ETHNOMATHEMATICS AND CONCEPT OF ZERO IN IGBO TRADITIONAL NUMERACY


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ETHNOMATHEMATICS AND CONCEPT OF ZERO IN IGBO TRADITIONAL NUMERACY

INAUGURAL LECTURE DELIVERED BY

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November 15, 2023

DEDICATION

This lecture is dedicated to;

His Excellency Most Rev Dr Michael Ugwuja Eneja
(3^{rd} Catholic Bishop of Enugu Diocese)
and
Chief Mrs. Nwanome Christiana Ozofor
(my mother)
and
Nono Nneozor Victoria Nwani
(my sister).

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INTRODUCTION

When the evolution of the natural phenomenon appears unscriptible, then the chart of human kind becomes incomprehensible. Then the encompass of the chart remains dimensionless. At this point only one thing remained comprehensible and that forms a force which pushes man to pursue good, face it, while evil flies away to give the man peace (Natural principle: *Bonum facendum et procequendum et malum vitandum*). But the pursuance of this good goal is not always smooth and safe (Harbour-Peters 2004). But the great philosopher Creto observed that the man's ingress is through naked and bare, the progress through trouble and care while the egress must be no body knows when (known, unknown theory). But the mathematical conclusions of this dictum is sure, if we do well here we will do well there. We are also sure that whatever one conceives and believes in this world, that the person will achieve. Moreso we are sure of the words of the sages that no true progress without problems. For Louis Maria De Montfort (the Saint) no pain, no palm; no gall, no glory; no thorn, no throne and no cross no crown. Things of the world are in pairs (ihe di n'ibo, n'ibo). The old adage, *nihil mutaribus dato sine labore* (nothing without labour) suffices.

When somebody gives a little bit of something to others, and others give a little bit of it, then a compromise is struck. This compromise is the hallmark of a progressive society which every professor wishes to observe, engineer and encourage. When this compromise settles a score of social conflict be it in education, politics or economics, then the professor can then raise his or her hands up and shout like Archimedes Eureka! Eureka!! Eureka!!! (I found it). Today, as a professor I thank God, I have found it. Inquirers may ask, found what? But active observers would reply that PROF. NDIDI OZOFOR has found happiness in some aspects of the teaching, learning and reducing mathematics abstractions into concrete evidence for a proper growth of man. From 2009 I have been working in the University, I served, and am still serving as a mathematics and statistics clinic to different people at different levels.

From century to century and from generations to generations many scientists thought about, and made frantic efforts in defining or rather explaining what mathematics is or what it ought to be. Some saw it as a process of determining quantities and or estimating values (Diophantus, 630AD, Format 1818, Rolle 1850) in Ozofor (2002).

Others explained it as a science of space and number and viewed it's broadness as necessarily large and unrestricting (Descorate 1920, Kepling 1925) in Ozofor (2007).

Some astronomers and earth scientists felt that the subject mathematics deals with the properties of projectorics, forecasting, predicting, formatting, measuring dissecting, counting, relationship and gesticulation of matter in where ever place and position they appear (Alven 1951, Appolo 1969, Collins 1970) in Ozofor (2002).

Yet some others believed that mathematics is a scientific art of initiating changes in space using quantities of varied cultures. This art of changing involves transformations, combinations, connections, projections, oppositions, transpositions and cancellations, in relations and non-relations. (Mohammed of Khowariz 415AD, Boole 1910, Elgisten 1946) in Ozofor (2014). Looking at the spectrum of mathematics and its roles in scientific development the author is convinced that the last explanation seems the one that is closely related to what mathematics ought to be. Many scholars believe that the role played by mathematics makes the subject a pivot of other sciences or the gateway for other study areas in life beginning with philosophy and ending at the new genetic engineering and nano technology.

Mathematics is viewed as unending activities without restrictions. All the interrelationships and combination of ideas for decisions as involved in an adult functional life and his / her practical use of numbers for domestic and business endeavours are aspects of his mathematical knowledge. Children as well as adults, working independently as well as in-group are mathematically encouraged by nature to experiment, to measure, to guess, to feel their way and conjuncture. The life in mathematics encourages one to refute and to play, so as to gain mathematical knowledge and acquire attitudes, modes of thought and working forms such as curiosity and problem solving ability. Mathematical conjectures obtained by induction from a number of instances, are accepted just as results obtained by deduction and proof. This is the nature of mathematics.

Mathematics as a culture has afforded man the opportunity to know and assess things and objects within his immediate and remote environment (ethnomathematics). A disciplined and ordered pattern of life is gained through the culture of mathematics. The usefulness of repeated observations in making inquires, the hypothetical format in relating with people, and in linking one idea to another are all aspect of mathematical communication of human culture. Approaching problems through short cuts,' applying precise models in solving human problems and identifying simple, concise ideas, a pool of ideas and ideologies is purely mathematical. The man's ability to graduate from a random thought process, trial and error method, guess work approach of solving problems to a systematic, objective oriented and analytic procedure of problems solving in the modern times is evident that mathematics is communicating the culture of man.“*** where is the Evidence”

From the evolution of science in the 18th century mathematics has evolved from disjointed study of natural phenomena like in earth measure (Geometry), trianglic measure (trigonometry), the study of heavenly bodies (astrology), science of life uncertainties (probability), study of relationship or mapping (functions), to themes involving projectorics, space functions and spatial constructions and utilities of numbers.

Today in the 21st Century, mathematics has become the Central focus of all-scientific investigations and studies. Mathematics is the only language of culture common to all studies involving human developments.

It was observed that ethnomathematics is no other than the mathematics of the indigenous cultural group. This type of mathematics includes the mathematics of the non-literate people. It is used to express the relationship between culture and mathematics. This type of mathematics according to the father of ethnomathematics exposes such mathematical activities of counting, measuring, explaining, comparing, classifying, playing and in a particular cultural environment. Ethnomathematics takes into account the cultural background of the learner, the experiences, which the learner brought to school. It's based on what the learner already know (his past experience) and builds the present thereby blending the past and present to build the future. It makes mathematics functional and relevant to the students particularly of the third world countries. It exposes the fact that every country has their own mathematics but no mathematics of any cultural group is perfect. Each cultural group borrows something from another cultural for better development. The literature reviewed addressed that Igbos have their own cultural mathematics which must not be relegated to the background. This is because their cultural mathematics is not only dear to them but that it is their way of conquering their environment thereby causing a better relationship. In ethnomathematics activities both males and females members of cultural group manifest their different ways of carrying out those mathematical activities which are exposed in their dedication and interest as manifested in those activities. Their achievements are seen in their fine product of arts, style, design of pattern and craftworks.

Zero is an important number in mathematics, even though it represent a quantity of nothing! Zero is a placeholder in number series or field of numbers. In whole and decimal numbers, zero represents a place with no amount or quantity. It is called null meaning nothing, empty or null. It can also be called disambiguation. Zero is in the mind but not in the sensory world. This is because one can do anything with a zero, it adds no value.

When we multiply any number with zero, the result is always zero: 5x0 = 0, 10x0 = 0. Also if we divide any number by zero, the result is undefined and taking as zero. 55/0 = undefined in arithmetic is relatively zero is a placeholder and symbol for representing nothing an absence of values.

If zero (0) is raised to the power of any number, then the result becomes unity or I. The square of zero is zero, $0^2 = 0$. The square-root of zero (0) is also zero: $\sqrt{0} = 0$. Zero activity means no activity. Mathematicians and mathematics educators believe that anything associated to zero has no importance. An Indian Mathematician, Brahmagupta applied zero in his mathematical operations in 628BC. He used zero when he wants a number to remain itself; like 5+0 = 5; 5–0 = 5. Just to hold a place, (Ndidi Ozofor (2002),).

Mohammed Ibn-Musa Al-Jgwaruzmi the father of algebra invented zero while solving algebraic equations in the 5th century.

Mathematics in Everyday Life

Mathematics is a methodical application of matter. Mathematics makes our life orderly and prevents chaos. Certain qualities nurtured by mathematics are:

i. Power of reasoning
ii. Creativity
iii. Abstract or Spacial Thinking
iv. Critical Thinking
v. Problem Solving Ability and Even
vi. Effective Communications

Mathematics is the cradle of creations without which the world cannot move an inch. Be it a cook or farmer, carpenter or mechanic, a shopkeeper or a doctor, an engineer or scientist, a musician or a magician, everyone needs mathematics in his day to day life. Even insect uses mathematics in their everyday life for existence (Canaghe Theory). Snails make their shells; spiders design their webs and bees build hexagonal combs. There are countless examples of mathematical patterns in nature's fabric.

In some homes, people decorate their parlours with mathematical shapes like parabolas and hyperbolas. The kitchen is dense with 3-dimensional shapes that speak of capacity and volumes. Adults; men and women make effective use of calculators in buying and selling in the markets, yet they hate mathematics. Almost every person uses hand phones making use of numbers for dialing people. Motor mechanics or Auto-technicians utilize mathematics a lot but they say they like mechanics without mathematics.

Do you know that if you stretch your two hands and clasp them: if they do not match exactly, it means you are symmetrically deformed?

The Nigerian child will express hatred to the subject mathematics, yet you can't cheat him in trading (buying and selling). If I can develop a type of mathematics titled “Naira mathematics”, many Nigerian students will like mathematics. However, this type of math will be narrow indeed.

In fact no one has any reason to be afraid of the subject at the basic level because anyone who can carry out the four mathematical operations: +, -, × and ÷, can be a basic mathematician. This is because in any level of mathematics learning, these operations are utilized in one form or the other.

The utilitarian values of mathematics are well known and appreciated by Nigerians, yet there is this level of insipidity and withdrawal attitude towards it. Hence Nigerian students, parents principals or even respected academics and officials still employ every means, even unethical means to pass mathematics at WAEC and NECO levels.

Anyone can be a mathematician if one is given proper guidance and training in the formative period of one's life. A good curriculum of mathematics is helpful in effective teaching and learning of the subject.

Experience has shown that learning mathematics can be made easier and enjoyable if our curriculum includes mathematics activities and games. Mathematics puzzles and riddles encourage and attract an open-minded attitude among youngsters and help them develop clarity in their thinking. Emphasis should be laid on developments of clear concepts in mathematics in a child, right from the primary classes.

Associational learning involves the development of associative chains or mental pattern by which facts, information and experiences are retained, recalled and recognized through the process of linking them together or establishing relationship between or among them. And the appreciational learning situation involves the process of acquiring attitudes, ideals, satisfactions, judgment and knowledge concerning values.

In evaluating language in terms of mathematical symbols and development of human mind and human thought processes, Egenu (1988) said that language has been described as an arbitrary code of symbols by which people communicate with each other, interact and cooperate. Language is vital to the development of the human mind and the thought processes, for without language there would be no thought and without thought there would be no human mind. This nature of language is that which mathematics offered to the modern society as language of nature.

Some Aspects of Mathematical Communications

One of the major objectives of schools mathematics is to enhance the understanding of basic concepts, principles and laws of mathematics to foster an attitude that can encourage the use of mathematics in application to daily life problems; to cultivate mathematics thinking, precise and logical reasoning (UNESCO, 1990). The use of photography and pictograms in mathematics textbooks of our school not only enhances aesthetic utility of mathematics but also serve as a powerful means of communication. It is especially useful in visualizations in spatial geometry and at times might even be helpful in the presentation of some unusual algorithms. According to Zawadowski (1992) it is easier to introduce and explain mathematics once a problem is clearly visualized by photography. The use of words to describe spatial relations is clumsy; a photography gives an impression of something authentic or real even if it is infact an abstract construct of the viewer. Such an approach could also be helpful in arguing for instance that the usual analytic definition given on the plane is equivalent to the spatial one, using planecuts of cylinder by Nandelin's spheres.

In the early 1970s education world over experience the apogee of modern mathematics teaching and learning. This was characterized by the wish to build school mathematics on the solid foundations of sets and on systematic logical education, spelling out all the details explicitly and giving the receiver little room for his own intention but today there is now a growing number of teachers and educators of a post – modern persuasion. Here post modern implies less emphasis on formal vigour, more on visual representation and the overt use of pictures in communicating mathematics. Post modern school mathematics is much more linked to personal experiences (Zawadowski, 1992). The inclusion of computer science programs and computer aided instructions in the teaching and learning of mathematics made the application of mathematics in today's world a viable means of communication in social engineering. This new approach to the utility of mathematical concepts makes mathematics qua tale the basic language for development of the human society in the technological age. In discussing the agenda of the school mathematics for the 3rd millennium, the National Council of Teachers of Mathematics of the USA, NCTM (1980) said that problems solving should be the focus of mathematics learning. Moreso, that the concept of basic skills in mathematics must encompass more than computational facility. That it must involve a wider range of measure than conventional modes of calculating, proving constructing graphs and engaging in measurations. It must get into high level of professionalism, solving individuals as well as society's problems in an efficient flexible and dynamic manner.

The 3rd millennium calls for a desire to emphasize the structural aspects of mathematics to follow the economic plans and policies of international organizations like the Organization of Europe Economic Co-operation (OEEC) the Economic Community for West African States (ECOWAS), North Atlantic Treaty Organization (NATO) and *et cetera*.

ETHNOMATHEMATICS

Ethnomathematics is seen generally as a broad cluster of ideas ranging from distinct, numerical and mathematical systems to multicultural mathematics education, Knijin (2000). The goal is to contribute both to the understanding of culture and the understanding of mathematics and can lead to the appreciation of the connections between them. Some see it as the mathematics of peoples' culture. Some yet see it as an association or function of Mathematics and culture.

There are six importance dimensions of ethno-mathematics. They are Cognitive, Conceptual, Educational, epistemological, historical and political.

It is the mathematics practiced among identifiable cultural groups in their sociocultural plane (of place and time).

Examples could be in examination of ratio patterns and symmetry in Japan origami, logic of kin relations (in Australia), chance and strategy games and puzzles from Native America, Symmetric Strip decorations Incan and Maori cultures, Ncho in Igbo culture, use of deck of cards amongst the British cultures, etc. (See Appendices).

Several methods of teaching these core school subjects are in use today which include: Socrates (question – answer), Discovery, Expository, Rote and Memorization, Laboratory, Project, programmed instruction, target – task, delayed formalization, and the computer Aided instruction with its models of Drill and practice, problem solving, simulation, Games and Tutorial. All these has its merits and demerits. In selecting any method of teaching for the classroom business, Okafor, (1984) emphasized that the only method which is good enough for the modern child is that which is progressive, positive, and open. It is that which is child – centred, because, since experience is conceived of as the interaction (the doing and undergoing) between the organism (his needs, desires, purposes, and capabilities) with his environment, learning is to be achieved within the open phenomenon of interaction. Learning must involve action. It must involve doing thing.

In discussing the methodological aspect of mathematics and science based subjects in German school system, Berker (1979) emphasized that the method of instruction should include many different activities for the student. The teacher should encourage self-activity and self determination (freework) by the student, learning by play activities, by working on problems and learning by discovery or through project work. The projects for activities should be multifaceted. And according to Munrigner (1977) and Grauman (1977), the modern German education is one whose methodology is defined by project activity, praxis orientierter (practical oriented) and the anwenduohorientierter (application oriented) methods.

The traditional teaching methodology in mathematics emphasized the authority of the teacher and the importance of the teachers function and activity in the selection, organization and presentation of the subject matter to the pupils in sequential format. The new methods: problem solving, Target – Task, Laboratory, programmed instruction and computer Aided instruction are sometimes called Activity technique and do take different approach depending on the subject to be taught. They place emphasis not on the activity of the teacher and his authority, but on the activity of the pupils or students. The teacher must no longer assume a supereminent position in the classroom situation. He becomes just a member of the class (although a more mature and more experienced member) in a problem solving arena. His role in this context becomes that of an adviser, a helper, a director, guide, a motivator and a facilitator. The problems to be worked on are not selected solely by the teacher. The pupils participate in such selection and it is to be done in response to the felt needs of the students.

According to Okafor (1981), the factor of felt need is important because thinking and learning are stimulated to the optimum when the individual perceives that through the activity, his objectives will be satisfied and his needs fulfilled. Hence, the child is to feel free to choose his own task according to his own impulses. In this way, the child will find joy and satisfaction in learning. In the words of Demiaskevich (1935), the progressive education method is.

Opposed to the general method of education which places emphasis upon sequential curricula. In place of such a general education method, the activity movement recommends as the only sound method of learning and teaching that of joyous, spontaneous activity on the part of the educand.

Okafor (1984), pointed that the students are active both in the selection of the task and its execution. They are active participants in the pursuit of their studies instead of being passive onlookers waiting for some authority (the teacher) to impose items, information upon them.

With regards to students who engaged in a project, the report on progressive education methods in USA stated that, in such situation, the children learn to work with one another as well as with the school community. They learn about life by studying life itself. The things which surround them and affect them are the things they learn first. Hence in the project method as in others, the emphasis is placed on learning by doing. It is a sort of cyclic process in which the child learns by what he does in order to do what he learns. This is in keeping with the philosophy of experience, and its basic epistemological implication.

The teacher must try to discover the students interest and needs in order to channel them into the learning experience so as to make learning purposeful, stimulating and rewarding for the youngster.

The USA report on progressive education methods said:

In school programs of the newer type,

Teachers strive to discover pupils / students interests and to use them in stimulating and directing learning. It is as natural for children to be curious, to ask questions, to try out things, and to seek to know, as it is for them to get hungry, or tired or sleepy. If they lose this basic learning characteristic, it is a sign that they are not well or that they have been badly educated. Modern schools are concerned with how children learn, they strive to preserve and to enhance in each individual the joy of learning. Such joy and enthusiasm for learning involve the disposition to ask questions and seek competent answer (Ozofor, 2005).

In his comment, Okafor (1981) emphasized that the child centered orientation of mathematics education also implies that not only his interest and needs should be primary factors, but also his other fundamental dispositions namely: the child special abilities, his aptitudes and talents. The good teaching must discover these and orient learning experiences accordingly.

The child should be guided to discover his own truth and to test its validity in the open domain of experience. He is to be disposed in such a way as to be prepared to dump his truth as soon as it ceases to work. This process of learning by doing is to replace mechanical memorization and the traditional lecture method of learning by instruction. Where textbooks are used, the traditional approach of using just one text or reference is not adequate for the progressive educator in a progressive education. The student must be prepared to use a wide variety of sources and must be disposed to test the validity and reliability of the pieces of information provided by the sources.

Role of Mathematics

Considering the role of mathematics for the new millennium, the Federal Republic of Germany decreed in August 1972 that mathematics in schools should provoke three reactions: first project orientierter mathematickum (project oriented mathematics), this should be characterized by interdisciplinary subjects and students self determination of themes, and methods in relation to the everyday word (Munrigner 1977). The second is prasis orientierter mathematickum (practically oriented mathematics). This emphasizes the use of mathematics as a tool for everyday life and as a method of solving real life situations (Grumman 1977). The third reaction is anwenduoh orientierter. The aim of this mathematics learning is individual's prominence. Its relevance is the applications of relationships with the environment and the use of computer science.

This German mathematics programme was exactly what Nigeria's mathematics curriculum planners designed in the 6-3-3-4 education system of the 1980s for the 21^{st} century mathematics, objective of mathematics study, which is practical, applicational and project oriented with thematic instructional approach. In Italy the story is the same, the mathematics of the 3^{rd} millennium is one with the growing influence of society, essentially based on the use of machines. Montaldo (1992).

Now is the era of the computer when society relies very heavily on information, using those most precious of human resources, the individual conscience intelligence and creative capacity. People use computer as providing a strong stimulus especially for interdisciplinary work. In the Scandinavian countries of Poland and Denmark mathematics has turned a viable tool for social engineering and high level development in the society. On this, Niss (1992) said that mathematics in the new millennium is highly meaningful in a social context and within some kind of structural and institutional framework.

Mathematical Analysis for the Modern Society

The needs of science and industry in a deeper understanding and exploration of phenomena of nature led to the investigation of processes and motions in the real world. This development was first of all connected with studying physical phenomena, since their quantitative nature of describing interrelations between the variations of the quantities evolved (Bermant, 1975). The main objective of mathematical analysis is the study of variables and their relationship. This is closely related to the study made by Descarte (1927) of relationships between algebraic and geometric methods in analytic geometry. It is also connected to the mathematical analysis of differential and integral calculus.

The fundamental idea of mathematical analysis is centered around the concept of functions of variables or the relationships of variables or the mapping of variables. It is in this function that the language of mathematics is found. The basic concept that explains this function is magnitude. According to Aramanovich (1975), "we regard as scalar magnitude everything that can be measured and expressed by a number." In concrete problems of natural, technical, and behavioral sciences we encounter magnitude of different types. For instance, scalar magnitudes are length, area, volume, mass, temperature and so on. Mathematics communicates on vector quantities such as force, velocity, acceleration, (that which makes an objection rest or move or stops object retardation and so on). This language begins in stating mathematical propositions magnitude involved are abstracted while the numerical values and laws of the concrete physical nature of the values are considered. According to Bermant (1975) mathematics deals with a general notion of a magnitude without considering its physical meaning. This fundamental feature of mathematics abstractness is extremely important since it makes it possible to apply mathematical methods to various kinds of activity and phenomena and provides its generality and universality. The abstractness of mathematics is a powerful tool in practical work and has nothing in common with the indifference to reality.

Within the context of a problem, some magnitude changes while others remain invariable. Those that change are said to assume different numerical values called variables. And those invariable magnitudes retain one and the same value and therefore are called constants. But variation is one of the most important features characterizing a motion or a process. An industrial process (a natural phenomenon) is usually observed as a variation of some magnitudes involved which is produced by the change of the others. Let us take some instances. If the volume of a mass of gas kept at a constant temperature varies its pressure also undergoes a variation. Also in a free fall of a body (in Vacuum) under the action of gravity we observe the variation the velocity of motion as the distance between the body and its initial position changes and also the variation of this distance and of the velocity of motion in time. At the same time the acceleration of gravity remains constant at any time moment along the whole path. From quantitative point of view, every process is characterized by a mutual variation of a number of magnitudes. This leads to the most important mathematical concept of a functional relationship ie to the idea of an interconnection between variables. According to Vygosky (1968) the main purpose of a natural or technical science is to establish the relationships between the variables involved in the process under consideration and to describe it mathematically. In his own analysis, Aramanovich (1975) believed that the law of a process is nothing but a functional relationship observed in this process and characterizing it. For instance, the functional relationship between the pressure (p) and the volume (v) of a mass of gas having a constant temperature is described by the equality P = K where $\frac{X}{V}$ is a constant and expresses the general law which the gases obey in the corresponding circumstances. The law can be verbally stated as: the gas pressure at a constant temperature inversely proportional to the volume. Moreso, the functional relationship between the path or length(s) covered by a freely falling body in vacuum and the time taken (t) is described by the formula $S = 1/2gt^2$ where g is the acceleration of gravity and expresses the general law of r fall. Hence the basic and most important aim of mathematical analysis is to provide a thorough investigation of functional relationships (ie ethnomathematics).

Teachers'/Instructors' Basic Competences in Ethno Mathematics
For child-centered / Activity method. The idea and successful teacher should:

i. Know his subject that is be an expert in his own field.

ii. Be thoroughly acquainted with the textbook being used as well as the teachers manual accompanying it.

iii. Demonstrate, illustrate and explain step by step every thing students are to learn.

iv. Be able to exercise unusual patience and understanding especially in the early stages of skill development, thereby reducing tension and frustration.

v. Insist on and hold students to good work habits.

vi. Give a concrete example of real life situation for any concept you want to teach.

vii. Set a reasonable, attainable goals for each student.

As soon as individual goals are reached, set new challenges, which will provide incentive to continue working.

Keep abreast current trends, method, materials, and technological advances by reading professional journals, joining professional organizations and participating in service training programs periodically.

At this point we need invoke the embellished thought of one of the finest philosophers and educationists of our time very Rev. Msgr. (Prof) Festus Okafor in his work on methodology of openness for a progressive education. Hence in Okafor (1983) the progressive education holds that there should be no indoctrination in the educative process. Here indoctrination refers to the closing of the mind to alternatives and to divergent thinking in any given issue or situation. It refers to what Dewey (1950) calls “a mere authoritative dictation”. It does not however refer to an exposition or openness to the concrete contingencies of learning perceptible in a particular culture and environment with its characteristic values and heritage. The youngster is not to be compelled to accept statements solely on magister dixit (on the authority of the teacher).

Instead of indoctrination, the pupil is trained in the method of critical thinking or the method of intelligence, which goes with creativity. This again is the method of problem solving by which the youngster is trained in data assembly and analysis as they relate to any given problem or issue. With the mastery of the skills for collecting and analyzing data in the problem area, he will be able to put to the test of critical intelligence the values and beliefs presented to him. He must be in position to raise the necessary questions as he sees fit.

There should be no dogmatism, no authoritarianism, no extraneous impositions; no truths not open to questions and to scrutiny in the public forum of experience. This is the ethno based teaching of mathematics.

Since ethnomathematics involves peoples culture in their naturally setting and in their day-to-day life, it is necessary therefore to expedient to analyze mathematics as a language of nature.

Analysis of Mathematics as a Natural Language

In analyzing mathematics as a language of nature, the author wishes to call up the relevance of mathematical models in doing a multiple work in the modern times. Real mathematics teachers especially at the post primary school level are always in search of interesting ways of showing the use of mathematics or how the knowledge of school mathematics is applied. This is often done in order to infuse the feelings of real – world relevance into the subject – mathematics. According to Williams (1971), very simple applications, especially if they are novel or varied in their scope, are a strong aid to a teacher in maintaining interest among students who do pursue careers in mathematics, engineering, or physical and computer sciences. As a matter of fact, many interesting and easy to follow applications of plane geometry and plane trigonometry are used by practicing plastic and re-constructive surgeons in their medical practices. According to a medical consultant Fleming (1971), "I would like to pass on a few "Scar revision" techniques that have come to my attention in the hope that the reader will find them interesting and unique addition to his or her repertoire of motivational materials used in the mathematics classrooms. We shall discuss as our first example the use of mathematical models in plastic surgery. Here the only necessary background for following the procedures here is an indept understanding of right-triangle trigonometry.

Let us therefore produce the mathematics models as they appear in medicine and surgery.

The Z – Plasty Revision

Frequently scars occur on areas of the body in such a way that the underlying muscle – tissue structure in that area creates tension along the line or axis of the scar. Causing the scar tissue to puff up and discolor. Examples of this type of scar are burn scars, vertical lacerations on the back of the neck, or scars on the inside or outside of the bend of the elbow or knee. The plastic surgeon, in revising such scars, desires to exercise the old scar tissue and suture the surrounding skin back together in such a way as to relieve the tension along the axis of the old scar. A technique called the "Z – plasty revision" is often used for this purpose and is an interesting application of simple plane geometry and trigonometry.

Suppose that AB is an unsightly scar such that the underlying muscle structure caused tension forces on the scar directed along AB, as shown in figure I.

The old scar tissue is exercised, and incisions AC and BD

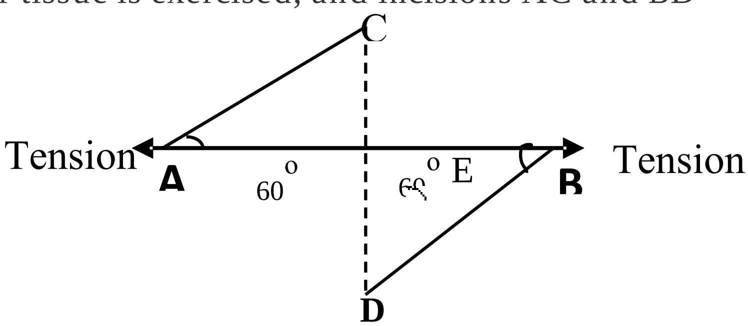


Fig. 1

Source: Z-Plasty Start Pearls (NCBI Science)

are made such that angle CAB and angle ABD are each approximately 60°, CD is perpendicular to AB, and E is the midpoint of AB. There will then be two flaps of skin CAB. In suturing the flaps back together a transposition of the flaps is made. Tip A is moved (or stretched) over to point D, and the upper edge of AB is sutured along DB. Tip B is moved over to point C, and the lower edge of DB and AC are seven together. The resulting configuration is as shown in figure 2, where the unprimed letters refer to the points as shown in figure 1 and the primed letter refer to the transformed positions of points.

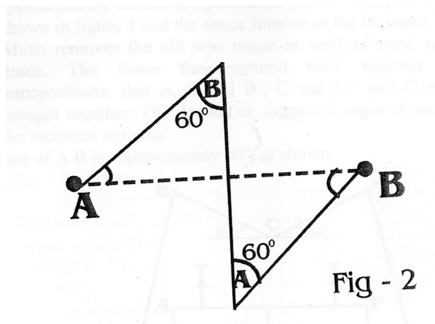


Fig. 2

Source: Scar Revision: Z-Plasty MNittany-Health

If the operation is properly performed, the angles at A' and B' will remain approximately 60° (perhaps slightly more due to stretching) and segment AC and BD will remain approximately the same length as prior to the operation.

In figure 1, AB = AC =BD. In figure 2,

$AE = AC \sin 60^o = \frac{3}{2}\ AC$ and

$EB = BD \sin 60o = \frac{3}{2}\ BD$

$AB = AE + EB = \frac{3}{2}\ AC + \frac{3}{2}\ BD$

$= 3\ AC = 1.73\ AC$

The distance between A and B is altered by this operation by a factor of approximately 17.3% increase.

The beneficial effects of this procedure on a patient are derived from essentially three features.

1. The old scar tissue excised and the skin tissue is carefully and skillfully rejoined.

2. As is shown is figure 2, the revised scars do not run parallel to the muscle tension lines but rather are oblique to them, thus allowing

the skin in the area to give or relax with the tension exerted by the muscle structure.

3. The distance between A and B has increased, thus relieving some of the tension from A and B physiologically, the trick that has been used to achieve this effect to borrow skin tissue from the vertical direction, where there is minimal muscle tension, and to re-channel this borrowed tissue to the horizontal direction, where tension is maximal.

For long Scars of this type, a multiple Z – revision is frequently used. The procedure is illustrated in figure 3. It can be seen that this procedure consists of a sequence of Z – plasty incisions as illustrated in figures 1 and

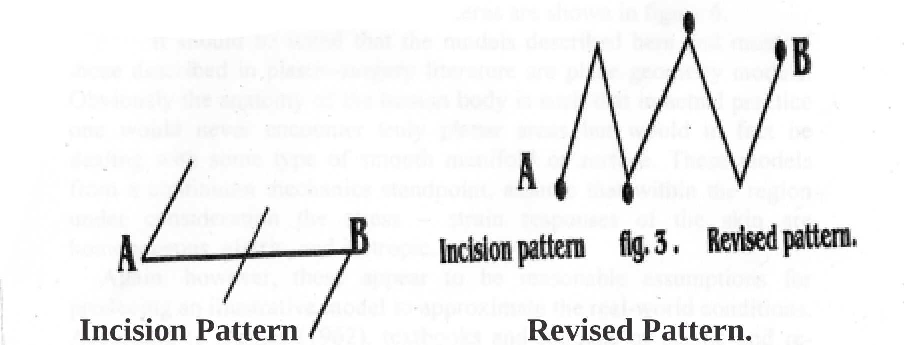


Fig. 3

Source: Verywell health.com

The W – Plasty Revision

There are other Scars encountered that are unsightly because the underlying muscle – tissue structure causes tension forces perpendicular to the line of the Scar. This caused spreading and discoloration. Examples of this are horizontal cheek Scars and vertical forehead Scars. A "W – plasty revision" is frequently used effectively to improve such a situation.

If AP is a Scar with muscle – tension forces T directed approximately normal (perpendicular) to AP, incisions are excised, which removes the old scar tissue as well as some surrounding tissue. The tissue then sutured back together with no transpositions; that is, B and B^1, C and C^1, and D and D^1, are brought together. The desired or suggested angle of inclination of the incisions with the line of AB is approximately 60^o, as shown.

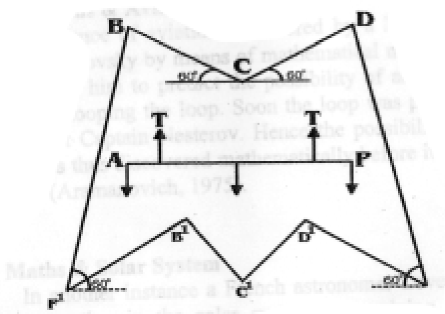


Fig: 4

Source: Z-Plasty Science Direct

The revised Scar is as shown in figure 5. The beneficial effects on the patient of this procedure are:

1. The revised Scar exhibits an "accordion effect" because it provides sufficient resiliency to absorb normal tensions.

2. At any point Q on the revised Scar of figure 5, the component N of the tension force T which is normal to the revised Scar is now

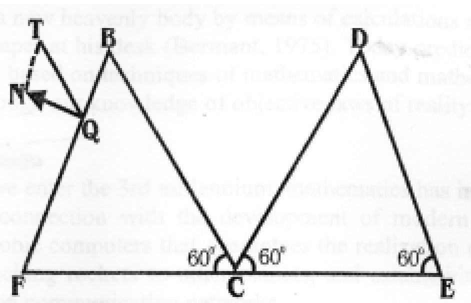


Fig. 5

Source: Scar Revision Sciencedirect.com

This may be compared to figure 4, in which the tension force normal to the Scar at any point was T. Thus a reduction of approximately 50% in normal tension forces on the Scar has been achieved through the use of this procedure.

For revision of long thin Scars, the W plasty is often used in sequence (as in the case with the Z plasty), creating a string of Ws in the final result.

Other Revisions

Several other Scar revision patterns are suggested in textbooks on the subject; however, they are not used with much frequency. None of these involve transpositions as the Z plasty. They are thus similar in nature to the W-plasty. Three such patterns are shown in figure 6.

It should be noted that the models described here and most of those described in plastic-surgery literature are plane geometry models. Obviously the anatomy of the human body is such that in actual practice one would never encounter truly planar areas but would in fact be dealing with some type of smooth manifold or surface. These models form a continuum mechanics standpoint, assume that within the region under consideration the stress – strain responses of the skin are homogeneous, elastic, and isotropic.

Again, however, these appear to be reasonable assumptions for producing an illustrative model to approximate the real – world conditions. According to Borges (1962), journals of plastic and re-constructive surge often show both preoperative and postoperative photographs of clinical procedures of the types described, confirming in most cases very dramatic and pleasing results from these techniques. And it is important to note that Furnas (1965) has suggested the use of three dimensional Z-plasty procedures and has outlined the underlying geometry as well as the clinical significance of such procedures.

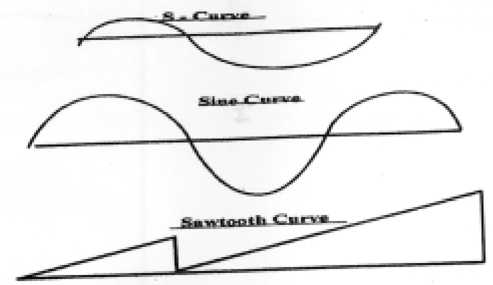


Fig. 6
Source: Scar Revision Sciencedirect.com

Mathematics and Aviation

The Science of aviation discovered by a Russian Scientist, Professor Zhukovsky by means of mathematical methods and laws which enabled him to predict the possibility of aerobatics and in particular of looping the loop. Soon the loop was performed by a Russian pilot Captain Nesterov. Hence the possibility of looping the loop was thus discovered mathematically before it was realized physically (Aramanovich, 1975). It is now used in computer operations.

Mathematics and Solar System

In another instance a French astronomer Leverrier studied planetary motion in the solar system by applying the laws of classical – mechanics expressed in the form of some known functional relationships. He discovered a discrepancy between the theoretical results and real observation. He then discovered that the planet processing a certain mass and moving in a certain orbit is assumed.

Soon this new planet (Neptune) was in fact found in 1846, exactly the time and position predicted by Leverrier who thus discovered a new heavenly body by means of calculations made on a piece of paper at his desk (Bermant, 1975). Today predictions in sciences are based on techniques of mathematics and mathematical analysis through our knowledge of objective laws of reality.

Harmony of Spheres

Life is a mathematical mystery. There is correspondence between the workings of our minds and the workings of nature. The mathematical principle known as Pythagorean theory of spheres has it that people do not just die like that kpum, no, they die minute by minute, day by day by little uncaring ways. People die by serious distortion of their environments. So when one distorts the harmony of his/her environments he/she becomes sick. Think about it. If you have been having money in your pocket and suddenly you have no money in your pocket, you become sick automatically. Consider the diagram below.

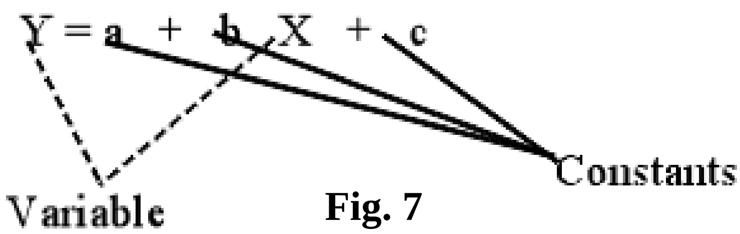


Fig. 7

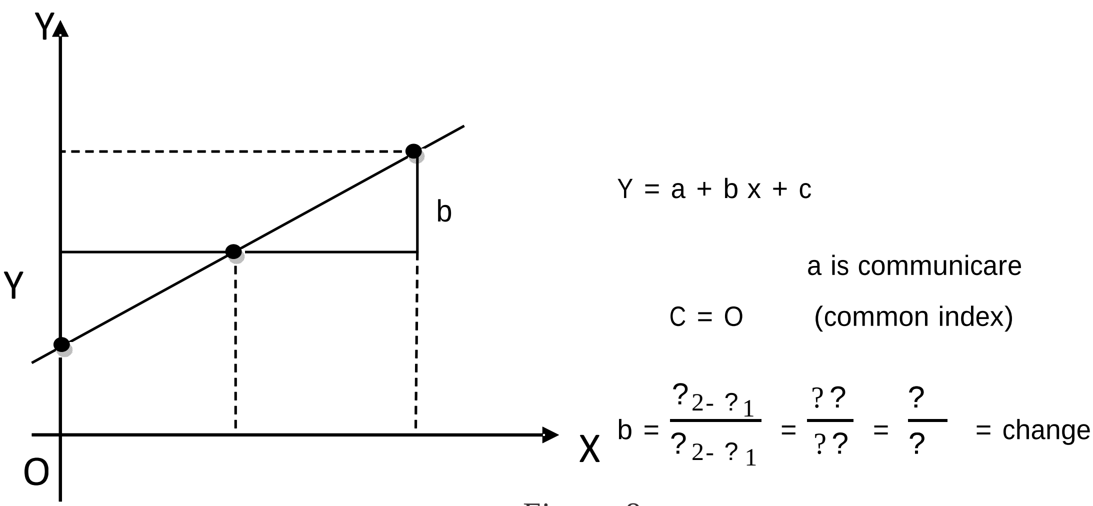
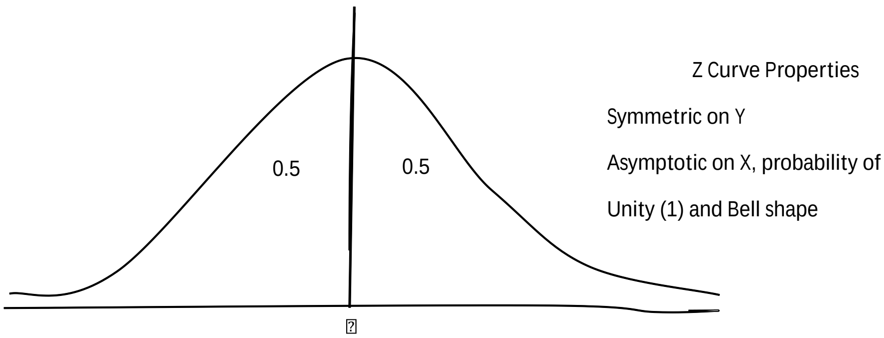


Figure 8

This is the measure of relationship of man and woman's health in relation with his/her environment. Y in the equation is the human health. X is the human environment (surrounding nature of sphere). Whatever happens to the environment manifests on the human health. How one eats, drunks, behaves (thought pattern) are part of the environment, the person's wellbeing (Y) is dependent on these factors (x) which is independent. Thomism summed the X variable(s) up by saying bomum facendum et procequendum est malum vitandum. (face goodness and pursue it while you avoid evil). This is mathematics natural principle. If one follows it, one becomes strong and lives very old (Harmony of Spheres). This implies cause and effect activities in the world. It follows also the Newtons principles that action and reaction are equal and opposite.

OPERATIONAL DICTUM: "PROVIDE EMPIRICAL EVIDENCE"



Source: Ronald Fisher (Introduction to Statistics)

With high dependence in mathematical reasoning, 1754 gave birth to scientific enquiry (empirical research), Abraham Demoivre a french mathematician discovered the curve that represents anything that happen in nature. Before this time in history, decision were made either by random missing or trial and error or guess work or at least by gossip. With this ? . Curve and its associated properties/ procedures these aforementioned methods of decisions were expelled and from then the only approach to decision making or drawing conclusions or making generalization is through empirical evidence. This of course is one of the most achievement of mathematics: for any decision to be empirically valid, empirical evidence must be provided. On this premise, I thank the GOUni Managemenet for being purely mathematical in her decisions on its affairs with this operational dictum; "where is evidence" instead of "hear says (or ShiwaShiwa)".

Pedagogical Issues

All through the ages mathematics has always been a popular subject both in the role it has played in its practical application in many aspects of human activities and in the development of other areas of learning or academic subject, it is no longer a thing 'wrapped up' in text books nor is it any longer a jig-saw puzzle merely to be displayed on the chalk board by the teacher whilst an awe-inspired class watch him soberly. The situation is much more promising than what it used to be in the past.

It has been a common knowledge that most people who do not like mathematics, and they are many, do not know what Mathematics is all about. Mathematical calculation, which is what is mostly emphasized in the school today, is just a very minimal aspect of the study of mathematics. Mathematics is a language and as in any language its truth depends on the meaning assigned to the words and symbols used. Consequently in mathematics we rarely say “such and such is true”. Rather we would say, “If A is true, then B is true”. And this is perhaps the reason why some people define mathematics as an “if-then” science.

Problems of learning and teaching are psychological problems and before we can make much improvement in teaching of mathematics we need to know more about how it is learnt. Sometimes, moreover, we think that we have understood something, only to find after-wards that we did not. So until we have a better understanding of understanding itself, we shall be in a poorer position either to understand mathematics ourselves, or to help other people to do so.

This tries to pinpoint some of the obstacles student encounter in their efforts though little, to understand mathematics in schools. This is essential due to the fact that more often than not the teaching of mathematics in our schools has degenerated into empty drill in problem solving which may develop formal ability, but does not necessarily lead to real understanding or to greater intellectual independence. Learning of mathematics, especially in its early stage and for the average students, very dependent on good teaching. To know mathematics is one thing, and to be able to teach it quite another. As a result of many teachers being, unable to teach mathematics. many people acquire at school a lifelong dislike, even fear of mathematics.

The issue of not understanding mathematics is the concern of mathematics teachers in particular and educational system in general. This is because teachers by their education experience and training seem to become oriented towards the wrong issues in the classroom. They tend to focus on why pupils fail to learn and not why teachers have not succeeded in teaching their students. The last issue would allow teachers of mathematics to rethink the task which the teachers should perform. The tasks are concerned with:-

a. Setting objectives
b. Selecting materials and method
c. Presenting situation and
d. Evaluation

Some mathematics teachers don't try to have the knowledge of the subject to be taught to the pupils prior to the lesson. How can we as teachers construct a test or examination or set an assignment, unless we have been able to identify and state clearly what we want the students to learn and which skills we wish the students to acquire? Mathematics teaching is not just a matter of referring students to theorems in textbooks but it is essential that the teacher value both the child and mathematics so that he can convince him of his importance and the importance to try and succeed bearing in mind that getting a wrong answer is not a crime.

At times students are taught using methods and device that are not suitable for the lesson. The teaching methods and devices used by teachers should be based on the nature of mathematics. The teaching methods generated should be based on the actual experiences of the students and intellectual development. The use of materials with which the students are most familiar helps to develop mathematical concepts and ideas. Students should first of all know at least a little of a new formular and the teacher should avoid frequent use of proofs as merely verifications of unmotivated, dogmatic statements.

It has been observed that mathematics is taught in such a way that students don't feel at home. To ensure that students feel at home with mathematics, any lesson on mathematics should go with greater clarity of presentation. First impression they say, last long. And mathematics being a conceptual and sequential subject, depends on preparation. Many mathematics are useful, enjoyable and stimulating, therefore teachers of mathematics should discover certain methods of teaching them that can be most effective.

The issue of teachers of mathematics not being frank and friendly with their students should be discouraged by all and sundry. This is because interpersonal relationship is very important in understanding mathematics, because anxiety itself may increase subjectively, the difficulty of understanding. According to Thorndike (1971) the educated man is the master of his collection of ideas, that a major purpose of education is to prepare individuals to interact effectively with other individuals in the realm of ideas. Given an exposition which though not excellent is nevertheless not altogether inadequate, some students will be able to understand it, some not. Those who do not understand, feel over anxious to comprehend. But this over-anxiety can be self-defeating in that it can actually diminish the effectiveness of their efforts. The more anxious the student become the harder he tries, but the worse he is able to understand, and so, the more anxious he becomes. It will become a vicious circle.

The ability to arouse curiosity is another task in mathematics teaching. Necessity is the mother of all inventions as curiosity is the germ of all scientific discoveries. The sine-qua-non for making mathematics exciting to a student is for the teacher to be exciting about it himself, if he is not, no amount of pedagogical training will make up for the defect. In our fully blow technology world mathematics play a pivotal role. The developing countries that aspire to catch up with their counterparts can only dream of doing so after a concrete and comprehensive effort has been made for preparing a brigade of mathematics teacher of sympathetic, creative innovative and sacrificing sort.

Another consideration is the ability of individual teacher to use Real-life analogies. Mathematics should be taught with reference to social sciences and other subjects so as to make it less abstract. Where possible materials should be provided for the students to use. Since mathematics is mental, all the materials for teaching mathematics should help the students develop the desired mental imagery. Appropriate teaching materials and their good use will provide panacea for learning certain mathematics concepts. Mathematics should be taught so as to provide understanding of the interaction between mathematics and reality. Regardless of his ultimate interest and career, a student of mathematics ought to understand something about the way in which mathematics is used in application and the complicated interaction between mathematics and the science. Mathematics offers the scientists a vast ware house full of objects, each available as a model for various aspects of physical reality.

Certainly, I should not fail to mention logical proof as one of the great processes vital to mathematics, taught more consistently in mathematics than in any other subject. Deduction of facts from other pre-supposed facts, the axiomatic foundation, the insistence upon reasoning as against instinct such as habits of thought one learnt persists.

It is common among mathematics' teachers to show care-free attitude towards teaching the subject, though mostly by non-professionals or inexperienced. In displaying lack of interest they forgot that the good teacher is a human and mature person who knows his subject thoroughly, has a keen interest in it and tries to get it across to his students in a thought provoking fashion. Teaching without being interested in what one is doing results in relatively, little permanent learning, since it is reasonable to suppose that only those materials can be meaningfully in corporated on a long-term basis into an individual structure of knowledge that are relevant to areas of concern in his psychological domain. We should ridicule a merchant who said that he had sold a great many goods although no one has bought any. But perhaps there are teachers who think they have done a good day's teaching irrespective of what pupils have learned. There is the same exact equation between teaching and learning that there is between buying and selling.

There is the problem of the instilling effects in mathematics teaching. This is due to the fact that many teachers are rigid in their use of methods of teaching. By instilling effect I mean the tendency to adhere to a previously practiced method of solving problem(s) even when such method(s) no longer offer(s) the most direct, efficient and or correct procedure for solving the problem(s).

There is a falling standard of education in this country and it results mostly from inability to achieve the aims and ideals of the adopted curriculum. Some teachers of mathematics succumbed to the students' low standard and therefore they give questions which are simple to the students so as to be called good teachers, thereby contributing to continuous low standard (Ozofor and Harbor Peters, 2001). Some of them felt that their individual efforts in their respective schools cannot revive our educational system, Nigeria being a vast country. It is because when a pebble is sunk into the sea, the ocean with all its vastness and might, must rise in level, even if the rise is but of epsilon measure.

Mathematics is a way of thinking; it is a way of arriving at a decision; it is a way of obtaining answers and a way of making prediction; therefore the purpose of mathematical teaching and learning is more than computational ability. mathematics is more than doing. In elementary school mathematics, therefore, the major goal should be to assist the learner not only to know how to solve problems but also to have a clear understanding as to why the process used in solving the problem yield the correct results, and that is thinking mathematically.

In teaching mathematics our primary concern is not that students should learn facts and routine computational techniques. Rather we are particularly concerned that they learn creative problem solving, that they acquire the ability to realize that mathematics is a discoverable science, and that they acquire self-confidence in their ability to discover in mathematics.

Students on the other hand should realize that some of them perform poorly in mathematics through lack of interest, self-confidence and clear personal plan for the future, not necessarily as a result of lack of capability. They should understand that mathematics is generally used no matter their future career and that it is more than a method, an arts and a language. They should also know that mathematics is a body of knowledge whose content serves the physical and social scientists, the philosopher, the logician, the educationist, satisfies the curiosity of the man who surveys the heavens and the man who muses on the sweetness of musical sounds.

Its content has undeniably, sometimes imperceptible, shaped the source of modern history.

Finally, the function of a school mathematics progamme is to modify the behaviour of students, therefore all activities of a mathematics teacher should be directed towards producing changes in students behaviour such as formation of concepts, acquisition of skills and development of attitudes. There is then the need to produce students who are capable of doing mathematics not just students who knows a lot of mathematics by doing it. It means not only the ability to solve problems by selecting an appropriate known techniques or algorithm, but also, and more importantly, the ability to create new mathematics, to provide original insight into problems.

The Instructional Framework

The instructional Framework shown in the figure 9 below illustrates the interrelationship among instructional approaches if properly used; are approved to be consistent with sound educational practices. The approaches are in line with the goals of education and apply to the objectives of the various curricula. This also illustrates the levels of approaches in instruction ranging from an instructional model, a broad approach; to an 'instructional' skill; which represents a specific teaching behavior, or technique, within each level the potential exists' for developing both the science and the art of teaching.

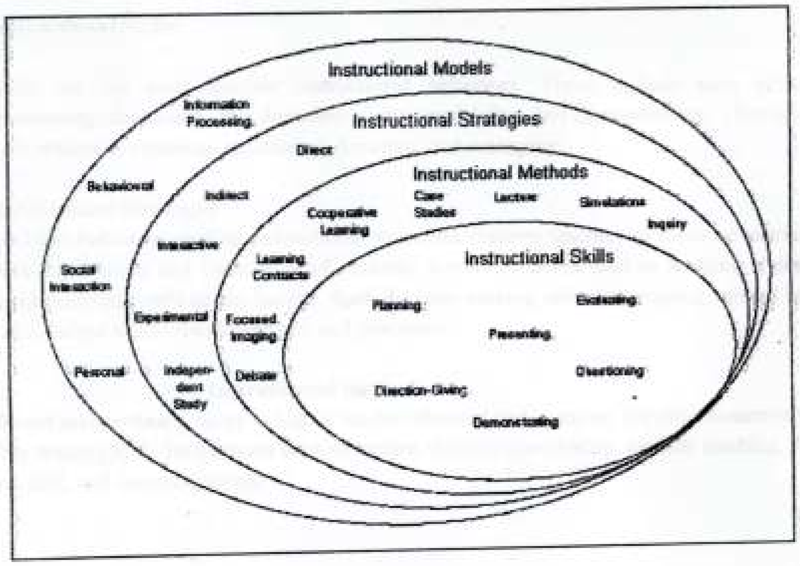


Figure 9.

Source: Gustafson (1996) New model

Instructional Framework

The following definition of terms will help to interpret the framework and to clarify the relationships between and among the levels.

Instructional Models

Models represent the broadest level of instructional practices and present a philosophical orientation to instruction. Models are used to select and to structure teaching strategies, methods, skills, and student activities for a particular instructional emphasis. Joyce and Weil (1986) identify four models: information processing, behavioral, social interaction, and personal.

Instructional Skills:

Skills are the most specific instructional behaviors. These include such techniques as questioning, discussing and direction-giving, explaining, and demonstrating. They also include such actions as planning, structuring, focusing and managing.

Instructional Strategies

Within each model several strategies can be used. Strategies determine the approach a teacher may take to achieve learning objectives. Strategies can be classed as direct, indirect, interactive, experiential, or independent. Decision making regarding instructional strategies requires teachers to focus on curriculum, the prior experiences and knowledge of students, learner interests, student learning styles, and the developmental levels of the learner. Such decision making relies on ongoing student assessment that is linked to learning objectives and processes.

Instructional Methods

Methods are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved during the lesson. While particular methods are often associated with certain strategies, some methods may be found within a variety of strategies.

Direct Instruction

Direct instruction strategy is highly teacher-directed and is among the most commonly used. This strategy includes methods such as lecture, didactic questioning, explicit teaching, practice and drill, and demonstrations. The direct instruction strategy is effective for providing information or developing step-by-step skills. This strategy also works well for introducing other teaching methods, or actively involving students in knowledge construction,

Direct instruction is usually deductive. That is, the rule or generalization is presented and then illustrated with examples. While this strategy may be considered among the easier to plan and to use, it is clear that effective direct instruction is often more complex than it would first appear.

Possible Methods

- Structured Overview
- Lecture
- Explicit Teaching

- Drill & Practice
- Compare & Contrast
- Didactic Questions
- Demonstrations
- Guided & Shared - reading, listening, viewing, thinking

Indirect instruction

Indirect instruction

Inquiry, induction, problem solving, decision making, and discovery are terms that are sometimes used interchangeably to describe indirect instruction. In contrast to the direct instruction strategy, indirect instruction is mainly student-centered, although the two strategies can complement each other. Examples of indirect instruction methods include reflective discussion, concept formation, concept attainment, cloze procedure, problem solving, and guided discovery. It seeks a high level of student involvement in observing, investigating, drawing inferences from data, or forming hypotheses. It takes advantage of students' interest and curiosity, often encouraging them to generate alternatives or solve problems. It is flexible in that it frees students to explore diverse possibilities and reduces the fear associated with the possibility of giving incorrect answers. Indirect instruction also fosters creativity and the development of interpersonal skills and abilities. Students often achieve a better understanding of the material and ideas under study and develop the ability to draw on these understandings.

Possible Methods

- Problem Solving
- Case Studies
- Reading for Meaning
- Inquiry
- Reflective Discussion

- Writing to Inform
- Concept Formation
- Concept Mapping
- Concept Attainment
- Cloze Procedure

Interactive Instruction

Interactive instruction relies heavily on discussion and sharing among participants. Seaman and Fellenz (1989) suggest that discussion and sharing provide learners with opportunities to "react to the ideas, experience, insights, and knowledge of the teacher or of peer learners and to generate alternative ways of thinking and feeling". Students can learn more from peers and teachers to develop social skills and abilities, to organize their thoughts, and to develop rational arguments. Interactive instruction requires the refinement of observation, listening, interpersonal, and intervention skills and abilities by both teacher and students.

The success of the interactive instruction strategy and its many methods is heavily dependent upon the expertise of the teacher in structuring and developing the dynamics of the group.

Possible Methods

- Debates
- Role Playing
- Panels
- Brainstorming
- Peer Partner Learning
- Discussion
- Laboratory Groups
- Think, Pair, Share
- Cooperative Learning
- Jigsaw

- Problem Solving
- Structured Controversy
- Tutorial Groups
- Interviewing
- Conferencing

Experiential Learning

Experiential learning is inductive, learner centered, and activity oriented. Personalized reflection about an experience and the formulation of plans apply to other contexts are critical factors in effective experiential learning. Experiential learning occurs when learners:

- ·participate in an activity;
- ·critically look back on the activity to clarify learning and feelings;
- ·draw useful insights from such analysis; and,
- ·put learning to work in new situations. (Pfeiffer & Jones, 1979)

Experiential learning can be viewed as a cycle consisting of live phases, all of which are necessary:

- ·experiencing (an activity occurs);
- ·sharing or publishing (reactions and observations are shared);
- ·analyzing or processing (patterns and dynamics are determined);
- ·inferring or generalizing (principles are derived); and,
- ·applying (plans are made to use (earnings in new situations).

The emphasis in experiential learning is on the process of learning and not on the product. A teacher can use experiential learning as an instructional strategy both in and outside the classroom. For example, in the classroom students can build and stock an aquarium or engage in a simulation. Outside the classroom they can, for example, observe courtroom procedures in a study of the legal system, or conduct a public opinion survey. Experiential learning makes use of a variety of resources.

Possible Methods

- · Field Trips
- · Narratives
- · Conducting Experiments
- · Simulations
- · Games
- · Storytelling
- · Focused imaging
- · Field Observations
- · Role-playing
- · Synaptic
- · Model Building
- · Surveys

Independent Study

For the purposes of this document, independent study refers to the range of instructional methods which are purposefully provided to faster the development of individual student initiative, self-reliance, and self-improvement. While independent study may be initiated by student or teacher, the focus here will be on planned independent study by students under the guidance or supervision of a classroom teacher. In addition, independent study can include learning in partnership with another individual or as part of a small group.

The importance of independent study is captured in the following statement:

Independent learning has implications for responsible decision-making, as individuals are expected to analyze problems, reflect, make decisions and take purposeful actions. To take responsibility for their lives in times of rapid social change, students need to acquire life-long learning capability. As most aspects of our daily lives are likely to undergo profound changes, independent learning will enable individuals to respond to the changing demands of work, family and society. (Saskatchewan Education, 1988, p. 53)

Possible Methods

- ·Computer Assisted Instruction
- ·Journals
- ·Learning Logs
- ·Reports
- ·Learning Activity Packages
- ·Learning Contracts
- ·Homework
- ·Research Projects
- ·Assigned Questions

Instructional Methods

After deciding on appropriate instructional strategies, a teacher must make decisions regarding instructional methods. As is the case with strategies, the distinctions between methods are not always clear cut although they are categorized for the purposes of this document. Figure 5illustrates how various methods relate to the five strategies presented in the previous section. It should be noted that the methods appearing in the diagram are examples only, and are not intended to be inclusive of all instructional methods.

A sampling of instructional methods with accompanying explanations is presented in this section. The methods are organized by instructional strategy, as they appear in Figure 9:

The Scientific Method in Mathematics

This area complements the pragmatic epistemology. It is a part and parcel of the latter. But because of its importance in the philosophy of pragmatism, it is being given special treatment and emphasis.

We have discussed in some detail the responses of pragmatism to the question. What can we know? Or in other words, what is "truth". The two other questions that come into every epistemological consideration are:

1. How do we know? In other words: how does man acquire knowledge?
2. How valid is human knowledge? In other words: can we know things with certitude?

The traditional approaches to human knowledge – the Platonic, Aristotelian and scholastic approaches – were made from the stand point of philosophy psychology. Man's thinking and knowing was examined in the light of metaphysical principles. For instance, the scholastic realists (or Thomists), both traditional and contemporary, hold that man knows primarily by "discursive ratiocination". This means the gathering of "intelligible forms" into the mind and subsequently employing these forms in making judgments and in reasoning. According to them, the knowledge attained by man can be attained with certitude and knowledge can be absolute. (Ozofor, 2004)

The pragmatist's approach to human knowledge is different. Pragmatism holds that man attains knowledge through the scientific method. This method is described by Childs in his American Pragmatism and Education, as the method of rejection of "the purely private and arbitrary" which (rejection) "necessarily follows from the scientific demand for data, procedures, and findings that are open to the test of criticism of others". All valid knowledge according to this theory must be attained through experimental method. For as Childs puts it, all knowledge must be generated from within the process of ordinary human experience, "since nothing while claims to be knowledge is to be derived by deliverances from on high, or by immediate mystical intuitions. Meanings and values are this – wordly, not other-worldly. It is the faith of the experimentalist that from within the empirical and shared situations of life all necessary motivations and guiding principles can be developed.(Ozofor 2021)

This again is in keeping with the basic philosophy which on account of having experience as its wheelbase posits that thought finds its fulfillment only in action and hence cannot be valid except when it passes through the crucible of experience and is tried out and tested in the "public" forum of activity, in the process of doing – and –undergoing.

Among all the pragmatists, it was John Dewey who, in my opinion, gave the best articulation to the position of pragmatism *vis-a-vis* the process of man's knowing. Having characterized instrumentalism as "a behaviourist theory of thinking and knowing" he added that this theory means "that knowing is literally something which we do; that analysis is ultimately physical and active experimentation is essential to verification". This implies that in the knowing enterprise, we are engaged in a sort of dynamic dialectic with the cosmos. It seems to me also that this implies that we know in the process of doing and we do in the process of knowing. (Okafor, 1983 P. 63).

The scientific method to human knowledge is explained by Dewey in his famous treatise, how we think (1910, revised 1933). Here, he divided the act of knowing into five stages or steps. On account of the importance of this aspect of Dewey's contribution to pragmatism, it will be useful to cite the five steps not only as they appeared in the first edition (1910), but also as they appeared in the revised edition (1933).

The 1910 edition:

i. A felt difficulty

ii. Its location and definition

iii. Suggestions of possible solution

iv. Development by reasoning of the bearings of the suggestion;

v. Further observation and experiment leading to its acceptance or rejection, that is, the conclusion of belief or disbelief.

The 1933 edition:

1. Suggestion, in which the mind leaps forward to a possible solution.

2. An intellectualization of the difficulty or perplexity that has been felt (directly experienced) into a problem to be solved, a question for

which the answer must be sought;

3. The use of one suggestion after another as a leading idea, or hypothesis, to initiate and guide observation and other operations in collection of factual materials;

4. The mental elaboration of the idea or supposition as an idea or supposition reasoning (in the sense in which reasoning is a part, not the whole of inference), and

5. Testing the hypothesis by overt or imaginative action.

Hence the pragmatist adopts the same kind of procedure used by the scientist in the research laboratory. For him all knowledge starts within the domain of experience during man's interaction with the environment, in the process of man's interaction with the environment. In the process of man's interaction with nature, some difficulties or problems do emerge. The emergence of a problem or a need is the beginning of knowledge, but only a beginning. To complete the process of knowledge, one must properly locate and analyze the problem, hypothesize toward possible solutions, scrutinize the proposed solutions for their anticipated consequences, and finally put to the test of experience the preferred hypothesis for final verification.

If at the end, this does not work, one has to go back for explanation of the factors. Even when the accepted hypothesis works and knowledge (or truth) emerges. This knowledge cannot be accepted as permanent or absolute. For all knowledge must be subjected to constant revision since every variation in a problematic situation calls for possible modifications in the solutions. When such variations in the solution occur, new knowledge (new truth) is effectuated. This means that “truths” can change from one generation to another. This factor of *relativism* is at the heart of the scientific philosophy. Unlike the traditional philosophers who hold that man can know things with certitude, and that can be absolute, the pragmatists hold that truths and knowledge are *tentative*, that is, they are valid only as they continue to “work” in human experience, in man's transaction with nature.

These are crucial features in the pragmatist epistemology as peirce put it"

The scientific spirit requires a man to be at all times ready to dump his whole cartload of beliefs, the moment experience is against them. The desire to learn forbids him to be perfectly cocksure that he knows already. Besides, positive science can only rest on experience: and experience can never result in absolute certainty, exactitude or universality.

In conclusion, it is evident that in pragmatic epistemology, there are no self-evident truths from which other truths can be derived and justified. Man cannot know by intuition nor by revelation since the mind is not a separate entity but rather man's physical organ in intelligent action within the domain of experience – not independent of and separable from the actions in the process of doing and undergoing. The mind is born within experience and is both the complex sum of past experiences and the operational activity of present thought. Hence the intellect is not apart from the process of thinking and knowing. It is a part and a parcel of the process.

A teacher cannot perform better than his method. Education is made or marred by the nature and operation of instructional method(s) used by teachers in the field. According to Ryans (1960), teaching is effective to the extent that the teacher acts in ways that are favourable to the development of basic skills, understandings, work habits, desirable attitudes, value judgements revealing personal adjustment of pupils.

Studies indicate incontrovertibly that teaching methods or instructional approaches adopted by teachers influence positively or negatively subject matter acquisition. A good instructional method helps develop in the learner favourable attitudes and habits, reinforces basic operational language, provides confrontation with a precision machine (interface) in the class; facilitates the gathering of general information in a subliminal fashion, fosters techniques immediately applicable to social life and school activities, liberates the creative mind from the inherent limitations and contributes to remedial education (Harbor – Peters, Ozofor, 2000).

An ideal teacher is practical and employs methods that guarantee a sympathetic attitude toward his learners, a thorough knowledge of his subject matter, confidence in his own ability to teach, a co-operative spirit with other teachers, and a constant interest in expanding his knowledge and that of his students. He should posses the attitude that would ensure a knowledge of how to organize and present this subject in such a stimulating, challenging and direct manner that each student is inspired to work to his fullest capacity and to attain the highest degree of skill for which he is capable. (Ozofor, 2000).

For a successful pedagogical approach, a teacher should possess a competent mastery of the subject matter and should be able to describe good techniques to the students as well as demonstrate these techniques for proficiency. According to Tonne (1965), a teacher should have a thorough knowledge of all the special innovative features of the different instructional models. The alert, the methodical teacher, will capitalize on the students' natural interest and through his own enthusiasm for his subject (theme) motivate them to their highest potentials. According to Ndinechi (1990), the enthusiasm of teacher is not only an attitude, it can be the willingness to accept the challenge of a variety of individual differences in a given class and to endeavour constantly to seek ways of improving and changing class presentations.

Problems Statement

It is the belief of many educationalists that the unprecedented poor performance of students in senior secondary school exams like WASC in some subjects like mathematics and sciences was as a result of inability of the teachers to use the necessary instructional methods that could engender more understanding in the students

Harbor-Peters (1988, 1992); Ali (1987), Sinclair (1992) and Ohuche (1986) were of the opinion that poor teaching methods are responsible for the observed poor performance in secondary school mathematics, English language and science-oriented subjects. Furthermore, Obodo (1990) observed that the failure rate of students in mathematics was purely as a result of unqualified teachers and consequent use of poor methods of teaching the subject.

In response to the problem of poor performance in secondary school mathematics and associated sciences, the chief examiners report (1992) recommended the use of effective teaching which is in tune with the ethno-science and technological dispensation as the only remedy to students' poor performance in sciences, mathematics and in English language for senior secondary school examinations.

THE CONCEPT OF ZERO

The Subject of Arithmetic

Arithmetic is the science of numbers, the name stemming from the Greek "arithmos" which means "number", it involves the most elementary properties of numbers and rules of calculation. Deeper properties numbers are studied in the theory of numbers.

Whole Numbers (Natural Numbers)

The first conceptions of number were acquired by man in remote antiquity. It began with the counting of people, animals, and the various articles and possessions of primitive man. Counting produced the numbers one, two, three, etc., which are now called natural numbers. In arithmetic they are also referred to as whole numbers or integers (the term "integer" has a broader meaning in mathematic.

The concept of a natural number is one of the most elementary notions. The only way to explain it is by

demonstration. In the third century B.C. Euclid defined number (natural number) as a "collection made up of units" similar definitions appear in textbooks even today. But the words "collection", or "group", or "aggregate", etc, do not seem to be any more comprehensible than the word "number".

The sequence of whole numbers 1, 2, 3, 4, 5,... goes on without end and is called the set of a natural numbers.

The Limits of Counting

In primitive society, man could hardly count at all. He was able to distinguish groups of two and three objects, anything beyond that being thought of as "many". This was obviously not counting, it was only a beginning.

Gradually larger groups were distinguished, giving rise to the notions of "four", "six", "seven". For a long time, the word "seven" was used in some languages to denote an indefinitely large quantity.

As man's activities became more intricate, the counting process developed and gave rise to a variety of reckoning devices; the making of notches on sticks and trees, knots in ropes, groups of stones, etc.

The human hand with its five fingers was an invaluable natural tool for counting. It could not preserve the information it conveyed but it was ready at hand, so to speak; and very mobile. The language of primitive man was poor; gesticulators often made up for lack of words, and numbers (for which there were no names) were demonstrated in finger counting (this is even done nowadays if two persons speaking different languages do not understand each other).

It is quite natural that the newly originating names for "large" numbers were often constructed on the basis of the number 10 corresponding to the 10 fingers. Certain peoples developed a number system based on 5, the fingers of one hand, or on 20 which is the total number of fingers and toes.

During the early stages of man's development, the range of numbers expanded very slowly. Counting proceeded through the first tens and only much later reached one hundred. In many languages, the number 40 represented the limit and designated an indefinitely large quantity.

When the counting process reached ten tens and a name was given to the number 100, it was also sued to denote an indefinitely large number (in some languages, Tartar for instance, one and the same word is used to denote 40 and 100). The very same process occurred again with the numbers thousands, ten thousand, and million.

The Decimal System of Numeracy

In many modern language, the names of all numbers up to million are made up to 37 words denoting the numbers 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 (for example, 918,742: nine hundred eighteen thousand seven hundred forty two). In turn, the names of these, 37 numbers are, as a rule built up from the names of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10, 100, 1000. The underlying element of all these word formations is the number 10, that is why the modern system of numbers is called the decimal system of numeration. The exceptional role of 10 is due to the fact that we have 10 fingers on our hands.

That is the general rule, but a wide variety of exceptions are evident in various languages. These are due to historical peculiarities in the development of the counting process.

In the Turkle languages (Azerbaijan, Uzbek, Turkmen, Kazakh, Tarter, Turkish, etc) the exceptions are the names of the number 20, 30, 40, 50, whereas 69, 70, 80, 90 are formed on the basis of the names for 6, 7, 8, and 9. In Mongollian, on the contrary, the names of the numbers 20, 30, 40, 50, follow the general rule, while 60, 70, 80 and 90 are exceptions. In Russian there is one exception, the name for "forty in French the names for the numbers 20 and 80 retain the nondecimal names, 80 is quatrevingt (four twenties). This is a remant of the ancient vigesimal system of numbers (based on 25 – the total number of fingers and toes). In Latin to the name for 20 is nondecimal (vigint), but that for 80 (octoginta) is decimal and comes from & (ecto). On the other hand, the names for the numbers 200, 200, 400, 500, 600, 700, 800, and 900 in all modern languages are constructed on the decimal (scale – 10) basis.

Development of the Number Concept

In the counting process, unity is the smallest number. There is no need to subdivide it, nor is it even possible at times (adding half a stone to two stones yields three stones, not 2½ , and of course it is impossible to select a committee made up of 2½ persons). However, unity often has to be broken up into parts when measuring lengths by means of steps (2½ steps long and the like). For this reason, the notion of a fractional number was known in remote antiquity, Subsequent development saw the expansion of the concept of the concept of number to irrational numbers, negative numbers, and complex numbers.

Zero (null) was a long time in entering the family of numbers. At first, zero (null), had the meaning of absence of any number (the Latin "nullum" literally means "nothing"). If say 3 is taken away from 3 we have nothing, for that "nothing" to be considered a number, we had to wait for negative numbers to appear.

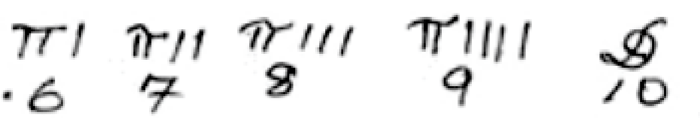
Numerals

A numeral is written sign depicting a number. In the most ancient times, numbers were denoted by straight-line strokes (rods"): one rod depicted unity, two rods, a two, and so forth. This notation originated from the use of notches. It still exists in the Roma numerals, which denote the numbers 1,2,3.

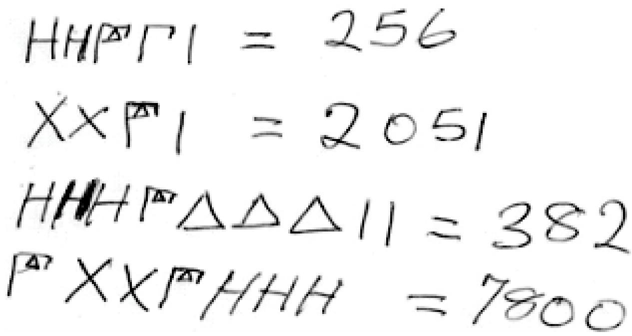
This notation is inconvenient for writing large numbers and so special symbols were used to depict the number 10 (in accordance with the decimal system of numeration, and in some languages, the number 5 as well (in accordance with quinary numeration which is based on the number of fingers of the human hand). Later, symbols were invented for still larger numbers. These symbols exhibited a variety of forms in the different languages and underwent considerable modifications in the course of time. There was also considerable variety in the systems of numeration, that is, modes of combining digits to form large numbers. However in most number systems the 10-scale was pre-eminent and formed the basis of the decimal system of numeration.

Systems of Numeracy

Ancient Greek numeration. The so-called attic system of numeration was used in ancient Greece. The numbers 1, 2, 3, 4 were denoted by vertical strokes I, II, III, IIII, the number 5 had the symbol I' (the first letter "pl", in its ancient form, of the word "pente", five; the numbers 6, 7, 8, 9 were written as



The number of 10 was depicted as (the first letter of “deca”, ten). The numbers 100, 1000, and 10,000 were denoted by H X, M the initial letters of the corresponding words. The numbers 50, 500, and 5000 were given as combinations of the sings for 5 and 10, 5 and 100, 5 and 1000, namely r, r, r. the remaining numbers, within the first ten thousand were written as follows.



Source: MIR Publishers-Moscow 1972

In the third century B., C., the Attic numeracy gave way to the so-called I onian system. Here, the numbers from 1 to 9 were denoted by the first nine letters of the alphabet

the letters ξ vau, C, koppa, and ? sampi, are archaic; the Greek alphabet is given:

α = 1, β = 2, γ = 3, δ = 4, ε = 5, ς = 6, ζ = 7, η = 8, ? = 9

the numbers from 10 to 90, by the next nine letters:

?= 10, χ = 20, λ = 30, μ = 40, ν = 50, ξ = 60, ? = 70, π = 80, ϲ= 90

the numbers from 100 to 900, by the last nine letters

ρ = 100, σ = 200, ?= 300, ν = 400, ? = 500

χ = 600, ψ = 700, ω = 800, ? = 900

Thousand and tens of thousands were denoted by the same numerals proceeded by a stroke or accent:

‘α = 1000, ‘β = 2000, etc.

a bar was placed over numerals in order to distinguish them from letters. For example,

$\overline{\tau\eta}$ = 18, $\overline{\mu\xi}$ = 47, $\overline{\chi\varkappa\alpha}$ = 621, $\overline{\chi\varkappa}$ = 620, etc.

A	B	Γ	A	є	ς	э	H	A
1	2	3	4	5	6	7	8	9
I	k	^	m	N	э	o	n	и
10	20	30	40	50	60	70	80	90
ρ	c	T	y	φ	χ	ψ	ω	и
100	200	300	400	500	600	700	800	100

Slavic Numeracy

The Slavic people of the south and east of Europe used the alphabetic system of notation for writing numbers. In some cases, the numerical values of the letters were established in the order of the Slavic alphabet, in others (including Russia) not all letters were used as numerals but only those found in the Greek alphabet. The letter used as a numeral was surmounted by a special symbol (see accompanying table), and the numerical values of the letters increased in the order of the letters in the Slavic alphabet was somewhat different).

This Slavic numeration persisted in Russia till the end of the 17th century. Under Peter the first the dominant system of numeration was the Arabic (see item 6 below) which is still in use today. The Slavic numerati persists, however, in clerical works.

The Slavic Numerals

Source: MIR Publishers-Moscow 1972

The Ancient Armenian and Georgian systems of numeration. Both Armenians and Georgians used the alphabetic principle of numeration. But the ancient alphabets of these peoples ha far more letters than did the Greeks. This enable led them to use special symbols for the numbers 1000, 2000, 3000, 4000, 5000, 6000,7000, 8000, and 9000. The numerical values of the letters followed the order of the letters in the alphabets of these peoples.

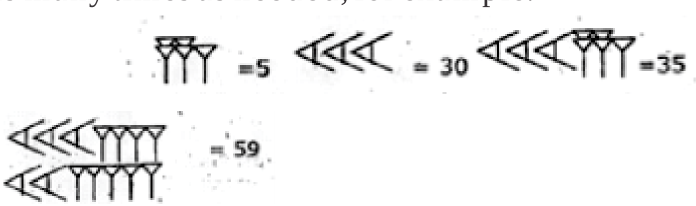
The alphabetic numeration persisted till the 18th century although the Arable numeration was used occasionally much earlier (in the Georgian literature such instances go back to the 10 or 11th century; sources of Armenian mathematical literature reveal such usage no earlier than the 15th century).

In Armenia the alphabetic numeration is still used in designations of chapters, stanzas, and the like. In Georgia the alphabetic numeration has gone out of use altogether.

Babylonian Positional system of Numeracy

Approximately 40 centuries prior to the Christian era, the ancient Babylonians developed a positional system of notation for their numeration. This is a mode of representing numbers in which one and the same digit is capable of denoting different numbers depending on its position. Our present-day numeration is also positional: in the number 52, the digit 5 denotes 50, that is, 5.10, while in the number 576, it same digit stands for five hundred, or 5.10.10. In Babylonian system, whence the name sexagesimal by which the Babylonian system is designed. Numbers less than 60 were denoted by two symbols: for unity and for ten.

They were wedge-shaped (cuneiform) since the Babylonians wrote on clay tablets with a stylus having the form of a triangular prism. These signs were repeated as many times as needed, for example.



Numbers exceeding 60 were written in the following manner stood for 1.60.60 + 2.60 + 5 = 3725, much like the modern notation 125 denotes 1.100 + 10 + 5. The sign used as a placeholder, playing the part of zero. Thus, the notation meant 2.60.60 + 0.60 + 3 = 7203. But the absende of any lower order digits was not indicated: for example, the number 180 = 3.60 was denoted as which is the same as the number 3. The same notation might mean 10,800 = 3.60.60. etc. Only the

10, 800, etc. the notation  could also signify $\frac{3}{60}, \frac{3}{60.60}, \frac{3}{3600}, \frac{3}{60.60.60} = \frac{3}{216,000}$ just as we use the numerical 3 to denote $\frac{3}{10}, \frac{3}{10.10} = \frac{3}{100}, \frac{3}{10.10.10} = \frac{3}{1000}$, etc in our system of decimal fractions. However, we readily differentiate between these fractions by annexing zeros in front of the 3, and we write $\frac{3}{10} = 0.3, \frac{3}{100} = 0.03, \frac{3}{1000} = 0.003$, etc. In the Babylonian notation these zero placeholders were not indicated.

Besides the sexagesimal system of num beration, the Babylonians used the deciamal systems, but it was not a positonal system. Apart from symbols for 1 and 10, there were symbols for 100, , 1000, , and 10,000, . The numbers 200, 300 and so on were written as  etc.

The sexagesimal system originated at a later period than the decimal system because the numbers up to 60 were written on the basis of the decimal principle. It is still not known when and how the Babylonians developed the sexagesimal system. There are numerous hypotheses as to how this occurred but there is no firm proof for any of them.

The sexagesimal notation of whole numbers did not spread beyond the Assyrians - Babylonian empire, but sexagesimal fractions spread far and wide to the countries of the Near East, Central Asia, Northern Africa, and Western Europe. They found wide use, especially in astronomy, right up to the invention of decimal fractions (which was at the beginning of the 17th century). Traces of sexagesimal fractions are still found in the divisions of the degree of angle and arc (and also the hour) into 60 minutes, and of the minute into 60 seconds.

Roman Numeracy

The ancient Romans used a number system that is still in use and is called the Roman system of numeration. We use it for designating congresses and conferences, for numbering the introductory pages of books, chapter headings, etc., in their latest form, the Roman numerals looked like this: 1 = 1, V = 5, x = 10, L = 50, C = 100, D = 500, M = 1000. The earlier forms were somewhat different. Thus, the number 1000 was denoted by the symbol (I), 500 by the symbol I).

There is no reliable information. on the origin of the Roman numerals. The numeral V might have originally depicted the human hand, the numeral X could have been built up out of two lives. In the same way, the symbol for 1000 could have developed out of doubling the sign for 500 (or vice versa).

The Roman system of numeracy exhibits evident traces of the quinary system of numbers. But Latin (the language of the Romans) does not have a trace of the quinary number system. This must mean that these numerals were borrowed by the Romans from another people (most likely from the Etruscans).

All whole numbers (up to 5000) are written by means of iteration of the numerals listed above. If a large numeral precedes a smaller one, they are added, if the smaller one comes first (in which case the symbol is not repeated), then it is subtracted from the larger numeral (in Latin, the subtractive principle is preserved in the names of two – is preserved in the names of two cardinal numbers: 18 and 19). For example, VI = 6, or 5 + 1, digit is repeated more than three times: LXX = 70, LXXX = 80; the number 90 is written as XC (and not LXXXX).

The first 12 numbers are written in Roman numerals as follows: I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII

Example: XXXIII = 28, XXXIX = 39, CCCXCVII = 397, MDCCCXVII = 1818.

Performing arithmetical operations with multidigit numbers is an arduous task when done in Roman numerals. Nevertheless, Roman numerals were still the dominant number system in Italy up to the 13th century, and in other countries of Western Europe they persisted till the 16th century.

The Positional Numeracy of India

The various regions of India had different number systems, one of which spread to other parts of the world and is today the generally accepted system if numeration. In this system, the numerals had the forms of the initial letters of the appropriate cardinal numbers in the ancient Indian language of Sanskirit (the Devanagari alphabet).

Originally, these symbols denoted the numbers 1, 2, 3, 9, 10, 20, 30, ..., 90, 100, 1000, which in turn were used to write the other numbers. Later, a special sign (a heavy dot, circle) was introduced to indicate an empty position in a number. The signs for numbers exceeding 9 ceased to be used at a later period, and the Devanagari system of numeration became the decimal positional system of numeration. It is not known how and when this conversion took place, but by the middle of the 8th century, the positional system of numeration was in wide use in India. It was about this time that it began to spread to other countries (Indochina, China, Tibet, into the territory of the present day Central-Asian republics of the Soviet Union, Iran, and elsewhere). A decisive role in the spread of the Hindu numeration in the Arabic countries was played by a manual written at the beginning of the 9th century by Mohammed 1bn - Musa al-khowarizmi (from Khoresm - the present day Khoresm Oblast of the Uzbek Republic of the USSR). It was translated into Latin in Western Europe in the 12th century. In the 13th century, the Hindu system of numeration became dominant in Italy, and by the 16th century it spread to the other countries of Western Europe. The Europeans borrowed the Hindu number system from the Arabs called it the Arabic system of numeration. Historically, this is not correct, but the name persists.

The Arabs also gave us the word "cipher" ("sifr" in Arabic) which literally means "empty position" (this is a translation of the Sanskrit "sunia" which has the same meaning).

The word was originally used to denote the empty position (as a placeholder) in a number and that meaning was still current in the 18th century, although in the 15th century the Latin term for "zero", "null" (nullum nothing), had appeared.

The shapes of the Hindu numerals underwent a variety of medications over the centuries; the form that we have today was established in the 16th century.

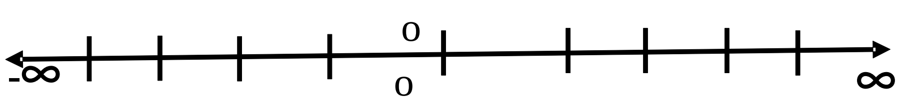
Axioms for Real Numbers

The set of all positive and negative numbers and zero is called the set of real numbers. In the number line, the starting point (origin) on a horizontal line is called zero "o".

The representation of real numbers as points on a line is based on several assumptions. In mathematics, assumptions are called axioms or postulates. These axioms guide one to the operations involving the real numbers.

These axioms are the following:

1. Axioms of Comparison, Transitive, Closure for Addition and Multiplication.
2. Others include: axioms of Equality which involves: Reflexive, Symmetric Transitive equality, and substitution.
3. Other axioms further include: Commutative axioms and Associative axioms.
4. The other important assumptions about real numbers, axioms of one, Axioms of multiplicative inverse, Axioms of the reciprocal of a product and the negative of a sum.
5. The last but not the least of the assumptions is the axioms of zero (0) which causes a lot of infractions on real numbers.



Real Number Line

If a and b denote real numbers then a-b = a+(-b). To perform a subtraction you replace the subtrahend by its negative, and add. Since every real number has a unique additive inverse, if you know b, then you know –b. also, since a+(-b) is a sum, it represents a real number. Hence, this definition implies that the set of real number is closed under subtraction.

Notice that 7-2 = 2-7 thus, subtraction of real numbers is not a commutative operation. Also, (7-2)-3= 5-3=2, where as 7-(2-3) = 7 –(-1) = 8, so that subtraction of real numbers does not have the associative property. Consequently, to give a numerical expression like 7-2-3 meaning, we agree on the following grouping: 7-2-3= (7-2)-3. In general, we define: a-b-c =(a-b)-c = a+ (-b) + (-c)

Since you can convert any subtraction into an addition, the following rules permit you to add and subtract real numbers by finding sums, differences, and additives inverse of non negative numbers:

1. If a = 0 and b = 0, a + b = /a/ + /b/

   Example: 2 + 3 = 5

2. If a = 0 and b = 0, a + b = - (/a/ + /b/)

   Example = -2 + (-3) = - (2–3) = -5

3. If a > 0 and b < 0 and /a/ = /b/, a – b = /a/ -/b/

   Example = 5 – (-3) = 5 – 3 = 2

4. If a = 0 and b < 0 and /a/< /b/, a – b = - (/b/ - /a/)

   Example 3 – (-5) = - (5 – 3) = -2

Properties of real Numbers

In the following list of properties of the set of positive and negative numbers and zero, a,b,c, and d denote any real numbers.

Closure Axioms:	For addition a + b represents a unique Real number	for Multiplication ab represents a unique real number
Commutative Axioms:	a + b = b + a	ab = ba
Associative Axioms:	(a+b) + c = a + (b+c)	(ab) c = a(bc)
Identity Element:	0 is the unique element Such that 0+a =a and a+ 0 = a	1 is the unique element such that 1.a = a and a. 1 = a
Inverse elements:	There is a unique real Number – a, the additive Inverse of a, such that a + (-a) = 0 and (-a) +a=0	Provided a is not O, there is a unique real number $\frac{1}{?}$, the multiplicative inverse of a, such that ?.$\frac{1}{?}$ = 1 and $\frac{1}{?}$.? = 1
Inverse of sum and Products	-(a +b)	if neither a nor b is zero $\frac{1}{?}$= $\frac{1}{?}$.$\frac{1}{?}$
Multiplication property of zero.	= (-a) + (-b)	a – 0 = 0 and 0.a = 0
Distributive Axioms	a(b+c) = ab + ac	(b+c)a = ba +ca

Properties of Order

Axiom of Comparison one and only one of the following Statements is true: a < b, a = b, a > b.

Transitive Property:
1. If a < b and b <c, then a < c
2. If a > b and b > c, then a > c.

Properties of Equality

Reflexive a = a

Symmetric If a = b, then b = a

Transitive If a = b and b – c, then a = c

Substitution
1. If a = b and a + c = d, then b + c = d
2. If a = b and ac =d, then bc = d

THE CONCEPT OF ZERO (0) IN IGBO TRADITIONAL NUMERACY

The new counting numbers (positive numbers)

otu (ofu)	abuo	ato	ano	ise	isii	esaa (asaa)	esato (asato)
1	2	3	4	5	6	7	8
itolu	iri	nnari	puku	nde	Ijeri		agukata agba ayalu
9	10	100	1000	1,000,000	1,000,000,000		λ

Ngwo and Agbaja Numbers of Old

Naa	Ibo	Ito	Ino	Ise	Ishii	Isaa
1	2	3	4	5	6	7

This is the traditional numeracy before the translation to the Arabic numerals. The Agbaja and Ngwo culture of old believe that the highest number in Igbo numeracy is 7. For instance for somebody to performed a task the highest number of times is described as, O dalu agu n'asaa da miri n'asaa da ugwu n'asaa showing that seven (7) is the highest number in their numeracy

Nsukka/Some Nkanu Area Numbers of Old

Mbu	Ebo	Eto	Ano	Ise	Ishii	Esa
1	2	3	4	5	6	7
Esato	Itenani	Iri	Nari	Adisi		
8	9	10	100	1000		
Tokoroki	Yerare	Agudolera				
1,000,000	1,000,000,000	λ				

A good observation here is that the Igbo do not regard zero (0) as a positive number. Zero is not worthy to mention except for worthless things. Zero here means ncha, chacha, efu, nkiti, okpokoro, oroghoro, mmaka or maka, shaku, ihoro etc.

Zero “0” is a unique element in the real number field. It is between the positive and

negative numbers.
It is unique as it is terrible. It seems to command no value in itself. If you multiply it to any real number their product becomes zero.
Example 5 * 0 = 0. 200 x 0 = 0.
If you add zero to any number, it brings forth no increase value.

Again any number that is raised to the power of zero is 1 (unity). $7^0 = 1$; $(555)^0 = 1$; $b^0 = 1$. Even the absolute value of 0 (/0/ = 0) where as the absolute value of a positive or negative number remain the same example /3/ = 3; / -2/ = 2 and $/\frac{1}{4}/ = \frac{1}{4}$. The division of any real number is closed except the division by zero. If you divide a number by zero then it is undefined.

Zero (0) concept continues:

Many cultures like Arabic, Babylonian Roman, Salvic, English etc have zero in their numerals and how to represent it but in Igbo culture, this number seems to be absent. In Igbo tradition and culture there is no room for the number called zero. My enquiries gave credence to the fact that a real Igbo person do not ever think – about zero both in his / her philosophy or day to day activity. The Igbos think of zero when somebody or something becomes irredeemably bad, when a child becomes terribly hopelessly worthless, the person is described as being a zero person (Madu Mmaka or efulefu, shakileshiwu or iholiho, madu-nkitii. etc).

If such person becomes a friend then the friendship in already doomed. If he / she is a child of a family then the family is childless, because he / she can't be trusted on anything and has no value to add. The Oho Madu (zero person) is a living dead and forgotten.

Conclusion

In concluding this lecture my dear people, owing to the dynamism of the human person, people should be taught mathematics using instructional framework known to their cultures. Instructional materials that are ethno (cultural) based.

"May the good God never allow us to bear a zero child or Madu mmaka".
Thanks and Soi Dei Gloria (to God be all the glory).

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ACKNOWLEDGEMENTS

In humility and joy I do acknowledge the following people who contributed to the progress of this academic voyage.

The very first is Chief and Chief Mrs. Christiana Ekperechi Ozofor (late), Ani John Ozofor and chief Mrs Christiana Ekperechi Ozofor, (late), my parents. My mother was my first education counselor who made it a duty to look at my notebooks daily. Am very grateful to my brother and sister: Ozo Lius Ozofor (Ph.D), Very Rev Fr. Joseph Ozofor, Chief Mrs. Victoria Nwani and Mr. Okwudili Ozofor my younger brother who is the only one living today.

I am indebted to my wife Mrs. Gertrude Ndidi Ozofor, my children: Chiemerie, Chiagozie and Chukwuebuka and all the members of Ani Ozofor's family especially Ifebuche Luke Ozofor.

During my primary and secondary school period, the following people were significant to my academic pursuit: my aunt Lolo Benedett Ani, my Cousins: Chief Charles Ogbozor, Chief Amechi Ozoeze, Hon. Cletus Ozofor, my principal Chief CKC Eze, my special teacher Chief Ekemezie, and other teachers especially Mr. Obiakor who taught me mathematics. In a special way I thank my co-students at Fatimah High School Aguobu Owa: my senior prefect and the teacher of our Christian Boy's Association, Dr. Donatius Adinde. I also thank my friend Dr. Peter Andrew Ani and his brother Dr John Ani, my house captain Barr Dr. Cyril Nkolo who is a lecturer now in Law at GO Uni Mr. Goddy Egboka, Dr Mike Asogwa, Mr. Moses Ejike, Mr. Hyginus Ike, Mr. Oliver Ejike, Rev Fr. Tobe Nnamani (Ph.D) and Mr. Kevin Okolie. In a special way, I thank my primary school friend Most Rev. Dr. Ernest Obodo.

In a special way I thank my primary school friend Most Rev. Dr. Ernest Obodo.

At the University of Nigeria Nsukka, first guide and academic facilitator is Chief Emeka Francis Ugwuagu (a Cousin): I am grateful to him for leading me towards academic progress. I thank my academic adviser and supervisor

Prof. Violet Fine Harbor-Peter. Am grateful to my Senior Colleagues who became lecturers in the UNN Prof UcheAgwaga, Prof BG Nworgu, Prof D.N Eze, Prof Usman and Prof Barth Alio of Mathematics Education department ESUT. In the course of my academic works in IECE in Nov, 1994, I express my grateful to my scout commissioner and revered master Very Rev. Fr. Prof Stan Ani who gave me job in IECE. I am indebted to very Rev Fr. Dr Chris Ofordile who continued to lace me with a conducive working environment in the IECE. Am grateful to the following principal officers I worked with at one time or the other very Rev. Fr. Dr. Mike Chime, Very Rev Fr. Dr Ignatius Emefor, Ozo Onwudinjo. Am grateful to my colleagues Assoc Prof Benedett Menkiti, Mrs. Okolo, Elder Nnadi, Mr. Madu Fabian, Mr. Isaac Nwibo, Mr. Friday Okemiri, Mr. Akaigwe (John Deco). I am highly grateful to the following people, Ikenga A. N. Ozoude, Brendan Igwebuike, Engr IK Ozoude, Chief Ossy Obodo, Mrs. Cordel Obi, Dr. Cosmas Ude, Mr. Cyril Ezeibekwe and Chief Humphery Ezeokafor.

At the Godfrey Okoye University Enugu, I thank the University Management led by Vice Chancellor Very Rev. Fr. Prof Christian Anieke, the Pro Chancellor Prof. Dr. Nwachukwu Okeke. The chancellor Most Rev Dr Ignatius Ayiu Kaigama (the Arcbishop of Abuja), I thank the Deputy Vice Chancellor Very Rev. Sr. Prof Sylvia Nwachukwu, the Registrar Dr. Nnamdi Eneh. The Bursar Dr. Mrs. Egiyi.

In a special way I express my gratitude to the emeritus Registrar of this University Prof Dr. F.C. Eze (Ochendo). I am immensely grateful to Prof. Dr. Eddy Onyeneje. I salute the deans of the faculties of this University especially my own dean Prof Dr. Miriam Unachukwu, and the Pioneer Dean of NAS Prof. Dr. E. Adinna my academic father. I thank Prof. Romanus Egudu for his encouragements.

In a special way I thank the Agbaja Professors Association and her leaders: Professors Ikechukwu Chidubem, O.C Eneh, Prof Anowor, Prof. Dr. Chime Orji, Prof. Anibueze. I thank my close friend Prof. Dr. Donatus Ndidibuike Nwobodo. I thank Prof. Dr. Nick Obodo, Prof. Dr. Nick Igwe, Prof. Dr. Segius Udeh (Mmuta), Very Rev. Fr. Dr. Benjamin Nze Eze. I thank my good friend, Chief Ugo Jerry of GOUni Registrar's office.

I thank my motivating Professors: Prof. GCM Mba UNN, Prof Akuma EBSU, Prof Sunday Okey Abonyi EBSU, Prof Amadi MOUAU,...Emeritus Prof. Dr. Nduka-Okafor GOUni, Prof. Dr. Aaron Eze, Associate Prof. Onyia, Prof. Dr. Ebuo, Prof. Gabriel Okenwa.

I also thank in a special way the father of Ngwo Undergraduates and Academics, Prof. Dr. Arc. Chris Orji. I also remain grateful to Prof. Dr. Cosmas Ani Uboji Ngwo first Professor. I thank my pioneer students in computer science / mathematics: Mr. Chinedu Chibuzor (ICT), Mr. Lucky and Ada computer Mrs. Chinyere, Mr. Emmanuel

I wish to thank the following young lecturers who enjoy my company. Dr. Kevin Anaeche, Dr. Johnson Iyioke, Dr. Eric Ozomadu, Dr. Mike Onwumere Nwosu, Dr. Frank Okegbulam (my HOD), Dr. Onyia Anezi Nicholas.

I thank in a special way member of my research group, Very Rev Sr Dr Kunuba, Dr Ebere Okolo, Dr. Anowor Mr. Ikechukwu Ani, Dr. Mrs. Odike, Mrs. Kelechi Obi, Ms. Chiegeonu, Dr. Godwin Engwa, Chief Ugo Iyioku, Barr. S. Egwu. Pastor Richard and Mrs. Ijeoma Chime (CSP, Udi Zone).

I thank my students who are priests: Rev Frs. Peter Chukwu, Chris Ogwudile, Stephen Egbo, Ugwu Barth Ozokeke, Humphery Ozokonkwo, Fr. Okwudili Ozor, Fr. Cally, Rev. Fr. Collins, Fr. Cliffmario Ojukwu, Fr. Paschal, Fr. Joseph (Aba Cath. Diocese), Fr. Nwodo.

In a special way I thank very Rev. Mother Chilota (DDL), Rev. Sr. Dr. Blessing Okoro, Rev. Sr. Ijeoma Chime, Rev. Sr. Julie Adeniran (SND), Very Rev. Sr. Dorothy Chime (SND), Rev Sr. Ossi

Also in a special way, I thank Very Rev. Fr. Paul Ogbozor, Very Rev. Fr. Dr. Evans Offor, Rev. Fr. Ekene Onoh, Very Rev. Fr. Patrick Malo, Rev. Fr. Reuben Ozoude and my scout trainer Elder Chief M.N. Nwabuko LT, Wbs.

I equally thank Chief and Mrs. Joseph Onah, High Chief Chukwudi Ndumele (Umuahia) and Dr. Rechard Ojiakor my Landlords at different levels of my academic sojourn, Very Rev. Fr. Dr Nwachukwu (HOD

Sociology, GOUni), Very Rev. Fr. Dr. Frank Eze (General Study, Gouni). I thank the legend of Uboji Ngwo, Chief Charles Ugwuagu and his Cabinet.

I am very grateful to HRH Igwe I.O.U. Ayalogu the Asaa of Ngwo Asaa. I thank the Crown Prince Uche Mike Ayalogu, I thank High Chief J.J. Chukwu, Dr. R. Orjiakor, Kim Greg Ani

I thank my Umunna, Obinagu Amokwe Uboji Ngwo. Am grateful to the Chairman Prince Mike Ume Ozor. To my grandfather Chief Pius Eze Ozougwu thank you, Mr. Paschal Ozofor (my cousin) and his brother Henry Ozofor.

I thank my friend/colleague at IMS-ESUT Chief Ikechukwu Ezegwuorie, Mr. Romanus Ngwu, Prof. Chinelo Igwenagu and others.

I equally thank my friends/colleague at UNI ZIK, GOUNI and IECE: Charlese Anibuike, Rev. Fr. Okwudili Ugwu, Rev Fr Anthony Nwachukwu. Mr. Christian Ajibo, Dr. Alloy Ezeagu, Very Rev. Sr. Theresa Ani, Very Rev. Dr. John Odey, Chief Ephraim Ozochinanuife.

I also thank the Provost of Federal Scholl of Social Works Emene Chief Chris Ajibola and family. I thank also Pastor Mrs. Ijeoma Chime from PPSMB Udi Education Zone and her workers. I am also grateful to Very Rev. Fr. C. Obe, and Dr. Theresa Ani (Counselor).

I am very grateful to good works of Bernadine Ugwuanyi in compiling this lecture. Nneka Manulu helped in the organization of the lecture. I appreciate the good works of my publishers and friends; Chief Eric Mbaeze and Daniel Mmadu, Mrs. Ijeoma Nwabueze.

Finally, I thank the following physicians: Dr. Ositadinma Ngwu (family Dr.) and Dr. Barth. Ezeude (Somadina Hosp) and Dr. Thom Ngwu (my personal physician).

I say Gracias! Gracias!! Gracias!!!

APPENDICES

Source: Otomeoha Research
Appendix I: Room furniture use for teaching shapes like circles, cylinder, rectangle, pipe, trapezium

Source: Otomeoha Research
Appendix II: This complete traditional basket is used for teaching cylinder or area of a ring.

Source: Otomeoha Research
Appendix III: Basket Making use for teaching latitude and longitude (Small and great Circles)

Source: Otomeoha Research
Appendix IV: Constructed geoboard and draft boards for teaching charts, graphs and some concepts in probability

Source: Otomeoha Research
Appendix V: Mathematics applications and practices in the market in an Igbo Village

Source: Information Nigeria Facebook
Appendix VI: Ncho game (Traditional Igbo Game for solving problems on probability

BIO-DATA

JOURNEY TO THE WORLD OF ACADEMICS

Professor Dr. Ndidiamaka Michael Ozofor was born on September 17, 1963 at Amokwe Uboji Ngwo Uno in Udi Local Government Area of Enugu State. He was the 9th Child of his parents; Chief and Mrs. Ani John Ozofor (Atu Obinagu). He attended Community Primary School Upata Ezama, Owa Imezi where he was staying with his elder brother Ozo Dr. Linus Ozofor(Late). After his primary school in 1976, he went to Fatima High School, Aguobu Owa where he sat for WAEC in 1981 and got all his 9 papers. He went to Institute of Management and Technology (IMT) where he studied Systems Science and graduated in 1985 with DIMT. He proceeded to the University of Nigeria Nsukka in 1986 where he studied Statistics and Education, double major and obtained B.Sc Statistics Education in 1990. He went to Sokoto State where he served for one year as the Corper Liaison Officer under the NYSC Scheme (1991). On finishing his NYSC, he went for further studies at the University of Nigeria, Nsukka where he got his Masters Degree in Mathematics Education (M.ED), 1993. He went further for his doctorate in 1995 to the same University of Nigeria Nsukka where he obtained a Ph.D. in Science Education – Mathematics in 2001.

On his post doctorate trainings, he went to Centre for Information and Communication, Technology Alvan Ikokwu College of Education, Owerri 2005, where he obtained certificate on informatics. Ndidi Ozofor went to National Institute for Science Laboratory Technology, Ibadan to study Data Analysis and Quality Control. He further went to National Centre for Science Equipment Maintenance and Services, UNN, 2008. At the same centre NCEMD UNN in 2011, he was trained on MATLAB / SCILAB for data Analysis / Visualization.

On his working and teaching career, Ndidi Ozofor was a farm manager in Ozo V. O. Nwani Farm Complex Ngwo from 1981 to 1982.He later become principal of Ave Maria Vocational College Ngwo (1985-1986). He was Senior Mathematics / Physics teacher at Community Secondary School Egede in 1994. He was at a time Head Planning Research and Statistics PPSMB Udi Education Zone. In 1999, he continued as the HOD Planning, Research and Statistics PPSMB Udi Education Zone Enugu, SGL on 14[8]. He worked as Principal Lecturer (Part Time) and later become External

Examiner / Consultant to Federal School of Social Works, Emene, under the Federal Ministry of Sports and Social Development from 2000 to 2005.

He was employed at IECE as Lecturer 1 and rose to Senior Lecturer in 1996 and right from then, he taught many courses like Introduction to Statistics for Education (EDU332), Measurement and Evaluation (EDU 333), Inference I,II, III, Computer Appreciation, Computer Programming, Population Education, Statistics for Economics (ECO 344)Mathematics Statistics, Research and Computer Processing, Probability Theory (STA221), Quantity Control (STA242), Sampling Distributions and Theory (STA 311), Numerical Analysis / Methods (MTH353), Experimental / Scientific Research Design (STA 423), Stochastic Processes (STA 433). He was once the HOD of Social Studies, Accounting Education, Business Education, Secretarial Technology and Commerce / Cooperatives (Degree Programme) Mathematics / Computer Education at Institute of Ecumenical Education Thinkers Corner Enugu, in affiliation with ESUT, Enugu (2001- 2006).

As a leader, Professor Dr. Ozofor leads so many groups and organizations as early as 1980 when he became the President of Uboji Students Union and Udi Local Government Students Union (IMT). President, Ngwo Undergraduates Association (NUA) (1983-1985), President, Pioneer Total Abstinence Association Ngwo Centre (1984-2003), Enugu Regional Vice President, Pioneer Total Abstinence Association (1995-2003), Group Scout Leader, Ngwo Boy Scout Groups (1982-2003), Headquarters' Scout Commissioner Explorer, Enugu State (1997-2009), Chairman Catholic Young Men Organization Ngwo Parish (1985-1990), President, Catholic Workers Volunteer Force of Ngwo (1989-1990), President, Ngwo Undergraduates Association UNN (1989-1990), Coordinator, Human Life Protection League Enugu District (1991-1998), Secretary, Financial Council CKC Parish Ngwo (198-2000), Staff Adviser, Ngwo Undergraduates Association (1999-2002), Member, board of Governors – Community Secondary School Ngwo – Uno (1999-2000), Diocesan President, Pontifical Association of the Holy Child Hood, Enugu Diocese (1998-2000), Secretary, Enugu Diocesan Inculturation Commission (1998-2002), National President of the Pioneer Total Abstinence Association of Sacred Heart of Jesus (2006 till date), President, Associates of Sisters of Notre Dame, Enugu (2010-till date). Ndidiamaka Ozofor is a stakeholder in the United Nations (UNIDO) Research on Resource Efficient and Cleaner Production, with Federal Ministry of Environment Abuja from 2021 till date.

Professor Dr. Ndidi Ozofor has published the following books: Population Education: A Pragmatic Approach, (1996). Enugu Chestern Press. A Brief History of Mathematics (2000) Nsukka, Easy Quality Press. Pivot of Statistics (2001) Enugu, Easy Quality Press Non – Parametric Statistics: An Introduction (2003) Enugu, Godswell Press Ltd. Science; Unending Voyage l (2004)Enugu, Mbaeze Press Enter. Ltd

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His Doctoral Thesis was Effect of two modes of computer aided instruction on students' achievement and Interest in statistics and probability. (Unpublished Ph.D Thesis 2001 UNN)

Professor Dr. Ozofor received the following Awards/Prizes: NYSC best awards on publication Sokoto (1991), NYSC Leadership award as a good liaison offer, Sokoto State (1991), 1st prize Igbo proverbs Udi Deanery Competition (1997), 2nd prize Enugu Diocesan Cultural Competition (1997), Long Service Award South East Scout Organization, Wood Badge (International Award) where, Excellent Teachers Award by PG students Union ESUT (2001), Community service award 2003 by Rotaract club, Institute of Ecumenical Education Enugu. (2003),

At Godfrey Okoye University, Professor Dr. Ndidi Ozofor was the pioneer HOD for Computer Science/Mathematics and was given a commendation letter for his embellished work as HOD after five years. He has been the mace bearer of this university. He teaches courses on statistics, mathematics, computer and research. He is a consultant to Federal School of Social Works, Emene; a consultant to the Invitative for Welfare of African Child and Development (WELDACY) Enugu; a consultant to National Centre for Technology Management (NACTEM) South East Nigeria. He is a member of the GO-Uni Senate Committee on Curriculum Development. He attended many conferences/seminars/workshops and presented many papers. He published over 30 articles in internal journals. He wrote 15 books. He is an adjunct Professor in Industrial Mathematics and Statistics, Enugu State University Science and Technology (ESUT).

Professor Dr. Ndidi Ozofor is the director of GO-Uni Students Industrial Works Experience Scheme (SIWES). He was promoted to the rank of Associate Professor in 2016. He has won many prizes and Awards. In 2011 he was awarded the best Mathematics pedagogist in Southeast, Nigeria by Longman's International Press Ltd and made a resource teacher in Mathematics for Mathematics teachers Southeast. Since 2021, he has been a Stake holder/Researcher with the United Nations Industrial Development Organization (UNIDO) in collaboration with Federal Ministry of Environment (Abuja), Member of Governing Council, Lux Mundi University, Umuahia.