



**OSUN STATE UNIVERSITY  
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SERIES**

**006**

**APPLIED MATHEMATICS AS A PANACEA TO ALL  
ROUND DEVELOPMENT: TRENDS AND PROSPECTS**

**BY**

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**ON WEDNESDAY, 15TH FEBRUARY, 2012**

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Mr. Vice Chancellor Sir, distinguished ladies and gentlemen, I stand before you today to give the first inaugural lecture from the Department of Mathematical and Physical Sciences of the College of Science, Engineering and Technology of the Osun State University, Osogbo.

May I first say that I am happy to have found such a congenial Department of Mathematical and Physical Sciences in which to work. I realize that much of the strength it has acquired over the last four or so years is due, in no small measure and often in the face of adverse conditions, to the untiring leadership of our Vice-Chancellor, Professor Sola Akinrinade. I thank the Osun State University for affording me the opportunity of being the first substantive Head of Department of Mathematical and Physical Sciences and also the first elected Provost of the College of Science, Engineering and Technology.

An inaugural address for a mathematician is a particularly frustrating affair. For, with a non-technical audience, as I take this to be, he is robbed of the basic equations which he uses to express his thoughts about his subject and which are the prime ingredients of his medium of expression. The purpose of an inaugural lecture is to allow the Professor to let the audience know what he has contributed to knowledge in his area of specialization. In doing this, he is expected, as much as possible, and in a very simple language, that is, avoiding very technical terminologies to explain his contributions to knowledge. It is for this purpose that I will try as much as possible to make audience appreciate my contributions to knowledge in my area of specialization without excessive use of mathematical technical terminologies.

It is very obvious from the title of this inaugural lecture that I am going to talk about applied mathematics. What aspect of it I am talking about is yet to be known. What is of most interest to me at this stage is what people know, think or talk about applied mathematics and mathematician for that matter. My utmost intention this afternoon is to let the mathematically uninformed in the audience know what applied mathematics is all about.

**MATHEMATICS** is a subject dreaded by many. To some students, if there is any way they can do without mathematics, they will readily welcome the idea. The reason students give is that the subject is difficult to comprehend. So, in most cases, they just study it because it is compulsory. However, a recent study states that there are people with the natural ability to understand the subject from birth and all they may need will be proper nurturing.

Mathematical sciences can be defined as the art of problem-solving through logical reasoning. We must admit that not all reasoning is logical. So there is no tautology in this definition. It does not matter what the nature of the problem is as long as it is amenable to solution through the use of logical reasoning. Thus, we cannot tackle a religious or spiritual problem successfully through the use of mathematical sciences, because logical reasoning really has no part to play in that sphere. But we can tackle any medical, technological or social-economic problem successfully through its use. Of course, all purely scientific and engineering problems are governed by the laws of logical reasoning, even if they do not appear to be so. The application of the methods of mathematics to Biology has led to a great deal of insight into the nature of biological systems. The unravelling of the group theoretical basis of the DNA molecule is a good example. There are many more examples with which you are all familiar.

Mr. Vice-Chancellor sir, any keen observer of the development of this nation over the past four decades will grant that the dominant approach of most of the governments that have managed the economy has been far from a problem-solving one. We have managed our resources as if there were no management rules to go by. In fact, one of our past Heads of State once marvelled that he had tried all the tricks in his bag without making any impact on the improvement of the nation's economy. Some cynics have interpreted what he said to mean that he had tried his best to ruin the economy and the country with it. But the country has behaved like the good old 'Volkswagen beetle', grossly abused by Nigerian roads, that refused to be killed off! The truth is that both his failure to improve the economy and the resilience of the country even in the face of such shameless plundering by those who should know better, all follow some principles that can be analyzed and resolved through the use of the methods of the mathematical sciences.

Thinking in the abstract seems to be something that is not well favoured in our indigenous cultures. That is probably why our native science is not well developed. In African traditional systems, the tendency has been to suppress the formal study and exposition of the science that underlies any technology. That may be because traditional African systems have been hampered by the absence of written records and complex arithmetic, two intellectual tools essential for the development of all scientific investigations.

Our definition and understanding of what mathematics is an outgrowth of an evolution of the mathematics processes over hundreds of years. Computers and

calculators have revolutionized how an information world deals with mathematics and thus has revolutionized our definition of what mathematics is.

Mathematics is a language we use to identify, describe and investigate the patterns and challenges of everyday living. It helps us to understand the events that have occurred and to predict and prepare for events to come so that we can more fully understand our world and more successfully live in it.

Mathematics encompasses arithmetic, measurement, algebra, geometry, trigonometry, statistics, probability, and other fields. It deals with numbers, quantities, shapes and data, as well as numerical relationships and operations. Confronting, understanding and solving problems is at the heart of mathematics. Mathematics is much more than a collection of concepts and skills; it is a way of approaching new challenges through investigating, reasoning, visualizing and problem solving with the goal of communicating the relationships observed and problems solved to others.

Mathematics is a way of describing the relationships between numbers and other measurable quantities. Mathematics allows scientists to communicate ideas using universally accepted terminology. It is truly the language of science.

We benefit from the results of mathematical research every day. The fibre-optic network carrying our telephone conversations was designed with the help of mathematics. Our computers are the result of millions of hours of mathematical analysis. Whether prediction, the design of fuel-efficient automobiles and airplanes, traffic control, and medical imaging all depend upon mathematical analysis.

For the most part, mathematics remains behind the scenes. We use the end results without really thinking about the complexity underlying the technology in our lives. But the phenomenal advances in technology over the last hundred years parallel the rise of mathematics as an independent scientific discipline. Without mathematics to describe physical phenomena, we might be living in a world with beautiful art, literature, and philosophy, but no technology. Even the medical advances of the last fifty years might not have occurred.

Science and technology, in their turn, have provided many of the problems that motivated progress in mathematics. Such problems include the behavior of weather systems, the motion, of sub-atomic particles, and the creation of speedier and smaller computers that can perform multiple tasks simultaneously. Mathematics attempts to capture the complexity of a problem using mathematical notation (signs and symbols) and concepts (theorems and proofs). Mathematical notation is a powerful tool, especially for

representing entities, processes, or relationships that are impossible to visualize. For example, in modern geometry, mathematicians may work with more than three dimensions of space, even with infinite dimensions.

Although these spaces are difficult to imagine, objects in these spaces can be studied through mathematics. Einstein's discovery of relativity depended on studying objects in four dimensions, with time as the fourth dimension. Mathematicians develop simple corresponding models in two or three dimensions and then use the symbols and logic of mathematics to extend their intuition to infinite dimensions.

Mr. Vice-Chancellor sir, mathematics, the language of science, has two dialects: pure mathematics and applied mathematics. Both kinds of mathematics are used to solve problems. Pure mathematics is the study of abstract relationships, whereas applied mathematics applies mathematical analysis to real-world problems, such as the rate of global warming. The relationship between pure and applied mathematics is a complex one, and the boundary between the two is constantly shifting.

Pure mathematics is more abstract than applied mathematics. It emphasizes rigorous proof, manipulates symbols rather than numbers, and seeks to obtain the most general results possible with the fewest possible assumptions. Applied mathematics, while just as concerned with rigorous mathematical methods, emphasizes applications. Applied mathematics has had close ties with the sciences and engineering throughout its history. Applied mathematicians believe that new mathematical ideas and areas of study can come from using mathematics to solve problems in physics, chemistry, biology, medicine, engineering, and technology. Much of the current research in applied mathematics takes place outside traditional mathematics departments.

Subject areas in applied mathematics often overlap areas associated with other fields, including economics, physics, mechanics, and the information theory. For example, mathematicians who study the structure of matter and the behaviour of sub-atomic particles overlap in their area of research with physicists. Some areas of applied mathematics depend heavily on pure mathematics. Numerical analysis, which studies computational methods for solving mathematical problems, relies on the pure mathematical areas of partial differential equations and variational methods. Other areas, such as computer science, are as broad as the entire field of mathematics.

***Job opportunities:*** Mathematics is a discipline for brilliant students; unfortunately most of these capable students do not like to read mathematics as a course in the university.

However, the truth is that mathematics is the most versatile discipline or course with the most promising job opportunities anywhere in the world. A good degree in mathematics guarantees good job any day because of the flexibility it offers. Unfortunately, it has been observed that most of those studying mathematics in the country in recent times are not really capable people. While the most brilliant pupils went for mathematics in the 60s, 70s and 80s in Nigeria, the majority of students studying mathematics in recent times are weak students who could not secure admission into the so-called professional courses. So, one should not use the plight of many of the recent graduates of mathematics to judge the job potential of the course. In fact, this is the situation with many of the important science courses. If you are bright and good in mathematics, you are assured of very lucrative career opportunities. Mathematicians are needed directly in all manufacturing industries, oil companies, and research establishments.

Mr. Vice-Chancellor sir, *two plus two equals four* may not be rocket science, but is it science? Mathematics is frequently associated with science and is certainly relied upon by scientists - the pages of any modern biology, chemistry, physics, geology, or psychology journal are peppered with calculations, statistics, graphs, and mathematical models - but how much like science is mathematics itself?

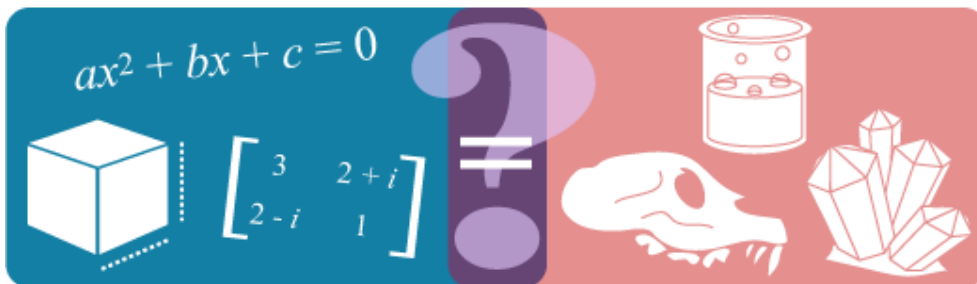


Fig 1: *Quadratic equation*

The answer depends on one's philosophical views on the nature of mathematics - and in this area, philosophers and mathematicians have not reached a consensus. For example, some view mathematics as sets of rules we have constructed for manipulating abstract entities - entities which may or may not have any relation to the real world. Others view mathematics as the deeply embedded structure of the natural world itself, which must be "discovered" just as protons, neutrons, and electrons were discovered. Many other views

of mathematics also exist. Here, we consider these common views of mathematics and use the Science Checklist to see how similar mathematics and science really are;

➤ **Focuses on the natural world?** Often mathematics is seen as dealing with entities that have parallels in the natural world but don't themselves exist in that world. Unlike, say, ants or atoms, the number two is not generally viewed as a physical entity, but as a powerful abstraction that can be used to describe physical entities. On the other hand, one could also argue that mathematical abstractions arise directly from the natural world - that the fact that two ants plus two ants yields a set of four ants is simply a description of how objects exist in the natural world.

➤ **Aims to explain the natural world?** Many mathematicians work on problems that help us understand and explain the natural world. For example, Isaac Newton's discovery of the basic rules of motion was made possible by the advances he made in calculus. While some mathematical disciplines (e.g., applied mathematics) are aimed at helping us understand real-world physical entities, others (e.g., algebraic geometry) mainly focus on advancing abstract mathematical knowledge - though even this abstract knowledge is often found to have real-world applications later on. And, of course, taking an entirely different perspective, if one views mathematics as embedded in the structure of the natural world, then *all* mathematical investigations could be seen as aiming to explain the natural world.

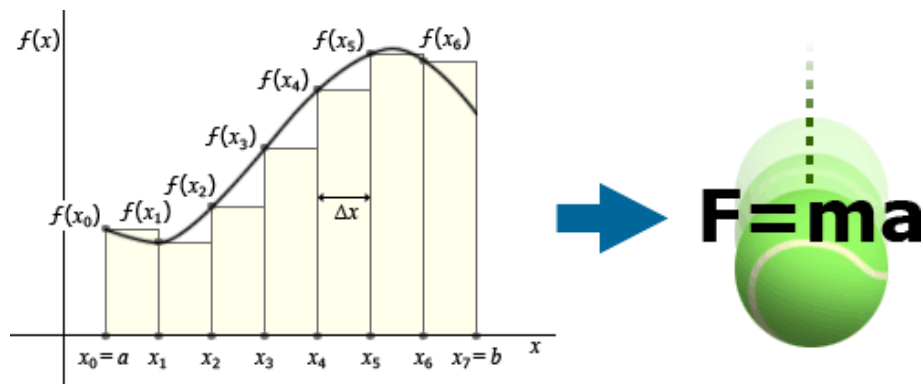


Fig 2: *Advances in calculus (left) helped Isaac Newton formulate a new understanding of how objects in the natural world move*

➤ **Uses testable ideas?** Mathematical ideas are testable - but not generally against evidence from the natural world, as in biology, chemistry, physics, and similar disciplines. Instead, mathematical ideas that are not yet proven may be tested computationally. For

example, we can test the idea that every even integer greater than two is the sum of two prime numbers. To test this, simply consider many different even numbers and try to find two prime numbers that add up to each of them. How about 6? That works because 3 is prime, and  $3 + 3 = 6$ . How about 24? That works because 17 and 7 are prime, and  $17 + 7 = 24$ . If we find many sets of numbers that fit with the idea, we have some evidence that the idea is correct. If we find even a single case in which an even number greater than two *cannot* be written as the sum of two prime numbers, we have strong evidence that the idea is incorrect. This idea is known as the Goldbach conjecture, and whether or not it's true is still an open question in mathematics. The method of testing described here involves searching for a counter example to a particular idea, but mathematicians have other ways of testing their ideas as well - and many of these have been applied to the Goldbach conjecture. These sorts of mathematical tests generally do not involve going out into the world to make observations that might support or contradict the idea - though, of course, if one views mathematics as embedded in the structure of the natural world, then simply observing that  $3 + 3 = 6$  could be seen as stemming from the natural world.

➤ **Involves the scientific community?** Mathematics relies on its own community. Just as in the scientific community, members of the mathematical community collaborate on projects, scrutinize each others' ideas, evaluate each others' work, and maintain ethical standards within the community.



*Fig 3: Mathematicians at a conference scrutinize each other's work*

➤ **Leads to ongoing research?** Mathematical breakthroughs contribute to new discoveries in mathematics and often to new research methods in standard sciences like biology, chemistry, and physics. Even mathematical knowledge that is developed purely

abstractly, without any thought towards potential scientific applications, frequently turns out to be useful in scientific research. For example, in 1909, mathematician David Hilbert began developing mathematical tools to study infinite dimensional spaces, which were used more than 10 years later to formalize quantum mechanics — one of the foundational theories of modern physics.

Mathematicians are expected to abide by the same set of rules for "good behaviour" as physicists, chemists, and other scientists are expected to follow. They build on the work of other mathematicians, share their ideas and results with others, respond to and incorporate criticism of those ideas, and are expected to "play fair" in their work (e.g., report their results accurately, objectively evaluate others' research, avoid stealing each others' ideas, etc.).

Mr. Vice-Chancellor Sir, in our world today, the meaning of mathematics is continuously and constantly evolving as man becomes more astute. The world is shifting from an industrial age into an informational age. Then what should the meaning of mathematics be as it becomes of age into information-oriented world? The constant increase of calculators, computers and technology has forced us to redefine mathematics in a new context.

Now it's up to you. How is mathematics similar to and different from science?

### **THE NATURE AND STRUCTURE OF MATHEMATICS.**

Mathematics as a discipline has a long history spanning thousand of years, with significant contributions to its developments at various periods of history from various cultures - e.g. Egyptians, Babylonians, Greeks, Indians, Mayans, Chinese, Europeans, etc. The historical development of the subject, as well as the evolution of modern Mathematics, is replete with lessons in symbiosis between Pure and Applied Mathematics with pure mathematics, once created, helping to solve Applied problems while Applied Mathematics motivates the creation of new areas of Pure Mathematics.

However, the subject has come a long way since Archimedes used to struggle to find the volume of a sphere through weighing infinitesimals (into which such a sphere was divided). Methods currently applied have become very profound, sophisticated, rather technical and diversified and we rightly see mathematics today in its various ramifications, *number* – involving such activities and counting, measurements of length, weights etc and displaying such deep understanding of rational, real, complex, p-adic numbers, etc. *shape* –

leading to studies in geometrics, topology, Lie groups with applications to gauge field theories, fractals, catastrophies, strange attractors etc *movement* – of waves, planets, involving the use of ordinary and partial differential equations, Fourier Analysis, Calculus of Variations; *chance and randomness* - with associated mathematics like probability, statistics, stochastic differential equations, etc. all with the added exploratory and processing power of new technology, e.g. computers.

The developments in mathematics in the last one hundred years in particular, have been so extraordinary and phenomenal that it is believed that more mathematics has been created in the last fifty years than in all previous age together. The subject is now so large with so many sub-disciplines that it is absolutely impossible for any one to grasp it all. And the fact that the subject continues to grow phenomenally in various directions creates a crying need to continue to find efficient; economical ways of co-ordinating and unifying ideas.

Many traditional applied areas e.g. Physics, Economics, Chemistry, Biology, Engineering now require sophisticated mathematics for their in-depth study and problems in mathematics that have confounded mathematician over the years have been solvable only through highly sophisticated and abstract techniques including the easily posed and innocent looking ones like “Fermat’s Last Theorem”. Furthermore, as we find ways of solving other outstanding problems, there will be more and more theories developed, and earlier results generalized to deepen our insight.

All these consideration raise serious pedagogical issues as to how to minimize the current global illiteracy in contemporary mathematics that has resulted in hostility towards the subject from parents, funding Institutions and the general public. A lot of the ideas that should have filtered down to schools and teachers’ training colleges are still circulating among relatively few specialists, if the educational system is to benefit from some of the enormous volume of desirable Mathematics still circulating among relatively few initiates and practitioners. The new school mathematics and the revised University Mathematics curricula of the future will inevitably popularize central ideas of new discoveries in mathematics.

It is not the aim of this lecture to go into the history of the development of Mathematics. Suffice it to say, however, that by the beginning of the Twentieth Century, the central core of Mathematics - Algebra, Analysis and Topology had emerged, the knowledge of which is sine-qua-non for any modern practising Mathematician. Indeed, efficiency in the understanding and the usage of the language of these three areas is a necessary condition for any one to be considered as truly literate in contemporary

mathematics. This central core is usually referred to as Pure Mathematics. Each of these area has also broken up into various subdivisions constituting part of the core of Mathematics, e.g. Algebra has such subdivisions as algebraic number theory, linear algebra, commutative algebra, group representations, category theory, etc. Analysis has such subdivisions as Real analysis, Complex analysis, Functional analysis, Harmonic analysis, Fourier analysis, etc. Topology, has such ramification as Differential topology, Algebraic topology, Analytic topology etc. A modern mathematician soon realizes the cross fertilization of ideas to the extent that some areas are difficult to classify under the rubrics of Algebra, Analysis or Topology, since they could be a combination of all. Under the rubrics of Applied Mathematics, also extending into Mathematical Sciences, we have such area mechanics electromagnetic theory, quantum mechanics, various types of Engineering, Operations research, Computer science, Statistics, Mathematical modelling, Mathematical physics, Mathematical economics, Mathematical biology linguistics, even Mathematical history otherwise known as Cliometrics, each of which invariably makes use of ideas from the central core.

So, the structure of Mathematics could be viewed as concentric circles with diffuse and ill-defined boundaries, all built on a central core of Pure Mathematics and extending outwards through Applied Mathematics to the Mathematical Sciences in such a way that red-hot ideas, theories and problems from the core percolate to the outside layers through the diffuse boundaries to enrich and solve the more applied problems while problems arising from the outer layers provide the central core with new structures, new concepts and methods. As will be seen later during this lecture, the artificial boundary being often created between the so-called Pure and Applied Mathematics is also counter-productive towards development. The truth is that, many areas of natural, technological and social sciences now require profound and sophisticated Mathematics for their in-depth study resulting even in new Mathematics and further extension of Mathematical frontiers.

### **THE CREATORS AND USERS OF MATHEMATICS**

It seems worth while to me to attempt a classification into four different groups of those theoreticians who use mathematics to a significant extent. These groups are:

***The pure mathematicians:*** Those concerned with the construction and deductive analysis of abstract, axiomatic systems and with the doing of algebra, analysis, geometry, and the like.

***The theoretical scientists:*** Those primarily concerned with the discovery of new scientific laws, i.e. with the construction and understanding of idealized models which fit the experimental facts either in the exact sciences, the biological sciences, or the social sciences.

***The theoretical engineers:*** Those concerned with the invention, design, understanding, the theory of maintenance of the constructs of applied science.

***The applied mathematicians:*** Those concerned with the deductive analysis of the accepted idealized models of science and engineering, and with the use of mathematical methods to explore and describe phenomena in terms of these basic models. In addition, they are concerned with the light that these concrete realizations throw upon the development of new mathematical methods and abstract mathematical structures. In this classification, the statisticians would have to be housed primarily with the applied mathematicians.

The above divisions are not watertight and probably the designations would not be acceptable to all. Clearly, there should be free interplay between all four at the mature level. Before we examine the relationship between these various theoreticians, it would be pertinent to survey the role of mathematics in science and engineering.

## **THE ROLE OF MATHEMATICS IN SCIENCE AND ENGINEERING**

***Scientific method:*** Starting from the observed facts of nature, the scientist tries to fit them to a simple pattern. Properties and relations which roughly hold are noted and a classified system is built up into which further facts are fitted. Roughly speaking, the broader the class the more vaguely it is defined.

If the system becomes sufficiently complete and interesting, it is usual to tidy up the reasoning and present it deductively in terms of conclusions drawn from an idealized model. The conclusions are then compared with experiment and, if the comparison is unsatisfactory, modification of the model is necessary. If, on the other hand, the comparison is satisfactory, the way is then open for generalization and extension of theory and experiment - and so the cycle of inductive and deductive reasoning repeats itself.

The question of the absolute reality of the model does not arise significantly; rather it is the simplicity of the model as viewed by our minds and its adequacy in accounting for the known and as yet the unknown experimental facts that are decisive. We may feel as Eddington did, that what determines the simplicity and adequacy of the

model is in some measure a function of the structure of the human mind and of the manner of its stimulation by the external world. Figuratively speaking, Martians, even favourite ones, may well find a different set of models simpler and more convenient.

***Classical Applied Mathematics:*** In those branches of science which can be adequately modelled, the part played by mathematics is mainly a deductive one. Broadly speaking, the whole subject is deduced by pure mathematics from the abstract properties and relationships of the entities of the model. Apart from the intrinsic interest, this approach has much to justify it. It presents the facts of the subject in a concise and assimilable form. Inconsistencies are revealed and further lines of possible development or generalization are made more apparent (e.g. Maxwell's theory of the non-stationary electromagnetic field).

Unfortunately, if the model is a detailed one, the general theory, when applied to a particular physical or engineering problem, usually leads to a highly complex mathematical question. Approximation then becomes necessary. In any case, the model, being a simple abstraction from a large body of facts, will only fit the practical problem approximately. Approximations may be made either in the physical details of the model or in the mathematics. Usually, it is a happy combination of the two that is required; the descriptive details of the model are modified in the light of previous mathematical and physical experience in such a way as to allow the desired analysis to be carried out and yet still maintain reasonable accord with the scientific facts.

***Mathematics as a Scientific Research Tool:*** The construction of suitable model is difficult and is far too easily neglected by both the mathematical and the scientific sides. Here, the role of mathematics is a much more inductive one. We add features to the model experimentally keeping in mind that they must accord with the facts and make mathematical development possible. Comparison of the mathematical model with experiment leads either to modification of the model or else to more quantitative detail about its features. (Thus, in the kinetic theory of gasses, we first assume a fairly general law of force between molecules and then by comparison of the mathematical consequences with experiment we deduce its quantitative nature.)

We try on the one hand to construct a model so that as many relevant scientific facts are encompassed as possible and yet on the other hand, we endeavour to simplify the features sufficiently to make them yield to mathematical analysis. The process is one of

intelligent trial by error, in which generalizations and speculations are made on both physical and mathematical grounds.

The complete analysis of any problem must not only account for the phenomena but must show just what features of the model are responsible for them and to what extent. Occasionally, it is only after a complete mathematical analysis of a detailed model that the relevant features for the phenomena under investigation are revealed and the way is paved for a simpler, more direct theory. More often, physical insight provides the model for the simpler theory and this pilot analysis breaks the path for the detailed mathematical analysis of the finer features.

The need for skill in the construction of models cannot be overemphasized. Often, this construction is more difficult than the mathematical work that follows. Such skill is best gained by experience and from a knowledge of the relevant science, as well as from an understanding of the various simple standard models and an experience of their use in synthesis. Also, a grasp of the scope of the available mathematical methods is vitally necessary.

As a research tool, mathematics is at its best when the questions asked involve a range of cases - for example, the effect of varying certain parameters. For particular engineering problems and experimental approach is frequently more suited and accurate than a detailed and complex analysis of an inevitably idealized situation.

### ***The Role of Mathematical Sciences in the third millennium.***

In the third millennium, there is need for us to chart a new course for our scientific efforts. It can be taken for granted that basic education for the masses is indispensable to the progress of any nation. Nigeria needs to be more deeply involved in this exercise, since it does not appear that the scientific attitude has made any significant impact on our value systems. It would seem to me that the principal value of the mathematical sciences is their ability to produce good thinkers and to nurture a crop of people who are not fatigued by long periods of sustained logic. This ability can be transferred to other fields of endeavour, once it has been acquired. It is unusual for people who have excelled in one area of Mathematical Physics to transfer their competence to another area of human activity such as biological science or even politics. The number of people whose task it is to find novel solutions is always small. It is for this reason that I think Nigeria should place very high premium on the cultivation of a small core of scientific activity.

It does not really matter what area of Applied Mathematics or Theoretical Physics we decide to devote our attention to, provided that the problems are such as to stretch our minds to the full, and provide some linkages with what is going on in the rest of the world and in our own environment. One area that is most relevant to our economy is GEOPHYSICS. We should in this century take steps to develop strong research groups in all areas of theoretical geophysics, including seismology. This is because our future depends so much on our mineral wealth and it is not good for us to depend so much on foreigners to explore our resources for us. We should at least take an active part in developing the tools needed for search and discovery in the area of petroleum and related resources.

### **The Role of Mathematics in Building a Democratic Society**

Political issues deal with government, economics, relations among nations and social classes, people's welfare, and the preservation of natural and cultural resources. Mathematics is deeply involved with these issues and mathematicians and mathematics educators cannot ignore them.

The possibility of the final extinction of civilization on earth is real, and not only through nuclear war, which was a major threat during the Cold War, and which, in 1955, prompted two eminent mathematicians, Albert Einstein and Bertrand Russell, to invite other Nobel laureates to subscribe to a moving document, which became known as *The Russell-Einstein Manifesto*, and which gave origin to the Pugwash Conferences on Science and World Affairs (Pugwash, retrieved 2002).

We are witnessing an environmental crisis, disruption of the economic system, institutional erosion, mounting social crises in just about every country and, above all, the recurring threat of war. And now, "Niger Delta" people have been attacking people in our country since 1994, the uncertainties are a real threat to our mental and emotional equilibrium. A scenario similar to the disruption of the "Niger Delta" is now before us, i.e. "Boko Haram", with the aggravation that the means of disruption are, nowadays, practically impossible to control. Survival of mankind, with dignity for all, is a most urgent and universal problem.

It is clear that mathematics is well integrated into the technological, industrial, military, economic, and political systems and that mathematics has been relying on these systems for the material bases of its continuing progress. It is important to look into the

role of mathematicians and mathematics educators in the evolution of mankind, especially because mathematics is recognized as the most universal mode of thought.

Thus, it is appropriate to ask what the most universal mode of thought-mathematics-has to do with the most universal problem-survival with dignity (D'Ambrosio 2001). I believe that the need to find the relation between these two universals is an inescapable result of the claim of the universality of mathematics. Consequently, as mathematicians and mathematics educators, we have to reflect about our personal role in reversing the current country situation.

**Role of Mathematics in Nation Building:** Today, it is a reality that it is the creation, mastery and utilization of modern science and technology that basically distinguishes the so-called developing from the developed nations of the world. That is to say that the standard of living of a nation is dependent on the level of science and technology of that nation. While science is the bedrock that provides the spring-board for the growth of technology, mathematics is the gate and key to the sciences. In other words, it is the level of mathematics that determines the level of the science and technological component of any nation. The foundation of science and technology, which is the basic requirement for development of nation is mathematics. Therefore, mathematics plays a vital role in nation building.

Mathematics as observed by Abiodun (1997) is the major tool available for formulating theories in the sciences as well as in other fields. It is used in explaining observation and experiments in other fields of inquiry. Adeyegbe (1987) observed earlier that there is hardly any area of science that does not make use of mathematical concepts to explain its own concepts, theories or models. Mathematics is a science of the methods by which quantities sought are deducible from others known or supposed. Thus, anyone who neglects mathematics may not be able to go far in the sciences and in fact other things of the world.

Practical work and observation of nature are the main source of scientific discoveries. Mathematical methods play a very important role in this. Mathematical methods lie in the foundation of physics, mechanics, engineering, economics, chemistry and so on. According to Bermant in Harbor-Peters (2000), an important feature of the application of mathematics to sciences is, that it enables us to make scientific predictions that are to draw on the basis of logic and with the aid of mathematical methods, correct conclusions whose agreement with reality is then confirmed by experience, experiment

and practice. Thus, mathematics is the bedrock of science and technology, which is the springboard of national development.

Mathematics today is having an enormous impact on science and society. The influence may be silent and appear hidden but has shaped our world in many ways. Mathematical ideas have made possible the revolution in electronics, which has transformed the way we think and live today. The information technology (IT) of today has transformed the world into a global village. These advances in science and technology are made possible by the numerous developments in pure mathematics. Mathematical sciences have helped to improve the ability to predict weather, to measure the effects of environmental hazards, project the outcomes of electrons, etc. Mathematical methods, structures and concepts have become indispensable to the functioning of the technological society. Indeed in this period of hi-technology and internet super highways, no nation can make any meaningful achievement, particularly in economic development, without technology, whose foundation are science and mathematics.

In this present age of science and technology, the achievement of any meaningful economic development must be largely dependent on science and technology, which is also dependent on mathematics. Ukeje (1997) observes that improved scientific knowledge and the availability of modern technology, even if indigenous, will certainly increase economic productivity and viability. However, the state of science and technology is a function of the development and application of mathematics. Reference could be made of the ever-growing mathematical concepts and systems that are being applied effectively for the service of man. Examples of this abound in areas such as the application of system analysis to achieve cost effectiveness in various industrial and management systems, utilization of fuzzy logic and fuzzy control for equipment manufacturing and econometric in the solution of economic problems.

Mr. Vice-Chancellor sir, today mathematics in its various forms has found applications in economics, science, chemical and energy development, engineering and technology, that it has become, a veritable and indispensable tool in national development.

### ***APPLIED MATHEMATICS AS AN INDEPENDENT DISCIPLINE***

Now that we have surveyed the role of mathematics in science and engineering, the question that next arises is: Who is responsible for seeing that this role is carried out to the maximum effect? Do we need an applied mathematician, or will the pure

mathematician, the scientist, and the engineer suffice? My main submission today is, needless to say, that indeed we do need the applied mathematician.

In America, there is growing concern at the widening gulf that is developing between modern pure mathematics and the sciences. Modern developments in pure mathematics encourage the mathematicians to create new fields of activity which are exciting and aesthetically pleasing in their own right without reference to either general or specific problems. One cannot help feeling that mathematics, science, and engineering are basically a coherent body of intellectual pursuits which is subdivided because of human limitations. If intellectual hedonism is to be avoided, it becomes important to maintain an even development. The crucial step for this purpose is to emphasize the mutual interdependence of mathematics as a legitimate self-propagating discipline of scientific activity, side by side with pure mathematics, the sciences, and engineering.

Such a statement immediately arouses doubts in the minds of many people. For the feeling is prevalent amongst certain groups that there are scientists and engineers who know how to use mathematics and that there are also pure mathematicians who apply their knowledge of mathematics to scientific and engineering problems. Are not these people applied mathematicians? Should applied mathematics exist as an independent discipline?

These are legitimate questions. If applied mathematicians are to consist only of the two categories just described, then applied mathematics cannot be regarded as a self-propagating discipline. Marriages will be consummated here and there but the progeny will be mules almost incapable of handing on the form they have achieved. The subject would then lack an educational childhood in which its ideals and philosophies had been nurtured.

A challenging but practicable programme of education which introduces young students to such activities will always be needed.

### ***THE CHARACTERISTICS OF THE IDEAL APPLIED MATHEMATICIAN***

Let us not talk of what applied mathematicians are but rather of what we would like to see in some ideal benign mirror held up to their minds and their activities.

Applied mathematics is a branch of science which seeks knowledge and understanding of the external physical universe in terms of idealized models and through use of mathematical methods and scientific inference. The ultimate goal of the efforts of the applied mathematician lies in the creation of ideas, concepts, and methods that are of

basic and general applicability to the subject in question, be it fluid dynamics, meteorology, biochemistry, space engineering, information theory, or economics.

As a discipline of intellectual activity, applied mathematics lies between the sciences (e.g. physics, chemistry, or economics) and pure mathematics. In essence, it represents an attitude, and approach, a way of thinking. The principal theme is the interdependence of mathematics and the sciences. A particularly challenging type of activity is the development of mathematical theories and adequate models in those scientific subjects which have not hitherto been subjected to systematic mathematical treatment. In turn, these efforts lead by abstraction and generalization to new mathematical theories and ideas which are interesting in their own right as a part of pure mathematics. It is the recognition of this duality and a willingness to use the cross-fertilization of ideas in either direction that characterizes applied mathematics. The ideal applied mathematician must be a versatile scientist, a specialist in mathematics with a clear perspective and general knowledge of the fundamentals of a wide area of the sciences.

There are three important phases in the approach of an applied mathematician to a particular field of problems: First, he must formulate and idealized model in mathematical terms and then seed the area with a set of precisely formulated mathematical problems; secondly, he must solve the mathematical problems; and thirdly, he must discuss, interpret, and evaluate the results of his analysis. The solution of specific problems often serves merely as a focus and an aid in reaching final understanding. Successful solutions open up further paths of synthesis towards reality.

Pure mathematics arising from such problems, if shared with willing pure mathematicians, provides us with a means of bridging the gap between mathematics and the sciences. Such mathematics has more chance of becoming applicable in other branches of science. Many pure mathematicians prefer to be free from the fetters of natural science and to become involved in a class of problems which are self-contained. This often enhances the aesthetic aspects of pure mathematics but can lead to a dangerous vacuum.

The basic difference in motivation between pure and applied mathematicians is reflected in the habits and practices of their activities. The applied mathematician must have a deep-seated love for the precision and economy of a rigorous mathematical demonstration but he cannot be made inactive by these loyalties. In the second phase of his activities, his primary emphasis is always directed towards the ultimate solution and

he frequently uses scientific reasoning to achieve this end. It is in this way that a feeling for the right emphasis is gained by plausible argument and an insight is acquired for approximations which will prove adequate in the mathematics. The applied mathematician's work is responsible and disciplined but he is not a deductive logician interested solely in the beauty of form and the power of abstraction. He must have enough background in pure mathematics to be able to distinguish between rigorous proof, reasonable demonstration, plausible argument, and hopeful speculation. There are times when he must be prepared to scrub up and determine with proper rigour the precise conditions under which results hold and indeed this is his ultimate goal.

In the first and third phases of his work, the applied mathematician must follow the practices of the theoretical scientist and co-operate with him closely. The construction of an idealized mathematical model is certainly the most important and most difficult phase, and calls for a detailed knowledge of the observational and experimental facts related to the particular phenomenon under consideration. Penetrating insight and mature judgment founded on wide experience are required. In the third phase the applied mathematician must examine his results to reach a deeper understanding of the whole field. He must attempt to abstract the essentials and form concepts which are of wider applicability. It is at this stage that the conclusions must be checked against the existing body of knowledge and the predictions verified by further experiment and observation. If a model proves too complex to handle mathematically, he must be prepared to undress the model to its bare essentials whilst remembering the features removed. This he can often do in applied mathematics without getting his face slapped. With his coarsest glasses on, the applied mathematician can see only three magnitudes, zero, one, and infinity. He will usually be prepared to consider various limiting cases in which the parameters become either zero or infinite or take on special values, even though these cases themselves may be unrealistic. His hope is, of course, that these limiting cases will lead to an eventual synthesis. Indeed, he is even prepared to dissect the model itself and, for the sake of an eventual synthesis, study sub-models in which certain physical effects, known to be important, are temporarily neglected.

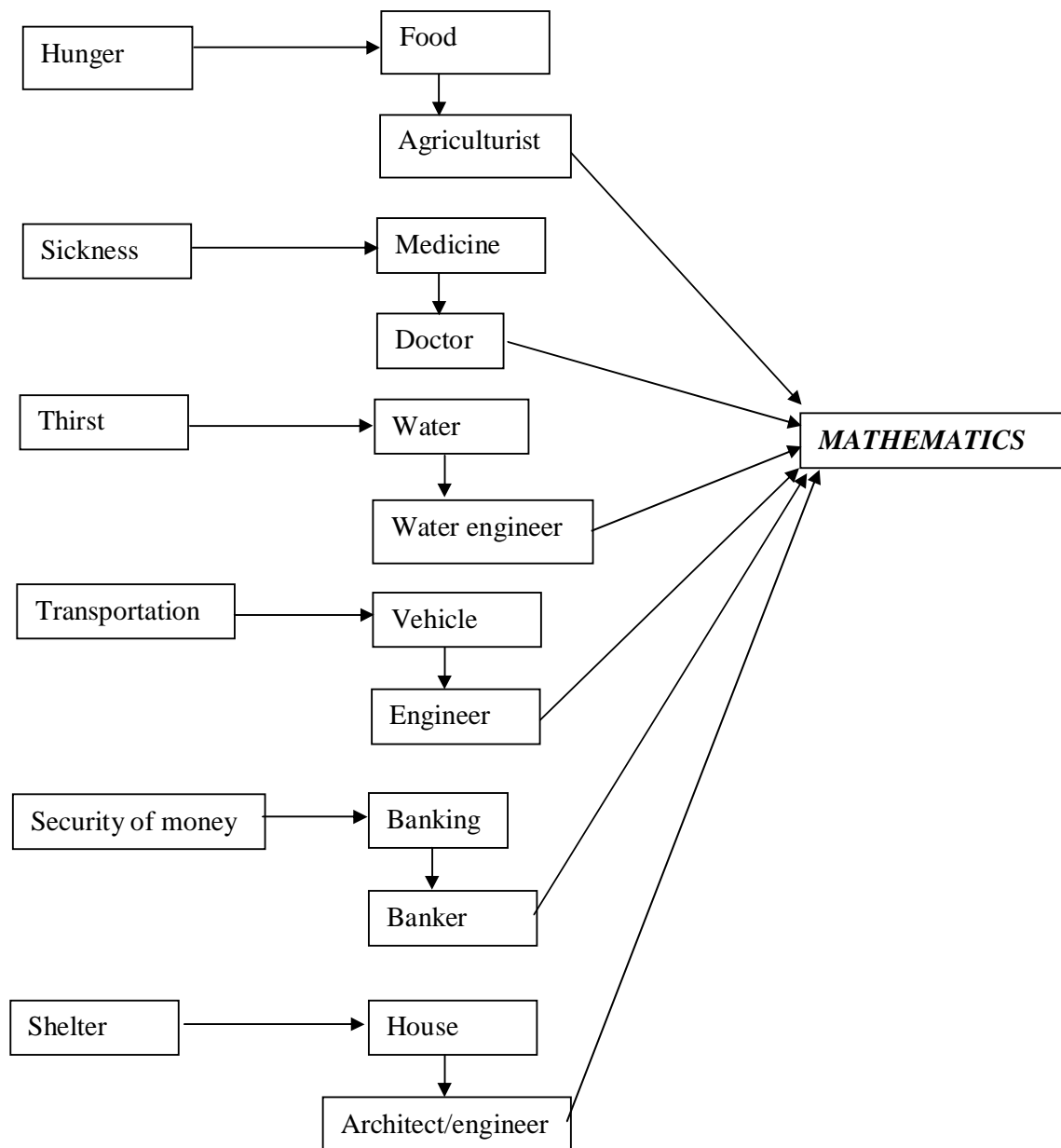
Despite the similarities in activity, there are subtle differences in attitude between a theoretical scientist and an applied mathematician. The theoretical physicist, for example, has his primary interest in the discovery of new physical laws while the applied mathematician, by comparison, places more emphasis on the use of mathematical methods for the description of physical phenomena in terms of known physical laws, and

on the new mathematical ideas these problems stimulate. One might say that the difference lies in the relative extent to which inductive and deductive reasoning are emphasized in each discipline. Perhaps one can say that the applied mathematician builds up to the actual problem synthetically from mathematical sub-models while the theoretical scientist analyses the actual scientific problems into their basic phenomena.

The good applied mathematician must adapt his interests to the present and future vitality of the subject if his research efforts are to have an impact beyond the development of applicable mathematical methods. The desire and ability to cut across traditional scientific disciplines through the medium of mathematics are perhaps the main characteristics of an applied mathematician. It is inevitable, therefore, from this description, that the applied mathematician, who is wide-ranging, is forced to stay at the general fundamental level of a broad spectrum of science and to work with humility in co-operation with the scientific or engineering specialist

### ***The Use of Mathematics in Solving Man's Problems***

It is noteworthy to state that mathematics is an instrument for the validation of several development affairs through the manipulation of data. In other words, it constitutes the solutions to human problems such as - hunger, sickness, thirst, transportation, security of money, shelter, education, which were also the seven problem areas that wanted to be eradicated by our former president Alhaji Sheu Musa Yar'Adua - all reside in mathematics in scientific concepts in solving various problems of man is what translate directly or indirectly to development.



*Fig. 4: The Use of Mathematics in Solving Man's Problem*

***The place of Mathematical Sciences relative to other  
areas of Sciences and Technology***

Most of the reasons for our under-development could be traced to low level of science and technology development, which in turn could be reduced to low level of development in the Mathematical Sciences. Many developed countries in realization of this fact, devote a sizeable part of their budget on education to training in the Mathematical Sciences. In the USA for instance, Mathematical education which involves at least 40 million students and two million teachers accounts for ten percent of the Nations educational annual expenditure of 35 billion dollars.

Indeed, some industries and technologies would not exist as they do today without mathematical sciences, for instance:

1. Faraday's unification theory of electricity and magnetism has led (surprisingly) to electrical generation technology.
2. Maxwell, from purely theoretical considerations (which become known as Maxwell equations) suggested that an accelerating charge would produce electromagnetic radiations; including radio waves, X-rays etc., and this has led to modern communication system- radio, television etc.
3. Computer revolution is Mathematics revolution. It is obvious that the impact of the current computer revolution is already being felt in present day Nigeria, with the current wave of computerization of some essential services e.g. payment of salaries, telephone and P.H.C.N bills, banking services, library services. However, I wonder whether most people realize that the computer revolution is no more than another mathematics revolution, which is being dominated by the developed world. For one thing, computers by their very nature are creations and also creator of mathematics. Computer themselves are Mathematics speaking, being only that, they are more efficient than human Mathematics since the best results would be obtained in minimum time with least effort.

There would have been no computers today without the work of Alan Turing, an English Mathematician, who a few years back before the second world war, gave a cogent and complete analysis of the motion of "computation" leading to the conclusion that it should be possible to construct "universal" computer which could be programmed to carry out any possible computation. Turing's logical proof of the existence of "universal"

computer resulted in the modern all purpose digital computer and influenced the thinking of other pioneers in the development of modern computer like John Von Neuman

Computers have not only been useful in improving the quality of life of people, but also recorded success in its use to solve outstanding Mathematical problem (e.g. Four-colour problem, classification of simple groups). Moreover, new areas of Mathematics have been created through the computer (e.g. Complexity theory, proof theory, theory of algorithms), while computers are currently being used to teach Mathematics (e.g. calculus, matrices, probability, statistics, and some geometry). Computers have also opened the way to new technologies for the betterment of the society as well as proved useful in solving various problems arising in technology, business, commerce, economics etc.

The question now is: how much have Nigeria contributed to this revolution? We were neither part of the mathematical process that brought it about in the first place, and neither have we been part of the creation of new Mathematics areas through computer, and neither do we have factories building and marketing computers. Something drastic has to be done.

4. The abstract area of Mathematics known as Fourier Analysis has since become a subject important in studying electro-magnetic waves such as X-ray, visible light, micro-waves, radio waves and their harmonic components. Many electrical and electronic devices such as - nuclear magnetic resonance and X-ray crystallographic spectro-meters are based on Fourier Analysis. Also, Fourier Analysis has provided a basis for understanding quantum theory, and hence, modern chemistry and physics. It also led to the discovery of the time-series analyses used in oil exploration for interpreting seismic rocks suspected of bearing petroleum. An ability to decompose sound into its harmonic components using Fourier Analysis has allowed computers to generate and recognize human speech.

5. Like Fourier analysis, wavelet analysis deals with expansion of functions, but in term of “wavelet” i.e. given a fixed function with mean zero. Variations of this theory have found applications in image processing, Acoustics, coding (in form of quadratic mirror filters and pyramid algorithms) and in oil exploration, analysis of rapidly changing transient signals, electric currents in the brain, impulse underwater sounds and monitoring of power plants. It has also served as a scientific tool for sorting out complicated structures occurring in turbulence, atmospheric flows and study of stellar structures.

6. It is noteworthy that the 1985 Nobel prize in chemistry was awarded to the mathematicians H.H. Hauptmann and J.Karle for their development of the models for the

determination of crystalline structure based on Fourier Analysis and Probability: on a lighter note, I just wonder how Alfred Nobel himself would have reacted to this award since he deliberately decided not to make his prize available to mathematicians because of his enmity with a mathematician by name Mittag-leffler.

7. Group theory, discovered (in the abstract) by Galois while studying Mathematical symmetries associated with the solution of polynomial equations, has subsequently been applied to significant advantage in the study of sub-atomic particles, in crystallography, information theory, photo-chemistry and even in the elucidation of certain complicated marriage systems studied by anthropologists. Graph theory, the mathematical study of abstract networks, was considered an esoteric kind of pure mathematics until it was applied to problems of transportation, communication, neutron-physiology and sociology.

8. Partial Differential Equations (PDEs) have been used to model shocks in non-linear waves, vortices in fluid flows with various applications including accurate tracing of hurricanes and to study blood flow through the heart, the efficient mixing of fuel in the internal combustion engine, air-craft flight, and the way in which radio telescopes sense distant galaxies. They have also been used to model icebergs melting in the sea, crystal growth and the flow of oil and water through a reservoir.

9. Linear PDE's govern small function of small disturbances from equilibrium while non-linear PDE's govern large disturbances. The real world is generally non-linear. PDE's are being used to solve problems in geometry, physics engineering etc for example, non-linear elliptic equations are PDE's arising in geometry, especially in the construction of surfaces with prescribed curvature.

10. Physiological fluid dynamics has various applications including computational models of the heart, the kidney, the pancreas, the ear and many other organs. Blood flow in the heart is governed by coupled equation of motion- of the muscular heart walls, elastic heart valve leaflets and the blood flowing in the cardiac chambers. Computational Fluid Dynamic (CDF) is a primary aero-dynamical design tool for any problem and the wind tunnel is treated as more of an evaluation and confirmation tool.

11 . Computer solutions of PDE's arising in physiological fluid allow the study of flow of suspensions, blood clotting, wave propagation of the inner ear, blood flow in the arteries and veins and air-flow in the lungs. Computer graphics have been particular useful in many studies including the theory of surface inspired originally by the study of soap films. Computer graphics enhance the understanding of global and stability problems in the calculus of variations.

12. “Green house effect” is the warming of the surface of the earth due to re-radiated energy by the “Green house gases” e.g. ozone, methane etc. from the atmosphere to the surface. The Green-house theory says that recent modification of the atmospheric gaseous composition will result in the gradual warming of the earth’s surface as well as a cooling of the upper atmosphere, leading to an unprecedented modification of earth’s climate. A three dimensional circulation model, involving numerical solution of PDEs, are used to compute differences between a climate forced by increasing in Green-house gases and a controlled climate.

13. At the turn of the 20<sup>th</sup> century, Poincare realized that the behaviour of trajectories of celestial bodies could display a “chaotic” motion – a motion forever oscillating yet irregular and aperiodic. In 1963, a numerical examination of some specific systems of Differential Equations from meteorology revealed the presence of chaotic trajectories in specific non-Hamiltonian systems but also suggested new directions of research in the theory of dynamical systems. Copious applications of these ideas exist in ecology, economics, physics, chemistry, engineering, fluid dynamics and meteorology. Dynamical systems (especially those representing chaotic behaviour) involve topology, number theory, measure and ergodic theory, combinatorics etc.

14. The nineteenth century witnessed the study of Hamiltonian mechanics i.e. study of many particles moving without friction and governed by equations which take the standard form when the Hamiltonian-total energy of the system is taken as the standard point. Modern Hamiltonian mechanics is the study of manifolds-symplectic geometry. A symplectic manifold is a higher dimensional surface on which the Hamiltonian procedure of passing from Hamiltonian to differential equations can be implemented.

15. A lot of social and economic problems can be modelled mathematically using notably the theory of games or combinatorial scheduling theory. Problems connected with inventory control, industrial production and efficiency in the allocation of resources can be solved by various methods in operations research including simplex method in linear programming. It is noteworthy that some recent Noble prize winners in economics are Mathematicians, e.g. Nash.

16. Population biology has to do with counting, estimating and predicting population sizes. The problems involved range from determining the mechanisms that cause and maintain biological rhythms to the problem posed by the management of exhaustible resources like timber and fish or even to geographical distribution of genes, age distribution of populations, the spread of forest diseases and genetic engineering.

It is note-worthy that population problems have led to the development of many theories and methods that are central to the core of mathematics e.g. theories of probability, dynamical system and wave propagation.

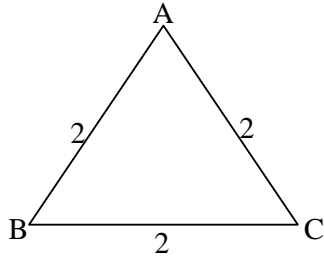
### ***My contributions to Computational Mathematics***

Mathematical tools make it possible to create representations of the world that facilitate analysis of a problem. The computational side provides the means for producing the numbers, graphics, rules and other output that enable designers and decision-makers to solve the problem.

Applied analysis and computation are essential to research in virtually every field of science and engineering. Modern engineering is, to a large extent, computational engineering. Computation and applied mathematics (CAAM) is the fundamental discipline that underlies practice and intellectual advancement in mathematical modeling applied analysis, the development and analysis of numerical algorithms and the implementation and dissemination of mathematical software. CAAM provides a key enabling technology for all aspects of computation engineering and numerical simulation.

My first research paper was on new method of finding the area of an Equilateral Triangle published in 1994 in the Journal of Pure and Applied Sciences (1), 14-22 when I was at Oyo State College of Education, Ila-Orangun now (Osun State College of Education). In this paper, a new computational technique for finding the area of Equilateral Triangle is presented and experimented. The newly established formula is  $\gamma L^2$ , where  $\gamma$  stands for Gbola's constant i.e.  $\gamma = \frac{\sqrt{3}}{4}$  and  $L$  stands for the length of the equilateral triangle.

Example: Find the area of triangle using Gbolagade's formula when  $L = 2$ .



Using Gbola's constant;  $\gamma = \frac{\sqrt{3}}{4}$  and

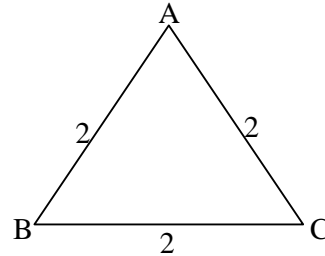
$$L = 2$$

therefore,

$$\begin{aligned} A &= \gamma L^2 = \frac{(2)^2 \sqrt{3}}{4} \\ &= \frac{4\sqrt{3}}{4} \\ &= \sqrt{3} \text{ sq. unit} \end{aligned}$$

Find the area of triangle using the widely used formula i.e

$$\frac{1}{2} \text{ base} \times \text{height}$$

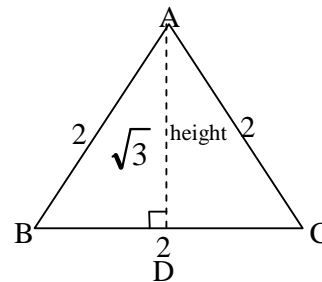


$$AC^2 = AD^2 + DC^2$$

$$2^2 = 1^2 + DC^2$$

$$DC^2 = 3$$

$$DC = \sqrt{3}$$



Therefore,

$$A = \frac{1}{2} \text{ base} \times \text{height}$$

$$A = \frac{1}{2} \times 2 \times \sqrt{3}$$

$$A = \sqrt{3} \text{ sq. unit}$$

Fig 5: Equilateral Triangle

**Comment:** It is noted that Gbolagade's formula is easy to understand and also simple to use.

### *Existence of Strong Solutions of Lipschitzian Quantum Differential Equation (LQSDE)*

In Ayoola (2002 c), the existence, uniqueness and stability of strong solutions of LQSDE were established. The locally convex topology on the space of quantum stochastic processes in this case is generated by a family of semi-norms induced by the norm of the Fock space. The second fundamental formula of Hudson and Parthasarathy concerning the estimate of the square of the norm of the values of stochastic processes on exponential vectors facilitates the existence results by method of successive approximations. Results here generalize analogous results concerning classical SDE driven by Brownian motion. Convergence in the sense of this paper generalizes the root mean square convergence of successive approximation in the case of classical process considered as quantum stochastic process in a simple Fock space. The study of Ayoola and Gbolagade (2005 a) happened to be a continuation of Ayoola (2002 c) concerning the existence and stability of solutions of QSDE satisfying a general Lipschitz condition in the strong topology.

Ayoola and Gbolagade (2005 a) established a class of Lipschitzian QSDE where the coefficients are merely continuous on the locally convex space of the quantum observables. The AMS mathematical Reviews of paper Ayoola (2002 c) and Ayoola and Gbolagade (2005 b) were written respectively by Professor Vassili N. Kolokoltsov of Warwick University, UK and Professor Debashisan Goswami of Indian Statistical Institute for the AMS Mathematical Review with review numbers respectively given by mR2003b:60081 and mR 2005m:81179.

Gbolagade, et al (2003 c) worked on the “Determination of the Running Time of the Effect of matrices A and B generator algorithm for the Tau Numerical methods” published in the Journal of the Mathematical Association of Nigeria. This paper investigates the ring time of the matrices involved in computing the solution of ordinary differential equations using the algorithm for Tau numerical method. It was shown that the complexity of the algorithm is of non-linear time as the input size gets very large.

Gbolagade, et al (2003 d) “On Genaralized Solution of Polynomials” published in Nigerian Journal of Mathematics and Applications, established a new computational approach for finding the roots of a general nth order polynomial. This computational technique is implemented on several test problems. Gbolagade et al (2006) is an extension of (2003 d).

Gbolagade et al (2004 c) “ On the application of Djikstra’s algorithms in solving the GSM network problem” In this paper, an attempt is made to resolve some of the GSM problem network congestion problem using Djikstra shortest distance algorithm.

Olayiwola, Gbolagade, Adesanya and Akinpelu (2009 b) show that the homotopy perturbation method is used to determine the period of a non-linear oscillator. The method produces the result even for large amplitude.

Olayiwola, Gbolagade and Adesanya (2009 c). In this paper, we used modified power series method to solve non-linear systems. Some practical examples were presented to show the ability of the method.

Olayiwola, Gbolagade and Adesanya (2010 a). In this paper, we proposed a numerical scheme to solve telegraph equation using modified Variational Iteration Method (MVIM).

Olayiwola, Gbolagade and Adesanya (2010 b) is an extension of paper (2010 a). Olayiwola, Akinpelu and Gbolagade (2011). In this research, the MVIM was applied to the solution of non-linear partial differential equations. The numerical results demonstrated that the method is accurate, reliable and converge faster with less computation when compared with other methods in the literatures. Gbolagade and Olayiwola improved on the Modified Variational Iterational Method. We consider the following general non-linear partial differential equation

$$Lu(x, t) + Ru(x, t) + Nu(x, t) = g(x, t) \quad \dots i$$

Where L is a linear time derivative operator, R is a linear operator which has partial derivative with respect to x, N is a non-linear operator and g is an inhomogeneous term. According to VIM, we construct a correct fractional as follows:

$$u_{n+1}(x, t) = u_n(x, t) + \int_0^t \lambda [Lu_n + R\tilde{u}_n + N\tilde{u}_n - g] d\tau \quad \dots ii$$

Where  $\lambda$  is a Lagrange multiplier which can be identified optimally via variational iteration method. The subscript n denotes the nth approximation.  $\tilde{u}_n$  is considered as a restricted variation i.e.  $\delta\tilde{u}_n = 0$ . The successive approximation  $U_{n+1}, n \geq 0$  of the solution u will be readily obtained upon using the determined Lagrange multiplier and any selective function  $U_0$ , consequently, the solution is given by

$$u = \lim_{n \rightarrow \infty} u_n \quad \dots iii$$

In (MVIM), equation (ii) becomes

$$u_0(x, t) = g_0(x) + tg_1(x) + t^2 g_2(x) \quad \dots \text{iv}$$

$$u_{n+1}(x, t) = u_n(x, t) + \int_0^t \lambda [Lu_n + R\tilde{u}_n + N\tilde{u}_n - g] d\tau \quad \dots \text{v}$$

Where  $g_2(x)$  can be found by substituting for  $u_0(x)$  in (i) when  $t=0$ .

### ***My Contributions to Solid Mechanics***

Solid mechanics developed in the outpouring of mathematical and physical studies following the great achievement of Isaac Newton (1642-1727) in stating the laws of motion, although it has earlier roots. The need to understand and control the fracture of solids seems to have been a first motivation. Leonardo da Vinci (1452-1519) sketched in his notebooks a possible test of the tensile strength of a wire. The Italian experimental scientist Galileo Galilei (1564-1642), who died in the year of Newton's birth, had investigated the breaking loads of rods in tension and concluded that the load was independent of length and proportional to the cross section area, this being a first step towards a concept of stress. He also investigated how the breaking of heavy stone columns, laid horizontally in storage as beams, depended on the number and condition of their supports. Beams are very important elements in civil, mechanical, and aeronautical engineering. The moving load problem has been the subject of numerous research efforts in the last century. Gbolagade et al (2002b) studied the mechanics of beam under partially distributed moving masses is examined. The importance of this problem is manifested in numerous applications in the field of transportation, bridges, guide ways, overhead cranes, cableways, rails, roadways, runways, tunnels, launchers and pipelines are examples of structural elements designed to support moving loads.

### ***Who uses solid mechanics?***

All those who seek to understand natural phenomena involving the stressing, deformation, flow and fracture of solids, and all those who would have knowledge of such phenomena to improve our living conditions and accomplish human objectives, have opted for solid mechanics. The latter activities are, of course, the domain of engineering and many important modern sub fields of solid mechanics have been actively developed by engineering scientists concerned, for example, with mechanical, structural, materials, civil

or aerospace engineering. Natural phenomena involving solid mechanics are studied in geology, seismology and tectonophysics, in materials science and the physics of condensed matter, and in parts of biology and physiology. Further, because solid mechanics poses challenging mathematical and computational problems, it (as well as fluid mechanics) has long been an important topic for applied mathematicians concerned, for example, with partial differential equations and with numerical techniques for digital computer formulations of physical problems.

Gbolagade et al (2002 a). In this paper, the governing equation of the fourth order partial differential equations for the dynamic behavior of infinite beam subjected to concentrated force is reduced to fourth order of ordinary differential equation by the method of Fourier Transformation. The results show that the load passes through a connection must be strong, complete and in equilibrium to all applied forces and shears.

***Application of the theory:*** The result shows that this theory is frequently used in the calculation of dynamic stresses in large-span railway bridges, resulting from the transverse of a train of cars hauled by a locomotive. According to experience, the bridge vibration produced by the cars is very irregular, with a lot of damping coming into play too. The reasons for this are track irregularities, the condition and lateral movements of the cars, damping of the car springs, damping in the connecting rods and other, mostly random courses. More often than not, the dynamic effects of the locomotive are damped out by the train of cars.

Gbolagade et al (2002 a). In this paper, the mechanics of elastic plates subjected to moving concentrated masses is investigated. The results show that the response amplitude due to moving concentrated forces are lower than those due to moving concentrated masses.

***Application of the theory:*** The results obtained from this paper can be used in calculations of plates of roadways or runways. The plates, concrete or reinforced concrete for the most, have large areas and rest on variously prepared foundations that can very roughly be approximated by the Winkler foundation.

Gbolagade (2004). In this paper, the mechanics of Rayleigh beam subjected to moving concentrated masses is presented. The results show that the response amplitude of simply supported Rayleigh beam not resting on a foundation is higher than that of the beam supported by a foundation.

***Application of the theory:*** The theory outlined in this paper, has found application in dynamic computations short-span bridges and crane runaways. In both instances the beam mass is really very small against the moving load mass and as such may be neglected.

It should be noted, however, that in the two cases quoted, the effect of the moving mass is fairly small compared to those structure. Thus, for example, in short-span railway bridges. It is the effect of impacts of flat wheels, rail joints etc in crane runaways the effect of sudden lifting and braking of the load, of track irregularities e.t.c that predominate over that of the moving load. Moreover, in short-span bridges, the vehicle can no longer be idealized by a single mass point.

### ***My contributions to Fluid Mechanics***

Man's desire for knowledge of fluid phenomena began with his problems of water supply, irrigation, navigation and water power.

Matter exists in two states; the solid and the fluid, the fluid state being commonly divided into the liquid and gaseous states. Solid differ from liquid and liquid from gaseous in the spacing and latitude of motion of their molecules, these variable being large in a gas, smaller in a liquid and extremely small in a solid. Thus, it follows that intermolecular cohesive forces are large in a solid, smaller in a liquid and extremely small in a gas.

Makinde and Gbolagade (2005 e). In this paper, the second law Analysis of Laminar Flow of a viscous through an inclined channel with isothermal walls is investigated. The result shows that the heat transfer irreversibility dominate along the group parameter may cause fluid friction heated walls.

Makinde and Gbolagade (2005 c). In this work, the effect of Biot number on thermal criticality in a strongly exothermic reaction of a viscous combustible material flowing through a channel with lower isothermal wall and upper non-isothermal wall under Arrhanus Kinetic neglecting the consumption of the material is investigated. The result shows that the computer extended series solution (CESS) method in conjunction with Hermite-Pade approximation technique is advocated as an effective tool to investigate several other parameter dependent no-linear boundary-value problems.

Makinde and Gbolagade (2005 e) investigated the thermodynamics irreversibility in the flow system. The result shows that for all values of flow behaviour index ( $n$ ), the Bejan number is  $0 \leq \beta_e < 1$  i.e the viscous dissipation irreversibility dominates.

Gbolagade and Makinde (2005 d) studied the thermal ignition in a strongly exothermic reaction of a variable viscous combustible material flowing through channel with isothermal walls under Arrhenius Kinetics, neglecting the consumption of the material. The result shows that the series summation procedure can be used as an effective tool to investigate several other parameter dependent non-linear boundary value problems.

Makinde, Gbolagade and Olajuwon (2007 c) studied the effects of thermal radiation interaction with magnetic field on steady flows of an incompressible Boussinesq fluid and mass transfer past vertical plate embedded in a porous medium with constant heat flux. The result shows that the momentum boundary layer increase with increasing buoyancy ( $Gr$ ,  $Gm$ ), Schmidt layer increases with increasing viscous dissipation  $Ec$  and decreases with increasing radiation mission.

Makinde and Gbolagade (2009 a). This paper studies the boundary layer equation of flow over a stretching sheet in the presence of a magnetic field and uniform heat. The results show that the effect of several parameters controlling the velocity and temperature profiles is practically shown.

In physics and fluid mechanics, a boundary layer is that layer of fluid in the immediate vicinity of a boundary surface where effects of viscosity of the fluid are considered in detail. In the Earth's atmosphere, the planetary boundary layer is the air layer near the ground affected by diurnal heat, moisture or momentum transfer to or from the surface. Gbolagade (2003a) investigated a two dimensional oscillatory flow and heat transfer past an infinite flat plate. The result obtained shows that on an aircraft wing the boundary layer is the part of the flow close to the wing. The boundary layer effect occurs at the field region in which all changes occur in the flow pattern. The boundary layer distorts surrounding non-viscous flow. It is a phenomenon of viscous forces. This effect is related to the Reynolds number.

### **Some of the Problems Confronting Mathematical Sciences in Nigeria**

Mr. Vice-Chancellor sir, according to Prof. Aderemi Kuku in his 2004 N.A.S quarterly lecture (Kuku, 2004), Prof. Ezekiel Olusola Ayoola in his inaugural lecture in 2011 at University of Ibadan and other mathematics inaugural lecturers and also from the foregoing, it is clear that basic scientific research as exemplified by mathematics is

intimately connected with development. As a nation, we should strive to develop our resources in all positive direction i.e. apart from producing scientists and technologists who are pursuing developmental research; we should endeavour to develop a critical mass of Mathematical Scientist who can contribute to frontier knowledge.

For the sake of emphasis, we now highlight some specific problems making giant strides in Mathematical Science elusive in this country:

1. **Inadequacy of Journal, Books, Teaching and Research Facilities:** It cannot be over-emphasized that scientific research can only be productive in an atmosphere of adequate journal, books and facilities. As remarked earlier, most scientific research in Nigeria is carried out in the Universities where the library, teaching and research facilities are less than adequate. Because of dwindling value of the Nigerian currency, imported books at all levels are very expensive. In Nigeria, primary and secondary schools, books are written and published locally, thus reducing cost. However, most tertiary Mathematics texts are imported, and so are unaffordable by students, teachers and sometimes the library. Teaching aids at school level are also being fabricated locally to reduce cost. Even then, these are not in adequate supply to schools. The uses of computers for teaching mathematics in schools are a rare occurrence as of now. Computers are even in short supply in the Universities. Inadequate funding of educational institutions result in lack of good libraries, infrastructures, computers, teaching aids and other facilities.

2. **Nigerian Mathematical Scientists Work in relative Isolation:** Specialists in various areas of Mathematical sciences are spread thin all over the country. Relatively, few universities have viable research groups. While access to the internet has improved of recent, it is still a far cry from the situation in Europe, America and Osun State University where every lecturer has a computer in his office.

3. **Poor Preparation and Shortage of Mathematics Teachers at All Levels:** Many primary and secondary schools have no choice but to employ teachers who have no special training in Mathematics because of shortage of Mathematics staff. Many University Mathematics Departments in Nigeria are under-staffed. As a result, Mathematics courses suffer quite a lot in term of quality of instruction, inevitability of large classes, inadequate tutorials, etc. Those of them offering graduate courses have to stretch their meagre human resources and facilities beyond reasonable limits

4. **Brain Drain of Nigerian Mathematicians:** Many of the Nigeria Mathematicians who are trained abroad either do not return to contribute their knowledge towards the

development of the country or leave the country for a career abroad for various reasons ranging from frustration, lack of enough facilities for productivity, maltreatment by the country or institution.

**5. Environmental Problems:** Environmental handicaps in form of political instability, natural and man made disasters; dis-functioning public utilities (such as electricity, pipe-borne water, telephone) make it an up-hill task to practise as mathematician. Moreover, quite a number of mathematicians trained in Europe and America in sophisticated areas of mathematics have problems continuing with their research in those areas in Nigeria. So they are forced to either change their areas of research or quit the country.

### **The Way Forward**

Prof. Ezekiel Olusola Ayoola in his inaugural lecture in 2011 at University of Ibadan and Prof. Aderemi Kuku in his 2004 N.A.S quarterly lecture (Kuku, 2004) and other mathematics inaugural lecturers have made a number of appropriate and well-thought recommendations for the improvements of science, technology and Mathematics learning, research and applications in Nigeria. The Federal Government through various channels including Federal Ministry of Education and Federal Ministry of Science and Technology have been making commendable effort to give science and technology education and research special attention, there is a lot of room for improvement. Among the various ways in which science and technology could be given further boost in this country, the following stand out for special mention.

#### **1. Need to intensify Population of Science and the Inculcation of Scientific Culture in the Society.**

The ministries of Education and Science and Technology should continue their current co-operative effort with the various scientific organizations to popularize science in the country. One notes with satisfaction, the activities of the science week all over the country, the JETS programme of the Federal Ministry of Education, the Olympiad programme in Mathematics, the extension services of the Ministry of Agriculture and some Research Institutes and Universities. There is need to intensify these extension services in-order to disseminate new knowledge and techniques particularly to the rural area to increase productivity in various sectors of the economy.

**The ways in which science, technology and mathematics could be popularized include:**

- i. Print and electronic media – newspapers, popular magazine, radio, television, video and other audio-visual media:
- ii. Science museums and centre with participatory hands – on and interactive exhibits:
- iii. Open – days and demonstrations by science, technology and mathematics research institutes and other scientific organizations/industries:
- iv. Science, technology and mathematics clubs in schools and in the community:
- v. National science, technology and numeracy weeks:
- vi. Various adult education programme:
- vii. Various mathematics, science and technology Olympiads:
- viii. Popular writings explaining various areas of contemporary Mathematical of Sciences in simple language. For mathematics in particular, the need for popularization is particularly compelling. From the historical development of mathematics, it is clear that most people who have studied mathematics at secondary- school level know little more than what was known in the seventeenth century. Most tertiary institutions in mathematics hardly go beyond what was discovered in the nineteenth century. Much spectacular and fundamental mathematics discovered in the last 100 years has only been circulating among relatively few initiates, with a consequent global illiteracy in contemporary mathematics.

The antipathy towards Mathematics by administrators in government, many parents, funding agencies and the general public, sustained by lack of appreciation of what mathematicians do, dictates a pressing need for a more aggressive and well- organized popularization programmes for Mathematics at local and global levels in Nigeria.

**2. Need for Massive Improvements in Teaching and Research Facilities**

It is a common knowledge that poor library, laboratory and infrastructural facilities at all levels of our educational system have contributed in no small measure to the pitiable state of our scientific and technological accomplishment as a nation. Granted that these facilities may be too expensive to duplicate for each school/university, it may be advisable to create such facilities for group of school or universities so that these facilities could be maximally used at minimal cost to the Government. It should be possible to find at least one institution in each of six Geo-political zone of the country with excellent library, computer, laboratory and infrastructural facilities.

### **3. Research for Scientific, Industrial and Technology self-Reliance should be intensified**

In this connection, the effort of the Federal Government in creating Raw materials Research institute, NASENI, SHEDA, National mathematical centre (NMC), etc. should be connected. But all these laudable institutions with laudable mandates would only be a pride to the country through quality leadership and staff that would ensure maximum productivity.

### **4. Large Scale Local Fabrication of Scientific Teaching Aids should be Intensified**

Quite a number of students find difficulty with some subjects, notably-Mathematics and Physics because of lack of or inadequate teaching aid. The relevant academic department in the University and other tertiary institution could spear-head the making of prototype of these aids (as has been done in Mathematics and Physics Department of the University of Ibadan and the Department of Mathematical and Physical Sciences of Osun State University) government should show interest in and support such efforts

### **5. Increased Funding and Fund-raising for Technologically Research Necessary**

One of the major set-back for science and technology in Nigeria is inadequate funding. The situation is even more serious since most universities are now under funded and moreover, neither the government non-sciences based multi-national companies are interested so far in funding basic research which they claim is not so 'relevant'. Even the research, 'relevant' to their companies is not being done in Nigeria. The multi-national companies in Nigeria should be compelled by legislation to contribute a percentage, possibly one percent of their profit to a central national science foundation to be created by the federal government. This should complement the Education Tax Fund (ETF) already established by the Federal Government. It is also high time educational and research institutions intensified their fund raising efforts within the country to find non-government sources of support for their research and educational activities as is being done abroad. Admittedly, not enough funding is coming from Government sources, but Nigerian institutions need to find sources that will complement government support. In all, it should be possible for good scientists to obtain support through the National science foundation mentioned above.

### **6. Need for Massive Mobilization Effort for Tertiary Scientific Textbooks Development.**

One of the major problems encountered in effective teaching of sciences especially Mathematical Sciences is due to lack of good texts especially at tertiary level. Nigeria

scientists in tertiary institutions should be encouraged to write books for Nigerian institutions. Importation of books is becoming an uphill task with the current foreign exchange problems.

### **7. Need for over-haul and Renovation of Mathematics Curriculum at all Levels.**

Mathematics curricular at all levels of education are long overdue for renovation for several reasons, including;

- i. The rapidly expanding frontiers and the discipline which render the current curriculum obsolete;
- ii. The need to teach and learn relevant Mathematics to support new and emerging technology, and
- iii. The need to adapt for school some of the hitherto ignored fundamental Mathematics required to explore patterns rather the simply learned formulae, that is, to search for solution rather than memorize procedures, to formulate conjecture and not just do exercises. The Mathematics curricula at primary, secondary and tertiary levels are no longer sufficient to prepare students adequately for work and life in the 21<sup>st</sup> century.

The canonical school mathematics curriculum contains topics in arithmetic, algebra, some geometry and later calculus, which emphasize rather old-fashioned perspectives Mathematics. A good curriculum is one which, according to L. Steen (1990), identifies various stands that have within them the power to develop a significant Mathematical idea from the informal institutions of early child-hood all the way through schools and colleges and on to a scientific and Mathematical research.

Some of the necessary ideas yet to be well embedded in school curricular include inculcating the ability to:

- i. Recognize symmetry, a useful model for explaining such diverse phenomena as the forces of nature, structure of crystals and growth of organisms;
- ii. Recognize the complexity of measurement, not just of geometric quantities (length, area and volume) or arithmetic quantities(size, order and labels), but also dynamic variables (Discrete, continuous and chaotic) and random variation;
- iii. Visualize, for example scrutinizing data to search of hidden patterns, exploring computer graphics which automate the process of projecting shapes in higher dimensional space; and;
- iv. Think algorithmically, for numerous examples, see Steen, (1990).

As remarked earlier, global illiteracy in contemporary mathematics is a major contributing factor in the unfavourable public attitude to Mathematics all over the world. If some of the mathematics hitherto circulating among experts are filtered to school, then school teachers must understand these ideas in-order to be able to teach their students. There is, therefore, a need to re-orientate the training of Mathematics educators (that is, prospective trainers of teachers) to promote the ability to explain contemporary Mathematical ideas in simple language as part of the requirements of a Master's or Doctor's degree in mathematics education.

#### **8. Need for Closer Links between The Universities Research Institutes and The Industries.**

There is urgent need for a new alliance and understanding among the Universities. Research Institute and the Industries and maximize the use of available talents. Multi-national co-operations should be encouraged to do their developmental research in Nigeria.

#### **9. Nigeria Should Spear-Head The Overall Industrial and Technological Development of Africa.**

Because Nigerians account for about one quarter of Africa population and also for a large fraction of productive Africa scientists and technologist, and because Nigeria is the largest concentration of the black people in the world, and in consonance with Nigeria making Africa the corner-stone of her foreign policy, Nigeria should champion the economic Industrial and Technological integration of Africa through participation in Africa of networks for the co-ordination of research and industrial efforts; encourage south-south co-operation with other African countries in terms of exchange of scientific and technological information and expertise. NEPAD should be considerably strengthened to encompass science and technology integration.

#### **10. Financial Incentives Necessary For Scientists.**

It is common knowledge that many Universities Science Departments, especially Mathematics and Physics Department have problems filling their quota mainly because most talented young people would rather opt for professional courses that would eventually give them lucrative jobs. As a result, many of the students who get registered in these departments are rejected from the professional departments like medicine or engineering. Yet, it is most desirable that good students are attracted to the basic sciences. One obvious danger of this trend is that the present generation of University lecturers in mathematics and physics may not be able to replace themselves with good material.

One way of attracting students to read mathematics and physics is to give automatic scholarship and I do hope the government will consider this possibility. Also, school teachers in mathematics and physics tend not to make a career of the job because of poor remuneration. It is hoped that the government would create special financial incentives for them also.

#### **11. Identification Of Contemporary Areas of Mathematics to be developed in Nigeria.**

There are numerous areas desirable in Mathematics that are yet to be developed in Nigeria, but which are already replete with application in Europe and America. Effort should be made to develop some of these areas e.g differential geometry, Lie groups/Algebras, algebraic geometry, Mathematical aspects of computer science (Complexity theory, Theory of algorithms, dynamical systems e.t.c). This could be done with the co-operation of the National Mathematical Centre by networking with Universities, research centres in Europe and America through exposure of graduate students registered in Nigerian universities for doctor of philosophy (Ph.D) to good centres abroad and through various staff exchange programmes.

#### **12. Generating Good Students For Research And Career In The Mathematical Sciences.**

It is becoming increasingly difficult in Nigeria to get good research materials in Mathematics because of the “internal brain drain”. The senior Mathematicians need to do a lot of counseling for bright young people to take first degree in Mathematics and for who do well in higher degrees. Also, the federal government should encourage careers in research in the Mathematical Sciences through provision of generous scholarships for this purpose and through making University teaching and research more lucrative.

#### **13. Removal Of Artificial Boundaries Between The So Called Pure and Applied Mathematics.**

It is clear that Nigeria is yet to have a critical mass of Mathematical scientists for development purposes, and what is important is to do good quality and contemporary Mathematics that will align Nigerian Mathematicians with the rest of the world. The point is that many traditionally applied areas now require rather sophisticated Mathematics for their in-depth study and even several simply posed problems have only been solvable through highly sophisticated, abstract and powerful techniques.

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