The Metamorphosis of Number in a Culture
(A Case Study of Ethnomathematics in Arfak)

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Abstract: Arfak numerical system is uniquely categorized. It is because Arfak tribe uses base number 10 sub base 5. This study is focused on the numerical construction and the shift analysis of its own construction. This research used ethnography. The study was conducted in Hingk District, Arfak Regency, West Papua, Indonesia. The subjects of the study were Arfak residents consisted of ordinary people, tribe leaders and public figures. Based on the development of the culture, the society of Arfak has 3 types of numbers in Hatam language. The both types are the number of base 5, 10 and base 10 sub base 5. The outsider affects the type of number in Arfak culture. This influence caused the metamorphosis of numbers in Arfak cultures. The metamorphosis is seen in the change of base number 5 to base 10 sub-base 5.

Key words: Ethnomathematics, metamorphosis, number, Arfak, base number, culture

INTRODUCTION

Ethnomathematics is a word for describing the numerical terms that correlate to certain culture in certain place. Culture proper is defined as the customs of human beings found at the place where they live in such as how urban and rural citizens behave to, group of profession, students based on their group of age and particular social group (D'Ambrosio, 1989, 2001). From the explanation above, it can be concluded that mathematics term is likely found in human being's surrounding in which they share the same thought to each other.

The meaning of ethnomathematics have been differently explained by different scholars. Zaslavsky proposes ethnomathematics as social mathematics that is applied in social life (Gerdes, 1986, 2011; Rosa and Orey, 2011). D'Ambrosio defines ethnomathematics as spontaneous mathematics which the method is unexpectedly used in specific culture (D'Ambrosio, 1989, 2001; Gerdes, 1986, 2011; Rosa and Orey, 2011). Posner calls it as informal mathematics used by students in outside of school (Gerdes, 1986, 2011; Rosa and Orey, 2011). Carragher and Kane State as oral mathematics, a cognition obtained from one generation to another

generation (Gerdes, 1986, 2011; Rosa and Orey, 2011). Gerdes mentions as non-standard-mathematics, the mathematics practice that overlap the laws and provision found on the field of mathematic (Gerdes, 1986, 2011; Rosa and Orey, 2011). He also, adds that ethnomathematics can be defined as hidden mathematics, a practice which is not realised by the people at their culture (Gerdes, 1986, 2011; Rosa and Orey, 2011). Last, Mellin-Olsen in Gerdes says as general mathematics in which it is always involved in every activity of human being (Gerdes, 1986, 2011; Rosa and Orey, 2011).

In the field of mathematics, number is always defined as the basic concept. Each culture may express its own number differently. For instance, Joseph (2011) that base number of 2, 4 as well as 20 are used at the African Culture. Meanwhile, Nigerians implement multiple base number such as base number 20 sub base 10 (Hall, 2007). These examples are totally different from what we usually found in hindu-arabic number for the reason that it uses base 10.

In this study, Arfak ethnomathematics is the numerical term used by Arfak tribe in West Papua, Indonesia. Arfak tribe lives in the rural area which the altitude approximately reaches ± 2000 m above the sea

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level. Because of its altitude, the culture of Arfak tribe is not entirely wide-open by external culture. In last 3 years, there are at least six articles published about Arfak proper. The results of those articles are Geometric transformation of Papuan Noken, shift of triangle shape at node house of a thousand feet, numerical system of Arfak tribe, numbers on the gesture of Arfak tribe, numerical system of the trade of Arfak tribe in the past years and The similarity of numeration of Arfak tribe and abacus.

Arfak numerical system is uniquely categorized. It is because Arfak tribe uses base number 10 sub base 5. This number is the result of construction that have been done from generation to generation. From the explanation above, this study discusses about Arfak ethnomathematics. This study is focused on the numerical construction and the shift analysis of its own construction.

MATERIALS AND METHODS

This research used ethnography. The study was conducted in Hingk District, Arfak Regency, West Papua, Indonesia. The subjects of the study were Arfak residents consisted of ordinary people, tribe leaders and public figures. The involved subjects were those who communicated by using local dialect. Then, the numbers spoken in Hatam language were translated into Bahasa Indonesia. After translating, the researcher asked some tribe leaders in order to double-check the outcome.

The taken data from this research were qualified into two, namely translated numbers and interview result. The translated numbers were presented through tables and the interview results were given in the form of dialog between researcher and interviewees. The data analysis was done by looking at the word structure of Hatam language. Furthermore, the researcher designed mathematical illustration based on the structure that had been found out.

RESULTS AND DISCUSSION

Table 1 discusses about the numbers from 0-10 accomplished by the illustration and its word former. From Table 1, the term of muhi which means five is symbolized by x and semenaik that indicates ten is represented by y. These symbols are made in purpose by the researcher for the reason that those are not base numbers and as word structure they are not the repetition from 0-4. Then, the term of 6-9 are the repetition of 1-4. For example, muhindagom is originally taken from muhi and gom which

Table 1: The number from 0-10 in Hatam language

Numbers	Hatam language	Word former	Illustration
0	Yibi	Yibi	0
1	Gom	Gom	1
2	Can	Can	2
3	Nengai	Nengai	3
4	Betai	Betai	4
5	Muhi	Muhi	X
6	Muhindagom	Muhi da gom	x+1
7	Muhindacan	Muhi da can	x+2
8	Muhindanengai	Muhi da mengai	x+3
9	Muhindatai	Muhi da tai(betai)	x+4
10	Semenaik (nengotegom)	Semenaik (nengotegom)	Y (bond one)

the earlier means five and the latter is one. The term of muhindagom means five more than one or it can be implied x+1. It is impllied also in seven, eight and nine. These numbers are began by muhi and ended by can, nengan and tai (betai). The are two ways of pronouncing the word "ten" in Hatam language, namely semenai and nengotegom. From the interviewee, semenai means ten and nengotegom means bond one. Each syllable of the word "semenai", there are no terms similar to one to ten. So, it can be summarised that semenai is not the repetition of one to five.

The word of nengotegom consists of a syllable which gom means one. Yet, the word one means the quantity of bond as many as one. Furtermore, it is clear enough that ten is not the repetition from the five basic numbers. The term of nengotegom creates a new base which is base ten, So, six to nine are called as base numbers. Still, there are three different ways to pronounce eleven to ninteen. The differences of those numbers are the first version the repetition of one to five are counted as many as twice, second and third version are counted as many as ten (Table 2).

The word of semenaimuhindip (fifteen) Version 1 in the table has different word formation from semenai bini gom (eleven) to semenai bini betai (fourteen). It is different as the written form is not as the same as Version 2 which is semenai bini muhi. Then, the illustration for fifteen is able to write by z. The column of base number five Version 1 is obtained from the illustrations of eleven to sixteen which is similar to nineteen. This similarity can be seen from eleven to sixteen which are y+1 dan z+1 with y = semenai and z is semenaimuhindip. y = 20 in base 5 and z = 30 in base 5. As a result, eleven is defined as y+1 = 20+1 = 21 in base 5 and sixteen is z+1 = 30+1 = 31 in base 5.

The column of base number ten sub base 5 Version 2 is dissimilar to column Version 1. It is different for the reason that sixteen is differently pronounced between these two versions. In the Version 2, sixteen is translated to be semenaik bini muhindagom in Hantam language. The illustration is y+(x+1) in which y

Table 2: Three ways of pronouncing eleven to twenty

Numbers	Version 1		Version 2		Version 3	
	Hatam language	Ilustration	Hatam language	Ilustration	Hatam language	Ilustrasion
11	Semenai bini gom	y+1	Semenai bini gom	y+1	Nengotegom gom	y+1
12	Semenai bini can	y+2	Semenai bini can	y+2	Nengotegom can	y+2
13	Semenai bini nengai	y+3	Semenai bini nengai	y+3	Nengotegom nengai	y+3
14	Semenai bini betai	y+4	Semenai bini betai	y+4	Nengotegom betai	y+4
15	Semenai muhindip	z	Semenai bini muhi	y+x	Nengotegom muhi	y+x
16	Semenaimuhindip bitei gom	z+1	Semenai bini muhindagom	y+(x+1)	Nengotegom muhindagom	y+(x+1)
17	Semenaimuhindip bitei can	z+2	Semenai bini muhindacan	y+(x+2)	Nengotegom muhindacan	y+(x+2)
18	Semenaimuhindip bitei nengai	z+3	Semenai bini muhindanengai	y+(x+3)	Nengotegom muhindanengai	y+(x+3)
19	Semenaimuhindip bitei tai	z+4	Semenai bini muhindatai	y+(x+4)	Nengotegom muhindatai	y+(x+4)
20	Nadugom	a	Nadugom	a	Nengotecan	a

symbolizes the base size. This number is indicated as base ten because y is ten. Meanwhile, it can also be called as base 5 in which muhindagom is represented by x+1 based on the table. Therefore, this number is able to be called as base number ten sub-base five.

The third column version in illustration model is compared with second version column. It is because the wording of version three is the same as Version 2. Therefore, the number in the third column version is the base number ten sub base five. The mentions of the twenty number in Hatam language has two versions, namely naduagom and nengotecan. Naduagom has a syllable word gom. Gom in Hatam language and on the creating number has a meaning one. The term gom is explained in the following examples:

- Q: does gom in naduagom mean one?
- DN: no, it doesn't Naduagom is twenty

Next, the researchers traced about the using of naduagom numbers. Below are the results of the interview:

- Q: how to know Naduagon?
- DN: let, sum up all fingers and toes

The explanation above shows that the naduagom are the total of all fingers and toes. Morphem gom in naduagom means one that expreses a whole or one unit of the number of fingers and toes. The word nengotecan similar to ten in nengotegom word. Nengotecan is derived from two morphemes nengot and can in Hatam language. Nengot means a bond and can means two.

So, nengotecan, means two bunches. Table 3 contains examples of nengot morphem in a number. The base number in the Hatam language which uses base 5 begins from 1 to 20. Subject explanation is as follow: DN: there are two ways in mentioning the number of tens in Hatam language, i.e., semenai and nengotegom.

Table 3: Lists the number of tens and model illustration

Numbers	Hatam language	Word formers	Model illustration
10	Nengotegom (semenai)	Nengote gom	$1 \times b$
20	Nengotecan (naduagom)	Nengote can	$2 \times b$
30	Nengotenengai	Nengote nengai	$3 \times b$
40	Nengotebetai	Nengote betai	$4 \times b$
50	Nengotemuhi	Nengote muhi	$5 \times b$
60	Nengotemuhindagom	Nengote muhindagom	$6 \times b$
70	Nengotemuhindacan	Nengote muhindacan	$7 \times b$
80	Nengotemuhindanengai	Nengote muhindanengai	$8 \times b$
90	Nengotemuhindatai	Nengote muhindatai	$9 \times b$
100	Nengotesemenai	Nengote semenai	$10 \times b$

EX: b: bonding (nengot), a bond = 10

Similarly with the number twenty, naduagom and nengotecan. Originally, the pronunciation of ten is semenai and twenty is naduagom. The term negote which means the bond influenced from the outside. As the explanation from leader of society that the number after twenty are influenced by outsider. The structure of number upper twenty has different structure from the numbers under twenty. The number in Hatam language has some bases. Firstly base 5, it can be seen from number six to nine. Secondly, base 10, it can be seen in number using morphem nengot. Thirtly base 10 sub-base 5, eventhough, it uses morphem negot, the usage of base 5 still appear in these numbers.

From the base number which used by Arfak community, it can be concluded that the numbers have a metamorphosis. It is caused by the changing or developing numbers from genertion to generation. The changing is from base 5 to base 10 sub base 5. The cause of the metamorphosis numbers of Hatam culture is influenced by the culture from outsider. The outsider affects the number in the Arfak culture. It is caused by the needs of larger numbers of 20 upwards. Based on the development of the culture, the society of Arfak has 2 types of numbers in hatam language. The both types are the number of base 5, base 10 and number of base 10 sub base 5. Both types of base ten numbers are not commonly used in mathematics. The number of the double base type is also, used in other cultures besides

Arfak such as Nigerian using base 20 sub base 10 (Hall, 2007), the China and Japan Abacus using base 10 sub base 5. These base numbers are different from from Hindu Arabic numbers which uses base 10. The usage of base 10 in Arfak is influenced by outsider. Because of ousider culture, Arfak society is forced to know larger numbers. It fits the purpose of the base number that the numbers can be used for greater numbers than the basic number. The base 5 in Arfak culture is difficult to be mentioned, if it is apper 20 because multiply 5 has not pattern, i.e., 5: muhi, 10: semenai, 15: semenaimuhindip and 20: naduagom. Therefore, people construct new numbers by creating numerical patterns. The result number is a number with base 10, the pattern uses nengot term for ten and nengot gom nengotcan and so on.

The basic number in Arfak society is not the base determinant used in the number. It can be seen that the Arfak society uses the base number of 5 but the number is using base 10. This base 10 is the result of the outer cultural providers. Although, they use base 10, the five basic numbers also form their own base known base 5. Therefore, this number can be called a double base number which is base 10 sub-base 5 because this number is looped in the number 10 and base 5 because this number is repeated in the number 5.

In addition to its unique base, the number of Arfak from the past to the present is metamorphosed. The process is due to cultural influences from outside. This number of arfacts does not change to the external culture but the Arfak society constructs new numbers to meet their needs in order to adapt to the culture from the outside. Metamorphosis is caused by the combination of two or more cultures that produce new culture by not leaving the old culture. The type of cultural change according to anthropology is called acculturation of culture.

CONCLUSION

From the data analysis and discussion above can be concluded as follow. The numbers in the language of Hatam (Arfak society) uses 2 types of base numbers, namely single base and double base. The single base is base 5 and base 10. The double base is base 10 sub base 5. Base 5 is used by old generation and the double base is using in nowadays. The ability of a number system to count large numbers is seen from the base and the pattern of the numbers. The outsider influences the type of number in a culture. This influence caused the metamorphosis of numbers in a cultures.

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