IDEA OF AFRICAN NUMERIC SYSTEM

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1. Numbering in African Thought

In Africa, sometimes we number our gain and try to ignore our loss not because they cannot be numbered but because in African thought, numbering is not just a question of signs but strictly, it is a question of things. We also number our dept because they are things although belonging to other people. From origin, man has always had a sense of numbering. The ancient Chinese, Indians numbered by group difference; the Persians numbered by group identity. The Greeks and the Romans developed a numeric system of individual identity and worked out the symbols I, II, III, IV, V, VI, VII, VIII, IX, X as their numerals. It was the Arabians who gave the world a much more flexible symbol of individual identity; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

In all of this period, the African man had his sense of numbering based on group identity whose symbols consisted of lines I, II, III, IIII, IIIII, IIIIII, IIIIIII, IIIIIIII, IIIIIIIII, IIIIIIIIII. In this way, he numbered his flocks, his wives, his children, his wealth, his assets, his credits, his dept and even his age. One year was a period between the beginning of one rainy season and another. The African drew these lines in the red earth walls of his inner chamber. Up until the coming of western civilization, the African retained his system of group identity because it offered a clear expression of his idea of number. He also has idea of bundle, five IIIII is half a bundle; ten IIIIIIIIII is a bundle and so on, bound by a horizontal bar in the middle or two horizontal bars on top and below as in tying with rope. Numbers for the African are not just

abstract accretions but representations of things. For example the number ten is not an individual sign, it consists of ten signs; it is not a concept, they are signs representing ten things. It could be ten tubers of yam, ten baskets of oranges or ten kegs of oil. The bottom line is that it is ten things. The concept ten is abstract, such abstraction does not make empirical sense to the African, and it is empty. This shows that for the African, numbers are adjectival in nature. They are not names! They merely qualify quantitative things in African thought system.

As a result of this radical conceptual difference between the African and the western/Arabian numeric systems, Africans encounter problems with the system introduced during colonialism.

a. As a child in school, arithmetic becomes a meaningless subject.
b. He crams the signs and memorizes the structures without understanding.
c. In businesses and transactions he labours to remind himself that ten Cedi or Rand note is Cedi or Rand numbered into ten.
d. The individual identity numeric system becomes a complicated puzzle.
e. Numbers are detached from their ideas; this makes it difficult for the African to think within the system.
f. Any numbers say 1000 is meaningless and is therefore difficult to think with.
g. To make sense of any number say 1000, an African must first integrate the empty sign with the idea of one thousand things. This slows down his thinking.
h. It is not easy for the African to be taught to see numbers as sign plus ideas because the Arabian signs were not generated from his system of group identity.

For all the reasons enumerated above, and also for the fact that the signs of group identity Africans use in the olden days would not

suffice for modern demands in arithmetic and business transactions, we develop here a new numeric system generated from the system of group identity. This new system we hope would denote in the mind of the African number plus its idea, such that when an African employs the sign , he knows in his mind without difficulties that it means three things. In this way, it is hoped that the new signs would become flexible for him to think with unlike the empty Arabian numerals and the cumbrous group identity signs.

There are eleven basic numbers in the new African numerals known as the tọọala. These tọọala numbers are generated with sign language and technical intensions such that each evokes a certain image of something at least and as such they are the foundation of the African numeric structure.

Additional considerations have been made in order to make them mathematically convenient. Some of those considerations include forming the unit in single digit, the tens in double digits and the hundreds in triplets, etc., just like in the Arabian numerals. In fact the fundamental reason for forming the African numerals is the creation of an image-driven figure structure. The Arabian numerals do not provide that to the African mind.

All humanity thinks mathematically i.e. in shapes and sizes, in angles and points, in figures, ratios, fractions and in percentages but the African additionally, must correlate these with images. A ratio has an image-the image of the ratio of … without this, the ratio makes no meaning to the African. Until it is ratio of or fraction of, it is ratio or fraction of nothing and is therefore not worth talking about. What we wish to portray here is that abstraction is not a veritable reasoning process for Africans. Consider the table of numeric meaning below:

Table. a : Table of numeric meaning

N/O (Arabian)	**MEANING**	**N/O(African)** tọọala	**MEANING**
1	One		One thing
2	Two		Two things
3	Three		Three things
4	Four		Four things
5	Five		Five things
6	Six		Six things
7	Seven		Seven things
8	Eight		Eight things
9	Nine		Nine things
10	Ten		Ten things
0	Nought/zero		All things

This image-driven conception of numbers in African thought system can be further explained by the interpretation of the eleven basic numbers. We understand that numbers for the African have meanings and these characterize the images they reflect on the mind.

Let us consider the interpretation of the tọọala numbers in the table above. We notice that the eleven African basic numerals can be grouped into three categories, the number "one" which is singular, the "all" number which is all encompassing and the rest which are plurals. The number one is called Ume-ezu (defective and imperfect), the all number is called Ezumezu (perfect number) while the rest are called Izumezu (imperfect numbers).

The number one is defective because when multiplied or divided by another one yields no new result and it is imperfect because like the rest of the imperfect numbers it contains no other numbers apart from itself. The latter has sufficed for the explanation of imperfect members. Then the perfect number is so-called because it is the all-number, it contains every other number in itself. In African numeric system, it is not called zero or naught but the all-number. It not only contains every number but every number is reducible to it, this shows it contains itself as well.

There are also a set of numbers called Njikoka numbers and Nmekoka numbers. An integer is an Nmekoka if it is formed by progressive increase of single digit numbers from two to nine. The Njikoka numbers are the various permutations of integers from double-digits to multi-digits. The first Njikoka number is ten whereas the first Nmekoka number is two. In an earlier paper, it was wrongly captioned that the first …integrativist whole number is two, one remains fractional until it is added to another one or any other number[1]. The question of abstraction raised earlier also needs further explanation. It is not that Africans are not capable of abstract reasoning such found in individual identity of Arabian numeric system but that to adopt such rivals their already

[1] Jonathan Okeke Chimakonam, "Toward Integrative and Eliminative Epistemologies: From Facts to Fancies" Integrative Humanism Journal (2.1) p.164. This stands corrected here, two is the first complementary whole number and not the first Integrativist whole number.

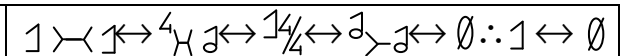
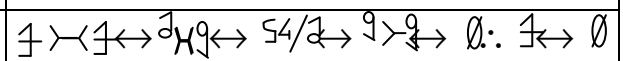
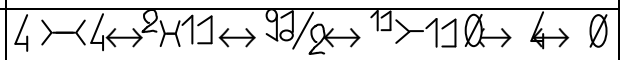
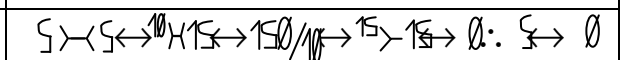
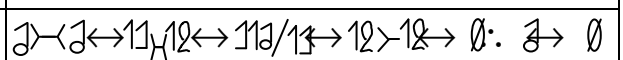
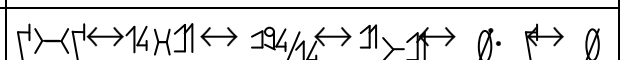
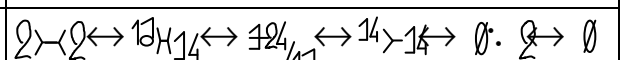
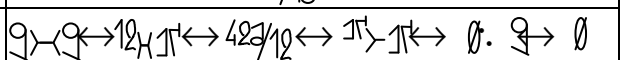
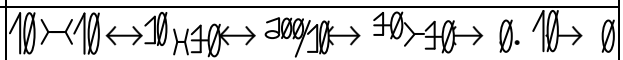
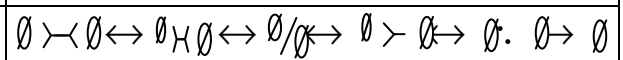
entrenched complementary and integrative ontology. It is only natural that to ensure numeric intelligibility, uniformity of thought among a people is imperative. Importantly, Africans do not make outright demarcations in their ontological and mathematical thoughts. There are strong connections among all areas of African thought. In the idea of African philosophy of mathematics integers which are mathematical objects are thought of as signs or symbols representing objective things. Both mathematical objects and objective realities are mere empty signs on their own until they conglomerate or form an amalgam; the former numbering, measuring and grouping or classifying the latter and the latter giving the former a pseudo-objective existence by receiving its predication[2].

The arithmetical apparatus for checking the value of different categories of tọọala number is what we may here call the "quadcheck", below is a quadcheck table:

Table. b : Quadcheck table

CATEGORY		QUADCHECK ANALYSIS
Defective & imperfect		

[2]Jonathan O. Chimakonam. "Metric System In Igbo Thought Long Before The Arrival Of The Europeans: A Systematization".Paper presented at The 11th Annual Conference of the Igbo Studies Association on "Ohaka: The Community is Supreme" Held at Modotel, Enugu, Nigeria June 27-29, 2013. In colonial times Igbo pupils found it difficult to follow the logic of number abstraction not because they do not understand what say number 5 means but because the Igbo linguistic culture presents number in predicative form. Thus the two ways present confusion which derail progress in mathematical studies. The first set of Igbo trained teachers understood this having faced the challenge themselves hence they adopted the highly successful predicative format. For example; otu – otu oloma, abua – oloma abua, ato – oloma ato, etc.

complementary / Nmekoka	1	
Imperfect	3	
Imperfect	4	
Imperfect	5	
Imperfect	7	
Imperfect	8	
Imperfect	2	
Imperfect	9	
Integrative/ Njikoka	10	
Perfect	0	

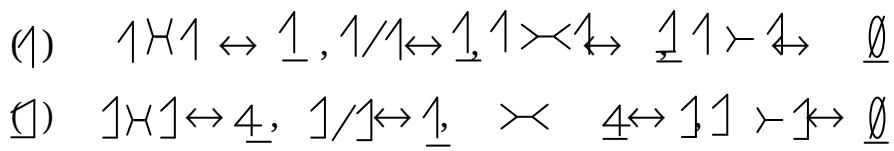
The above analysis is interpreted for example one plus one equals two times the sum of two and one which is three, equals six divided by the remote preceding number two equals three minus the remote preceding number three equals the all-number, therefore one equals zero. In the same way, the rest could be read (see the section on mathematical signs).

We find in the above table that number ten is a Njikoka or integrative number; integrative, because it contains two numbers or that it is more than one digit. If a single digit number is more than one it is an Nmekoka or complementary number e.g. two to nine. Other double or multi digit numbers that are identical such

as 𝍐 𝍐𝍐 𝍐𝍐 etc., are called jiga number i.e. equal integration. All numbers that are more than one are called a Jikọọ or (double or multi-digit number). Number ten is the first integrative number while number two is the first complementary number in the range. But number Ø is a complementary number because it contains all possible numbers belonging to different categories; it is therefore the most complemented number.

According to the group identity thesis in African philosophy of mathematics, the number one does not exist ontologically. Every being exists in relation to another or others therefore one, cannot possibly exist since it stands alone. Yet if one is added to another one or subtracted from another one, it becomes a meaningful number. If on the other hand, one is multiplied or divided by another one, it remains meaningless and non-existent. One plus one is two; one minus one is zero, these are meaningful numbers in the integrativist theory but one times one is one; and one divided by one is also one. The integrativist ontology holds that being exists only in relation to another. No reality that is isolated exists and since African mathematical thought holds that mathematical truths describe the features of experience, one (𝍐) which does not describe anything in the network of experience does not exist. On this count also, we substantiate the position that the number 𝍐 is defective. This is also a point of debate between the two schools of thought in African philosophy of mathematics i.e. the integrativists and the complementarists. While the former views the number one as meaningful only when it is in a network of other numbers constituting a *necessary link* of. The latter sees it as meaningful outside a networking of other numbers because any network of numbers without the number one is incomplete. In this way, the number one serves or constitutes a *missing link* of reality. Note the expressions *necessary link and missing link of reality* the present

author has adumbrated this in the forthcoming book co-authored with Prof. Godfrey Ozumba[3].
On the whole, what the above table shows through the algorithm of quadcheck analysis is that every number is reducible to the all number which makes the all-number the only perfect number comprising of every other number whereas the number one is not only imperfect but defective. Let us consider a simplified quadcheck analysis for two selected numbers:



We can readily observe that in the analysis of number , two of the four yield as their results, whereas in the analysis of number , none yields as its result which shows an adequate capacity of flexibility and interaction with other numbers in the network.

The negative numbers are not often reflected in African numeric system because they represent realities that no longer exist. The present author makes this case in his treatment of the Idea of Igbo thermometer:

> You may have also noticed that the Igbo thermometer does not read in negative numbers e.g. -5,-10, -20 etc., this is because such integers do not form standard mathematical expressions in Igbo thought system. We do not say by implication that the mathematical sign of subtraction does not exist

[3] G. O. Ozumba and J. O. Chimakonam, *Njikoka Amaka: Further Discussions on the Theory of Integrative Humanism. (A Contribution to African Philosophy).* Forthcoming

> in Igbo thought, what we wish to emphasize is the image created when we make such expressions -5 in Igbo thought does not make reference to 5 objects that do not exist but to 5 objects that existed, so it becomes trivial and sometimes misleading to add the minus sign '-'. The important difference marker here is 'time' such that when we talk of 5 objects that existed we do not look out for the sign '-' but to the time indicator which conveys the accurate image.[4]

Therefore, in African numeric system, negative numbers are not functionally represented due to concerns for confusion.

2. Some Signs in African Mathematics/Logic

In African numeric system, signs are not just empty symbols, they are prognostics. There are two main technical reasons why we choose to create some new signs rather than adopt all of the signs of classical mathematics and they are: (a) to create image-driven signs and (b) to give the mind of the learner a new configuration in order to avoid a possible confusion with already popular western mathematical principles. If Africans are to think in original way, then there must not be confusion between their mathematical framework and the already popular classical framework such that mastering the newly articulated African mathematical framework does not in any direct form become reducible to learning the classical mathematics. If the reducibility theory survives in the operational discourse of the newly articulated African mathematical principles, then the goals of this construction have

[4] Jonathan O. Chimakonam. "Metric System In Igbo Thought Long Before the Arrival of the Europeans: A Systematization". Paper presented at The 11th Annual Conference of the Igbo Studies Association on "Ohaka: The Community is Supreme" Held at Modotel, Enugu, Nigeria June 27-29, 2013.

come to nullity. As a result, the study of African mathematics must be non-reducible at least directly to the study of classical mathematics. The learner must therefore, come upon this subject with a mind similar to the Lockean tabular rasa i.e. setting aside anything he must have learned in classical mathematics. His two reference points are to be this note and his natural African thought system. The table below shows some signs and their interpretations.

Table. c : Table of signs

S/N	SIGN	ORIGINAL NAME	ENGLISH TRANSLATION
1		ngụkọ	Multiplication
2		mgbakọ	Addition
3		Nwepụ	Subtraction
4	→	Bukarịa	Greater than
5	←	Pekarịa	Less than
6		Bukarịa mọ'hara	Greater or equal to
7		Pekarịa mọ'hara	Less than or equal to
8	↔	Hara/ Hara-ọnụ	Equality/identity
9		Ahaghị	Not equal

	/	Kebie	Division
	( )	Mkpokọ	Parenthesis
	[ ]	Nchịkọ	Square bracket
	{ }	Nkwakọ	Braces
	.	kpọm	Point/period
	∹	Nkeji	Ratio
	⇔	Bụ-out	Equivalence
	⊢→	Site-na	Wedged-implication
	←⊣	Sitelu-na	Wedged-reduction
	∨/∧	Ma-ọbụ/Na	Disjunction/conjunction
	~	Ọbụghị	Negation
	↕ (iff)	Belụ-sọ	If and only if
	⊢	Detuo	Provable/derivable
	⊨	Mezuo	Satisfiability
	≯	Anọghị	Opposition
	≠	Esoghị	Inconsistency
	⊭	Emezughị	Not satisfiable
	≅	Isoghị	Contraries

12	⊬	Edetughị	Not Provable/derivable
19	⊣	Zutuo	Deducible
10	⊭	Ezutughị	Not deducible

3. Agụsị- Agụsị (Agụkata -Agba – Awaa) : The Idea of Infinity in African Number System

Once upon a time in the Ibo country, the moon was dim and the stars lit up the sky in great numbers; an elder spoke to a youth "son, look up into the sky, can you see the stars? And when the youth answered yes, he asked him to number them. Thus the youth began, otu, abụọ, atọ, anọ, ise, isii, asaa, asatọ, itenanị, iri, …otu naari, puku abụọ, nde-atọ, ijeri-anọ, nzeri-ise…nzeri – nzeri- nzeri … the youth stopped and the elder asked: are you finished? When the youth answered yes, the elder asked again; how many are they? And the youth responded, "agụkata-agba-awaa" which literarily means "counting till the jaw breaks" and figuratively "numerable-innumerability" or "countably –uncountable" hence the concept of agụsị-agụsị. These explain the idea of infinity in African numeric system. It is not that imaginary number series which is endless or limitless or unknown; on the contrary, the infinite for Africans is that idea of numbers which though countable in itself cannot possibly be counted by man. So it is in itself countable but which no man can count. Any man who attempts such a project would surely fail because his jaw would break thereby preventing him from completing the project. The analogy above shows two things that the stars are countable but that man cannot do this.

The Western idea of infinity which translates to the concept of agwụ-agwụ (endlessly endless) is different from agụsị-agụsị (countably uncountable) which depicts the African idea of infinity. In African thought, numbers are not different from the things they are predicated upon. All the numbers in existence are in one-to-one

correspondence with all the things in existence. In other words, numbers have equal cardinality with things. This is to say that for the set whose elements are all the known numbers and the set whose elements are all the known things; the elements of the two sets can be paired off without remainders. So it is not the case that one set has the next cardinality greater than the other. We may have the set whose elements are unknown numbers, and the set whose elements are unknown things, yet the two are necessarily of equal cardinality.

From the forgoing, we arrive at four different sets, two for numbers and two for things. Out of these, one of the two sets of numbers and things is known while the other is unknown. The question that arises here is; does the set of known numbers for example have equal cardinality with the set of unknown things? The answer is no! But this does not mean as it should be in the Western idea of infinity that the set of unknown things has the next cardinality greater than the set of known numbers. In African thought, this could go either way; as a matter of fact, there is no way of knowing which has the greater cardinality, we may tag this "the problem of cardinal indeterminacy". What this also shows is that the two sets could possibly have equal cardinality-this is also against the idea of infinity in western thought.

It is important to explain here that even the unknown sets are countable. The fact that it is not known to man does not change anything. Numbers do not exist if there are no things to predicate them upon. Numbers in African thought are numbers of things. The only set that cannot be numbered is the empty set, but the empty set does not exist in African thought because there are always things[5]. We cannot even imagine it because we cannot imagine nothingness!

There is a way Africans express infinity that is strict. For example they do not say "there are infinite properties" to depict the attribute

[5] cf. Jonathan Chimakonam Okeke. "An Investigation into the Nature of Mathematical Meaning". *Filosofia Theoretica*…1.1, 2011. P. 2 - 4

of agwụ-agwụ (endlessly endless) as it is in Western thought; this is called categorimatic expression of infinity. Africans however say, “there are infinitely many properties”, to depict the attribute of agụsị-agụsị (countably uncountable), this is called syncategorimatic expression of infinity. In the latter idea, the set of unknown things is perfectly countable in itself even though it is uncountable to the man who does not know it. If a man named Madume fills up a sack with kolanuts which he has carefully counted, the set of kolanuts in the sack would be unknown to say, Emenike who has not counted it. However, that it is unknown to Emenike does not mean that the set of kolanuts in the sack is (a) infinite (b) innumerable (c) has no equal cardinality with the set of any known numbers.

On the contrary what it means is that (a) it is uncountable to Emenike who does not know the set of kolanuts in the sack. In this work we have chosen to call this anti-categorimatic (relative) expression of infinity where what is countable to one man is relatively uncountable to another man. We call another expression of infinity possible or non-categorimatic (absolute) if there exists a set of unknown things which are uncountable to the set of all men but countable to the set of all non-men. The idea here is that if a set of things exists but which is unknown to all men, it is nonetheless countable to entities other than men in-so-far as it exists. So such a set of unknown things may be possibly infinite to men but not actually so in itself. Thus the non-categorimatic (absolute) is an inferential extension drawn from the anti-categorimatic (relative) expression of infinity.

In African thought we also say:

ㄱ ↔ ㄱ thing

ㄱ ↔ ㄱ things

ㅿ ↔ ㅿ things

…n↔ n things, where the unknown number n has equal cardinality with unknown things, called n things. This shows that the set of

unknown things is in one-to-one correspondence with the set of unknown numbers. Thus, for every unknown thing in the set, there corresponds an unknown number in the other set. In this way, it is possible to pair off every element in the set of unknown things with the elements in the set of unknown numbers without remainders. In other words, none of the two unknown sets could possibly have greater credibility than the other.