Symbolic measuring: an exploration of ethnomathematics based on people's daily communication

Uba Umbara¹,²,*, Wahyudin³ and Sufyani Prabawanto³

¹School of Postgraduate Studies, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No. 229, Bandung 40154, Indonesia
²Department of Mathematics Education, STKIP Muhammadiyah Kuningan, Jl. Moertasiah Supomo No. 28B, Kuningan 45511, Indonesia
³Department of Mathematics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No. 229, Bandung 40154, Indonesia

*uba.bara@upmk.ac.id

Abstract. The purpose of this study is to show that ethnomathematics has an important role in people's daily communication. This study discusses the exploration of existing symbolic measuring instruments used by the Cigugur indigenous community in their daily activities. The research uses a phenomenological approach that can strengthen the study of a comprehensive analytical framework in describing experiences experienced by people based on phenomena. Meanwhile, ethnomathematics design adopts four elements consisting of generic questions, initial answers, critical constructs, and specific activities. Research findings show that people are accustomed to using symbolic measuring instruments rather than formal measuring instruments. Through the use of assumptions, researchers describe and demonstrate the relevance of symbolic measuring instruments with formal instruments that are internationally recognized. The results showed that the indigenous communities of Cigugur possessed and applied ethnomathematics in their lives for generations, so it can be concluded that ethnomathematics is part of their lives and cultural roots which are included in the language system in the universal cultural elements.

1. Introduction
Various studies on the concept of mathematics related to culture have been conducted by many researchers. Evidence of the close relationship between mathematics and culture has been widely discussed both by rationalism and empirism. The research Program that focuses on slices of both has been widely known as ethnomathematics. Ethnomathematics focuses on the relationship between mathematics and culture [1]. Ethnomathematics as a research program shows its capacity to examine mathematical applications in the lives of various groups of people. It shows that mathematics has existed and is used by society even if the community does not know the concept of academic mathematics at all.

Various ethnomathematics studies empirically provide evidence that mathematics is not entirely universal. In this case, more precisely the universality of mathematics is restrictive. Many mathematical assumptions and theorems are universal but in their applying and learning are influenced by identity and cultural entities [2]. The view of the universality of mathematics is basically a dominant form of aprioristic knowledge, so that it impacts on the slowness of the emergence of ethnomathematics than other ethnosciences [3]. In this case, it is important to believe that mathematical concepts and values
that are universal need to be placed as something that is restrictive when dealing with their implementation in the life of the wider community.

The emergence of ethnomathematics is actually influenced by the growing awareness of mathematicians about aspects of social, mathematical culture and mathematics education in the late 1970s and early 1980s. This awareness arises because of the growing resistance to racist prejudice and neocolonialism against eurocentrism in mathematics and its history [3]. Since D’Ambrosio coined in 1985 in a scientific forum, the definition of ethnomathematics has continued to develop to find equilibrium so that it can be generalized as a research topic. However, it should also be realized that the difficulty of generalizing ethnomathematics research is part of the uniqueness of this research genre due to differences in identity and cultural entities themselves.

Ascher & Ascher [1997] defines ethnomathematics as a mathematical idea of illiterate people [4]. This definition is considered too simple and too narrow by experts because it implies that ethnomathematics occurs only when discussing mathematics from primitive societies [5]. The limitations of ethnomathematics understood as such can actually narrow the development of the study because it is too static. Mathematical ideas are influenced by mathematical ideas, procedures and actions which are precisely based on the axiological aspects of mathematics. Based on this, another rationalism review is needed that is able to complete the empty space of the definition. An important basis for ethnomathematics thinking lies in mathematical and cultural concepts as ways and results of thought and information processing in individual cognitive structures [6].

Ethnomathematics is defined simply but more feministly as the study of mathematical concepts on a small scale or indigenous culture [7], while coverage of people or cultural groups in the practice of ethnomathematics is broader then described as indigenous peoples, urban and rural communities, labor groups, groups of children based on a certain age, professional class, and other groups that can be identified through objects and traditions [8]. The feminism then led various ethnomathematics researches to ethnic groups, such as the Incas [9]; the Hausa, in Nigeria [10]; Baduy, in Indonesia [11]; Kabihug, in the Philippines [12]; and Sundanese, in Indonesia [13]. Meanwhile, the study of ethnomathematics in certain community groups can be seen from research on slum city children, in Brazil [14]; carpenters in Cape Town, South Africa [15]; farmers and fishermen, in Mozambique [16]; karara weavers, in Maranao [17].

These various studies provide empirical evidence of the wide scope of ethnomathematics studies conducted by ethnomathematicians. However, the broad scope of the discussion of the concept of ethnomathematics in these studies does not appear to discuss the language system used by the community groups that are the object of research. Whereas the language system occupies the basic things that need to be studied considering its role as a communication tool which ultimately raises the habits of the community in carrying out mathematical activities and procedures. This is in accordance with the objects studied in ethnomathematics including symbols, concepts, principles, and mathematical skills [13]. Some things that can be studied related to mathematical symbols related to the language system include how to pronounce numbers, number operations, and units of measurement that are often used by community groups. Among the community activities that are trading, agriculture, construction, children's games and other activities in the social life of the community. Related to this in this article, the researcher will describe the measurement units used by the Cigugur indigenous community in daily communication.

2. Methods
This research is a qualitative study that emphasizes holistic descriptions using a phenomenographic approach that is conducted to strengthen the study of a comprehensive analytical framework. Phenomenology is used to describe experiences experienced based on phenomena [18], research is designed to answer certain questions about thinking and learning [19], relating to the study of people's experiences of certain aspects of reality, referring to the general and intersubjective meanings of certain aspects discovered through phenomena, culturally studied individually developed to connect ourselves with the world around us [20]. Data was collected through structured and in-depth interviews with
respondents who knew and underwent intensive communication with fellow Cigugur Kuningan indigenous communities. The data analysis process begins by examining all data collected from various sources which is conducted interactively and continues until the data is saturated. Data analysis techniques used in this study were content analysis techniques, triangulation techniques and finding patterns. The content analyzed focuses on the six dimensions of basic universal mathematical activities such as counting, measuring, discovering, explaining, designing, and playing [21].

3. Results and Discussion

Language occupies an important portion in the analysis of human culture and has a central role in the development of civilization and culture of a tribe. The results showed that the Cigugur indigenous community knew and still made simple measurements that were actually used more often by parents first. In detail some of the symbolic measures are described as follows:

3.1 symbolic arithmetical unit for several objects

Some terms in the unit of calculation used to refer to a particular object are shown in table 1 below.

| Term     | Used to mention                                      |
|----------|------------------------------------------------------|
| Satangkal | Mention one tree                                    |
| Sajodo   | Mention of female and male animal pairs, for example: chickens, birds, and others. |
| Sagebing | Mention bamboo matting or also called “bilik”       |
| Sakeclak | Mention a drop of water                             |
| Sabuyung | Mention the water in the water container or also called “buyung” |
| Sasikat  | Mention one banana comb                             |
| Saturuy  | Mention one banana stalk consisting of several brushes of sikat |
| Samanggar| Mentioning coconuts in one stalk                    |
| Sapetak  | Mentioning rice fields or gardens                   |
| Sahulu   | Unit for one coconut                                |
| Sasiki   | Mention 1 item. Usually used for 1 grain of rice, beans, and others |
| Sabatok  | Around 1 liter of rice                              |
| Sakulak  | Around 2.5 kg of rice                               |
| Satolombong| Around 20-25 liters of rice                          |
| Saperelek| The size used for rice is taken in a small container.|
| Sarangeuy| One rice hilt                                       |
| Sapococong| Unit for mentioning a bunch of rice weighing ± 10 kg |
| Satanggung| 2 pocong                                             |
| Sabawon | 4 pocong                                             |
| Saacar   | $1/3$ atau $1/2$ pocong rice weighing ± 5 kg        |
| Sagendel | 4 acar rice                                          |
| Sagegeus | 2 acar rice                                          |
| Sasangga | 5 gegeus rice                                       |
| Samadea  | 100 gegeus rice                                     |
| Salajer  | 4 sangga rice                                       |
| Sapereket| 1 handle of jengkol consisting of ± 10 jengkol in 1 stalk |

The arithmetic units used on some of these objects are closely related to agriculture so that the term used is a number of types of crops or staple food because most people have jobs as farmers.

3.2 symbolic weight measurement

The symbolic weight measurements used by the Cigugur adar community are shown in table 2 below.
Tabel 2. Unit of Weight Measurement

| Term     | Weight measure                                      |
|----------|-----------------------------------------------------|
| Sagandu  | Around 0.25 kg, it is usually used to mention salt or brown sugar |
| Saeter   | One bamboo section which is equivalent to 0.25 kg    |
| Saentik  | The weight size is determined using coconut shells. It weighs around 0.5 kg. Usually used for rice. |
| Sagantang| 20 entik or about 10 kg                            |
| Sapikul  | 10 gantang or about 1 quintal                      |
| Sacang   | 100 gantang or about 1 ton                         |

The weight unit used is closely related to food consumed daily by the community in the Cigugur indigenous community such as salt, brown sugar and rice.

3.3 symbolic size in mentioning length
Several measures that are often used mainly in measuring activities are shown in table 3 below.

Tabel 3. Measure in mention length

| Term   | Length measure                                      |
|--------|-----------------------------------------------------|
| Sauted | Thumb length                                        |
| Sadim  | Along the segments of the palm                      |
| Sarus  | Throughout the knuckles on the index finger         |
| Sacentok | The length between the tip of the thumb and the middle of the index finger |
| Satekem| The length of the index finger to the first knuckle on the thumb |
| Satunjuk| The length between the tip of the thumb with the tip of the index finger |
| Sacekang| Length from the tip of the thumb to the tip of the middle finger |
| Satelapak| Along the soles of the feet                         |
| Sajeungkal| Length from the tip of the thumb to the edge of the circumference in a way stretched |
| Sasiku/sahasta| Length from the tip of the middle finger to the elbows |
| Sabeulah | 1 hand starting from the tip of the middle finger to the shoulder |
| Salengkah| Along steps (when walking)                          |
| Sadeupa | Throughout both hands stretched                      |
| Satangtung| As long or as high as someone from head to foot    |

The length used is inseparable from the use of limbs, this aims to facilitate them in taking measurements because it does not require special tools. However, the resulting size does not meet standardization. This happens because the length of the human limbs differs from one another, both in terms of the sex, age, and size of each limb.

3.4 symbolic measure of length related to volume
This length is usually used by the community to determine the depth of the surface water. Length measurements related to volume are shown in table 4 below.

Tabel 4. Symbolic measure of length related to volume

| Term                | Used to mention                                      |
|---------------------|------------------------------------------------------|
| Samet tuur          | The depth of the water from the sole of the foot to the knee of an adult |
| Saluput hulu        | The depth of the water from the sole of the foot to the tip of the head |
| Jerona saleunjeur awi | Along bamboo stems used to measure water depth       |

This length is used to determine the depth of the water. In mathematics this size is referred to as height in the wake of space.
3.5 Symbolic size related to area
The area size is used to indicate the area of land owned by the Cigugur indigenous community. Measures related to area are shown in table 5 below.

| Term        | Used to mention                        |
|-------------|----------------------------------------|
| Sabata      | 14 m$^2$                               |
| Sapatok     | 15 x 15 *deupa pasagi* or about 400 m$^2$ |
| Sabau       | 500 *bata* or around 12,500 m$^2$      |
| Sapasir     | Around 28 hectares                     |

The measure used to mention the area of land is still often used by the community, especially in the jual buying activities in the plot of land. This measure is still generally used to determine the price of land with a certain area, because in rural communities the price of land is still determined by the size of the brick, not the area m$^2$.

3.6 Symbolic measure of time
Timing is done based on natural signs that are felt by the community, shown in table 6 below.

| Clock     | The term used              | Clock     | The term used              |
|-----------|---------------------------|-----------|---------------------------|
| 1         | Tumorek                   | 13        | Lingsir                   |
| 2         | Janari leutik             | 14        | Kalangkang satangtung     |
| 3         | Janari gede               | 15        | Menggok                   |
| 4         | Kongkorongok hayam        | 16        | Tunggang gunung           |
| 5         | Balebat                   | 17        | Sariak layung             |
| 6         | Carangcang tihang         | 18        | Sareupna                  |
| 7         | Meletek panon poe         | 19        | Harieum bengeut           |
| 8         | Ngataluh tanaih           | 20        | Sareureuh budak           |
| 9         | Haneut moyan              | 21        | Tumoke                    |
| 10        | Rumangsang                | 22        | Sarereuh kolot            |
| 11        | Pecat sawed               | 23        | Indung peuting            |
| 12        | Tangange                  | 24        | Tengah peuting            |

The symbolic measurements above are still mostly used by the community, especially farmers, paternal, traders, carpenters, builders, and others. This measure is a unit of measurement commonly used in daily communication. The unit of calculation used on several objects is often used by farmers, ranchers and traders. The unit of measurement of weight and length associated with volume is commonly used by farmers and traders. Measures in Mention Length are more often used by builders and carpenters. Lengths related to volume are used by builders and fish farmers. Meanwhile, symbolic measures of time are rarely used even some young respondents do not know.

The results of this study provide strong evidence that the language system has a strategic role in the production and development of mathematical ideas. The main function of language, especially in a series of patterns that appear in several noun phrases that contain basic language vehicles to present arithmetic concepts, even Thorndike said that the measurement of ability in arithmetic is based on two things namely insight into mathematical knowledge and language [22]. The use of limbs or symbols of an object in symbolic size used by the community is one of the benchmarks that in the culture of society there are mathematical signs or symbols, even though these symbols or signs are not formal symbols that apply internationally.

This is supported by the fact that, mathematical signs and symbols may be pictorial, or may refer to operations or expressions [23], mathematics has formal and informal expressions, which can be
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described in terms of "school mathematics" and "folk mathematics" [24]. However, it must be realized that this symbolic size has the potential to cause confusion for anyone who does not recognize it because it has a different symbolic representation. Thus, it seems natural, given that in reading mathematical texts one must decode and understand not only words but also signs and symbols that involve different skills especially skills related to words and decoding which involve the relationship between sounds into alphabet symbols or letters [25]. On the other hand, relating to the relationship between culture and mathematics, it can be empirical evidence that culture and mathematics intersect with each other. In other words, Mathematics originated from various cultures [26].

The language system in the cultural element that is explored based on ethnomathematics is a description of the unit of measurement of some symbolic objects so as to produce symbolic measurements used by the people in their lives. The results of this study are reinforced by previous studies, which stated that Sundanese people were accustomed to using symbolic mathematical calculations with regard to the calculation of basic units, length, width, area, height, weight, and time [13] and specifically other research conducted in the Baduy tribe concluded that the competence of measuring, comparing, adding, subtracting, multiplying, and dividing was used to weave cloth [27]. The existence of symbolic measures and the capacity of the community to reflect a strong cultural character in the midst of society.

The results of this study, fully support Barton's proposal about the relative conceptualization of the nature of mathematics. Barton urges ethnomatematics and other researchers who wish to discuss the possible simultaneous existence of culturally different mathematics to consider a system of mathematical relativity in which different meanings for mathematics are developed and shared by each cultural group [28]. This research is expected to be a reference in laying the foundation of the importance of recognizing the mathematical thinking of every person who has a different culture, so the role of mathematics cannot be separated from the development of the culture itself.

4. Conclusion

The results of ethnomathematics research in this language system illustrate that the Cigugur indigenous community has the ability to communicate mathematical ideas, activities and practices. The mathematical object that shows the way of thinking mathematically the Cigugur indigenous community is found in the use of units of measurement. This ability is identified through the existence of the basic unit symbolic size, length, width, area, height, weight, and time. The use of units of measurement as mathematical objects for some objects shows functional mathematical functions as nouns, has inseparable objects, and as a form of assimilation of contextual content. Mathematics does not appear suddenly but is created from activities carried out based on community activities or culture. The mathematical context in daily life that is built based on this noun can also morph into a verb because it is related to the empowerment of mathematics in everyday life. In this regard it can be concluded that symbolic measures are abstract ideas, but are able to provide information that can be understood in their entirety in a public communication. Symbolic measures that are and are still used by the community can be used in generating ideas, procedures and other more complex mathematical activities.

5. References

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