in each ethnic community. This study of the relevance of mathematics and culture is known as ethnomathematics. Ethnomathematics are defined as mathematics practiced by certain cultured groups identified by activities and traditions that are common to each group [2]. The exploration and inventory of ethnomathematics in Indonesia is seen as a potential that must continue to be optimized given the diversity of cultures throughout the archipelago [3]. Exploration aims to explore and uncover ethnomathematics from the culture of society. Several previous studies have examined the exploration of ethnomathematics in various tribes and ethnicities in Indonesia. One tribe that has begun to be studied is the Minangkabau tribe. The Minangkabau tribe is a cultural group that occupies the central region of Sumatra Island, Indonesia which is characterized by the use of Minang language, *adat* or custom with matrilineal kinship system, and adheres to Islam.

One of the traditions with mathematical practices in Minangkabau is the *Marosok* tradition in buying and selling livestock. *Marosok* tradition is a tradition of shaking hands that are covered with a kind of cover
between sellers and buyers in buying and selling livestock by means of "marosok" or touching fingers as seen in Figure 1. Marosok or touching fingers is done with the aim of obtaining a price agreement without verbal communication. Bargaining in the Marosok tradition carried out in the livestock market (Figure 2) is not spoken out loudly but through exchanging the fingers that hold each other [4]. The use of finger symbols is done to maintain the confidentiality of the price agreement.

Some studies have been examined the Marosok tradition from different perspectives. A study has investigated how the social processes that occur specifically in the Payakumbuh City livestock market through the Marosok tradition from social science [4]. Another one, from communication science [5] has defined the meaning of the Marosok tradition as symbolic interaction patterns between sellers and buyers without words, only done with sign language (using codes and symbols). This tradition uses the exchange of finger symbols that hold each other to determine the price agreement [5].

![Figure 1. Transaction in Marosok Traditions](image1.png)  
![Figure 2. Koto Baru Livestock Market](image2.png)

However, it has not yet been explained how the exchange of symbols of fingers in Marosok activities is carried out mathematically to obtain a price agreement. Taking this into account, we carried out this research to reveal mathematical representations and formulate a system of calculations used in ethnomathematics Marosok tradition of buying and selling by the Minangkabau tribe in West Sumatra.

Marosok which means "touching" is interpreted as an activity of shaking hands covered with cloth (a kind of cover), between sellers and buyers by touching fingers as a form of bargaining special prices for buying and selling livestock such as cows, buffaloes and goats. This tradition originated from prevailing social culture in Minangkabau tribe. By adat, selling livestock as inheritance is seen as a less commendable act. For this reason, the Marosok tradition is used to keep the prices of livestock as secret. In social interaction, maintaining the confidentiality of the transaction value also aims to avoid third-party interference in the ongoing bargaining activities between the seller and the buyer. Non-verbal communication with this touching method is used specifically to communicate the prices. Buying and selling is not always done in a quiet state but still uses verbal communication for greetings or asking livestock’s specification needed.

The traditional philosophies used in this tradition are Alua jo Patuik (suitability and decency). Alua or suitability has the meaning of conformity with the custom (habit) or having consideration using a sense of appropriateness (feasibility). According to Alua’s philosophy, the Marosok tradition is specifically carried out by men. Based on the conformity with Islamic Shari'a adopted by the Minangkabau people, it is not permissible for men and women who do not have blood relations or are not bound by marriage to shake hands as in the Marosok tradition. The Patuik’s philosophy is used when sellers and buyers estimate the price and weight of livestock before buying and selling. The weight of livestock is estimated from its physical form by Patuik’s philosophy.

2. Methods
To reveal mathematical representations and formulate a system of calculations used in the Marosok trading tradition by the Minangkabau tribe in West Sumatra, we carried out qualitative study using the ethnography method. It used a natural setting to interpret the phenomena buying and selling livestock through the
Marosok tradition by Minangkabau tribe which involves the participation of researchers in the natural lives of practitioners of cultural practices [6]. The framework design of ethnomathematics research [7] showed in Table 1. This study was conducted in the livestock markets, which are located in five different places in the Luhak Nan Tigo (indigenous region as center of Minangkabau culture); Muaro Paneh, Sungai Sariak, Koto Baru, Batusangkar, and Payakumbuh. Each market operates on different day, allowing sellers and buyers to mobile from one to another market in a week. The subjects were four traditional livestock sellers and buyers in livestock markets and one traditional stakeholder known as Datuak who master the history, meaning and philosophy of the Marosok tradition. The research used human as instrument, namely the researchers themselves who were native to the Minangkabau tribe. Data collection techniques were carried out through field notes, interviews, and documentation studies. Interviews conducted are unstructured interviews that depend on social interaction between the researchers and the informants where the next question in conversation arises as a response to the previous explanation of informants [8].

| Table 1. Framework design of the ethnomathematics research. |
|---------------------------------------------------------------|
| **Generic Questions** | **Initial Answer** | **Critical Construct** | **Specific Activity** |
| Where to start looking? | Cultural practices in the Marosok trading tradition | Culture | • Conduct unstructured interviews with traditional stakeholders about the Marosok trading tradition. |
| | | | • Describe the traditional practice of the Marosok trading tradition in the livestock market. |
| How to look? | Investigating QRS (Quality, Rational and Spatial) aspects | Alternative thinking | Determining QRS ideas embedded in the Marosok trading tradition in Minangkabau (such as philosophy, language and history) |
| What it is? | Proof of alternative concepts | Anthropology and historiography methodology | Identify external criteria to justify the Marosok trading tradition in Minangkabau as a mathematics representation. |
| How to understand what it is? | It is important for culture and mathematics | Anthropology and historiography methodology | • Identifying reciprocal relationships between the two forms of knowledge |
| | | | • Describe mathematical representations found in the Marosok trading tradition |

The technique of checking the validity of the data used in this study is the triangulation technique in the form of triangulation with sources and triangulation with data collection techniques. Furthermore, the data were analyzed using data analysis techniques proposed by Miles and Huberman, namely data reduction, data display, and conclusion drawing/verification [9].

3. Results and Discussion
Figure 2 shows an illustration of a buffalo trading transaction with the Marosok tradition that occurred in Koto Baru livestock market. Buyers coming to the livestock market are welcome to sight-seeing livestock that have been lined up. Buyers start conversation with the seller in Minang language for greetings or asking livestock’s specification needed. The buyer who has decided which buffalo to buy, starts asking the price with marosok. The seller and buyer then start shaking hands covered with cloth to communicate the price of livestock. The price of livestock offered uses a rupiah currency unit. In the Marosok tradition, the numbers used are one digit numbers, two digit numbers and three digit numbers in front of the price. Then the number be converted later into rupiah by adding a nominal value of tens of thousands of rupiahs, hundreds of
thousands of rupiah and millions of rupiah. By using the traditional philosophy, *Patuik*, sellers and buyers alike have known that the price of livestock prices is seen from its size and physical characteristics. For example, the price of buffalo to be traded ranges from 15 million to 20 million.

![Figure 3. Buyer (left) holding index finger and middle finger of the seller (right) symbolizes 2 or 20 million](image)

![Figure 4. Buyer hold the thumb indicating the nominal 2.5 million rupiah](image)

![Figure 5. The thumb broken down means reducing 2.5 million Rupiah](image)

The seller holds the index finger and middle finger of the buyer representing 2 or 20 million and is released. That is, the seller offers his livestock to buyer worth 20 million rupiah. But the buyer wants to bid prices by holding the index finger and middle finger of the buyer symbolizing 2 or 20 million as Figure 3. Then the buyer holds the thumb of the seller and breaks it down, meaning less two and a half or less 2.5 million and become 17.5 million rupiah as Figure 4 and Figure 5 showed respectively. The handshake is released which is means the agreement is obtained. The buyer buys the buffalo at a price of Rp 17,500,000.00.

Livestock buying and selling transactions through The *Marosok* trading tradition use finger and gesture symbols as an expression that represents a meaning. This means they can be interpreted as mathematical representations. The symbol holding a certain finger contains a number meaning, while the gesture contains the meaning of a number operation and other signals needed in buying and selling. From the examples of livestock buying and selling transactions above, there were obtained several mathematical representations that contained their respective meanings. Table 2 shows the various finger and gesture symbols used in the *Marosok* Tradition.

| Mathematical Representation                                      | Meaning          |
|-----------------------------------------------------------------|------------------|
| The index finger                                                | One              |
| The index and middle fingers                                    | Two              |
| The index finger, middle finger and ring finger                 | Three            |
| The index finger, middle finger, ring finger and little finger  | Four             |
| The five fingers that are pursed                                 | Five             |
| The thumb                                                       | Two And A Half   |
| Grasping the fingers and turning it to the right                | Adding           |
| Grasping the fingers then bending it or break it down           | Reducing         |

This basic representation only contains one, two, three, four, five and two and a half as basic numbers and two types of operations, namely addition and subtraction. This mathematical representation is used to obtain other numbers needed in livestock buying and selling transactions. The number range used is one digit number, two digit number and three digit number. These numbers will later be converted into rupiahs by adding nominal tens of thousands of rupiahs, hundreds of thousands of rupiahs and millions of rupiahs.
in accordance with the intended rupiah value. The mathematical representation is used to obtain other numbers with the formula as follows:

1. One digit number, for example $m$.
   a. One digit number for example $m$ where $1 \leq m \leq 5$ is obtained using the basic finger symbol. Mathematically, the mathematical equations used are:

   $$m = a \quad a = \{1, 2, 3, 4, 5\}$$

   As an example:
   - Number 4 in the Marosok Tradition is obtained by "holding the index finger, middle finger, ring finger and little finger together which represents number 4".

   b. One digit number for example $m$ where $6 \leq m \leq 9$ is obtained by subtraction from the nearest tens, namely 10. Mathematically, the mathematical equation used is:

   $$m = 10 - a' \quad a' = \{1, 2, 3, 4\}$$

   As an example:
   - Number 7 = $10 - 3$ in the Marosok tradition is obtained by "holding the index finger representing 10, then holding the index finger, middle finger and ring finger together then breaking down or twisting to the left to represent minus 3 so become 7".

2. Two digit number, for example $k$.
   The first digit is $k$, the second digit is $l$.
   a. Two digit numbers, for example $k$ where $1 \leq k \leq 5$ and $1 \leq l \leq 5$ is obtained using the sum of the basic finger symbols. Mathematically, the mathematical equations used are:

   $$k = b + a \quad a = \{1, 2, 3, 4, 5\}, \quad b = \{1, 2, 3, 4, 5\}$$

   As an example:
   - Numbers 1 = $1 + 3$ in the Marosok Tradition is obtained by "holding the index finger representing 10, then holding the index finger, middle finger and ring finger together to represent plus 3 so that the number 13 is obtained".

   b. Two-digit number, for example $k$ where $1 \leq k < 5$ and $6 \leq l \leq 9$ is obtained using mathematical equations, namely:

   $$k = b - a' \quad a' = \{1, 2, 3, 4\}, \quad b = \{1, 2, 3, 4, 5\}.$$  

   As an example:
   - Numbers 1 = $2 - 2$ in the Tradition Marosok is obtained by "holding the index finger and middle finger representing 20, then holding the index finger, and the middle finger together then broken down or twisted to the left to represent minus 2 to obtain 18".

   c. Two-digit number, for example $k$ where $k = 5$ and $6 \leq l \leq 9$ is obtained using mathematical equations, namely:

   $$k = 5 + (1 - a') \quad a' = \{1, 2, 3, 4\}$$

   As an example:
   - Numbers 5 = $5 + (1 - 1)$ in the Marosok Tradition is obtained by "holding the index finger then broken down or twisted to the left to represent minus 1 so that 50 + (10 - 1) gets number 59".

   d. Two-digit number, for example $k$ where $6 \leq k \leq 9$ and $1 \leq l \leq 5$ is obtained using mathematical equations, namely:

   $$k = (1 - b') + a \quad a = \{1, 2, 3, 4, 5\}, \quad b' = \{1, 2, 3, 4\}.$$  

   As an example:
   - Numbers 7 = $(1 - 3) + 1$ in the Marosok tradition is obtained by "holding the index finger representing 100, then holding the index finger, middle finger and ring finger together
then broken down or twisted to the left to represent minus 30 so obtained number 70. Next hold the index finger that represents plus 1 so that the number 71 is obtained ".

**e. Two-digit number, for example** $k$ where $6 \leq k \leq 9$ dan $6 \leq l \leq 9$ is obtained using mathematical equations, namely:

$$k = (1 - b') + (1 - a')$$

$a' = \{1, 2, 3, 4\}, \ b' = \{1, 2, 3, 4\}$

As example:

Numbers $7 = (1 - 3) + (1 - 3)$ in the Marosok tradition is obtained by "holding the index finger representing 100, then holding the index finger, middle finger and ring finger together then breaking down or twisting to the left to representing minus 30 so that 100-30 is 70. Next holds the index finger represents 10 then holds the index finger, middle finger and ring finger again then breaks down or twists to the left to represent minus 3 so that 10-3 is obtained 7. Finally, 70 + 7 is obtained, namely 77 ".

**3. Three-digit number, for example $klm$.**

The first digit is $k$, the second digit is $l$ and the third digit is $m$.

The three digit number $klm$ is obtained by separating the first two digits $k$ with the third digit $m$.

| $k$ | $l$ | $m$ |
|-----|-----|-----|
| The first two digits of $k$ are obtained using one of the 5 formulas for numbers on two-digit numbers. $k$ and $l$ digits occupy hundreds and tens of places respectively. | The third digit $m$ is obtained using one of the 2 formulas of numbers in one digit and occupies the unit place value. | The three digits of $k | l | m$ are written sequentially according to the value of each place. |

As example:

Number $237$ is obtained by separated the first two digit 23 with the third digit 7 as follows:

| $2$ | $7$ |
|-----|-----|
| Numbers $237 = 2 + 3$ in the Marosok tradition is obtained by "holding the index finger and middle finger representing 20, then holding the index finger, middle finger and ring finger together to represent plus 3 so that the number 23 is obtained. 2 and 3 respectively occupy place values of hundreds and tens. | The number 7 in the Marosok Tradition is obtained by "holding the index finger representing 10, then holding the index finger, middle finger and ring finger together then breaking down or twisting to the left to represent minus 3 so that 10-3 becomes 7. Number 7 occupies the place value of unit. |

These three numbers are written sequentially: 237 | 7 to 237

**4. Conclusion**

Mathematical representations in the Marosok trading tradition contain basic numbers one, two, three, four, five, two and a half as well as two types of operations, addition and subtraction. This mathematical representation is used to obtain other numbers needed in livestock buying and selling transactions using certain formulas. The formulas are divided into three parts, namely the formula for one digit number, the formula for two digit numbers and the formula for three digit numbers. These three formulas are used with basic mathematical representations to obtain one digit number, two digit number and three digit number. These numbers will be converted into rupiah to obtain the final price in buying and selling livestock using the Marosok trading tradition.

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