

INAUGURAL LECTURE

Delivered by

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MAKING SCIENCE EDUCATION ACCESSIBLE TO ALL

Felicitations and Preamble!!

It gives me pleasure and satisfaction to be given this opportunity to deliver my inaugural lecture which I had for long wanted to do. I was appointed Chairman of Senate Ceremonials Committee whose functions include organizing inaugural lectures. Within the 7 years tenure as Chairman, I organized several inaugural lectures and indeed helped to restore the culture of delivering inaugural lectures in this University. Now I am ready to share with you my experiences as a Professor of Science Education, so that you can appreciate what I have been professing. I am happy and excited but before I go further, I must express my gratitude to the Vice Chancellor, Professor Chinedu Nebo and his entire administration for sustaining this essential aspect of academic life and also for providing Senate Ceremonial Committee the finance and other support needed to organize this inaugural lecture. I thank Chairman of Senate Ceremonials Committee, Professor Obi Njoku and his colleagues for organizing this great event.

Introduction

I am here as a Professor of Science Education to tell you a little of what I have been professing. In this lecture, I will take you through science education, what science education is all about, the need to provide everyone access to science education and how this objective can be achieved. I have titled my lecture, “**Making Science Education Accessible to ALL**”.

Let me start by asserting that since 1976 when I obtained Ph D degree in Science Education at the University of Leeds, I have been led by my conviction that everyone needs science education, no matter how rudimentary, to enjoy life fully. Indeed, it is the responsibility of all science educators to ensure that science education is made accessible to all. Throughout my career as a teacher, I put in a lot of efforts to make science education accessible to many. This inaugural lecture which is on science education, its importance, how it can be made accessible to all as well as my score card in that field is organized as follows:

- **Meaning of Science and Technology,**
- **Science and technology in National development.**
- **What science education for all means.**
- **The Need to make science education accessible to all.**
- **Barriers to science education for all.**
- **Breaking the barriers to science education for all.**
- **My contributions in promoting science education for all.**
- **Science Education for all -Our collective responsibility**

Meaning of Science and Technology.

Surely, there is scarcely anyone here who cannot venture a definition of science as a field of study. The definitions you offer would greatly depend on your level of exposure. They will however include the following:

Science is the study of nature.

Science is the study of man and his environment

Science is a body of knowledge about living and non living things in the environment.

Science is a process of gaining knowledge about the environment.

Science is a body of interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation.

Science is the systematic investigation of nature with a view to understanding and harnessing them to serve human needs.

Science is a changing body of systematized knowledge that is discovered by scientific processes and techniques.

The above definitions indicate that science is a study, it is systematic, it is a process of investigation, it is anchored on verifiable knowledge, it deals with nature and natural phenomena, it employs observation and experimentation as tools. In a way, all genuine activities aimed at understanding the environment in order to manipulate such knowledge for better human living constitute science. Thus I have defined **Science** as a systematic process of obtaining testable/ verifiable knowledge about nature and natural occurrences, utilizing careful observation and experimentation. This definition is appropriate for science education because it emphasizes the process and product nature of science. The emphasis is necessary for science educators whose duty it is to train teachers to effectively teach the various basic and applied science disciplines in the manner that presents the subject matter of science, first as a process [characterized by skills] which culminates in products [knowledge].

Closely related to science is technology. What is technology? **Technology** is the disciplined process of devising and utilizing techniques to convert resources to material objects and/ or processes aimed at meeting human purposes and progress on earth. Technology refers to practical solutions humans have fashioned out in response to their needs or in attempt to solve problems requiring the modification of the environment. Technology includes, therefore the productions and utilisation of tools, devices, machines_ whether traditional or modern_ that improve efficiency of labour. MacLeod [1986] in a UNESCO document defined Technology as the know-how and the creative process that may utilize tools, resources, and systems to solve problems to enhance control over the natural and man made environment in an endeavour to improve the human condition.

Science and technology have come to be regarded as inseparable twins. Why? First, science and technology both developed as human endeavours seeking to understand nature, predict nature, control nature and solve human problems. Second, science provides the principles on which most technological advancements rests and similarly technological problems propel scientists into scientific discoveries. As a matter of fact, modern science and technology as fields of study share the following goals:

1. development in command of rational power
2. development of an understanding of the changing nature of the environment in terms of matter, energy life and their interaction
3. development of ability and confidence to inquire into unknown phenomenon
4. elimination of superstition
5. prediction and control of the environment
6. development of rational exploitation of the environment

It is important to note that every society has some tradition of science and technology being that each society is successfully inhabiting one part of the earth. However, in this lecture I will be referring to modern science and technology which have gone far in addressing the problems of survival in the area of food sufficiency, good health, shelter, safety and security, etc. I will also like you to note that though science and technology are inseparable and I have no intention to separate them, my emphasis in this lecture is on science and science education.

Science and technology in national development

Science and technology serve as the key to modern or developed society. Actually, scientific and technological knowledge, skills and products now dominate our lives that we are forced to become increasingly dependent on them for nearly everything. Consider the fact that many of us here resort to calculators even for simple calculations of our salary deductions. I will not want to bore you with discussion of the benefits of science and technology in today's world. But in a discourse like this we lose nothing by refreshing our minds on the subject. I hasten to present in a summary form some of the many benefits of science and technology to humanity in such areas as health, agriculture and food production, information and communication and wealth generation.

1. Science and Technology in Health: Applications of science and technology have resulted in improved health status and longevity of human specie. For instance, scientific and technological knowledge, skills and attitudes in medical fields have greatly changed our responses to prevention, spread, control and treatment of common diseases such as malaria, transmittable diseases such as HIV-AIDS, genetically inherited disorders such as sickle cell anaemia, and other health related phenomena such as multiple births.

2. Science and Technology in Agriculture and food security: Applications of science and technology to agriculture have completely changed the face of agriculture through the introduction of mechanical devices for planting, tending, harvesting and processing of various food crops. Science and technology research have not only through hybridization resulted in improved varieties of food crops, animals and other food products but has boosted yields through the use of fertilizers and pesticides. There is increase in food supply. It is a fact that today we consume a wide range of foods in and out of season. Our diet and food habits have also changed based on knowledge of food technology.

3. Provides testable explanations of phenomena: Scientific findings, principles and theories provide testable explanations to many of naturally occurring phenomena such as eclipse, famine, multiple births, diseases and sudden deaths. In other words, science has helped to dispel superstition and unfounded beliefs which are inimical to progress and development.

4. Science and Technology in Information and communication: With Science and technology applications by way of computers and internet facilities, information dissemination and communication with persons thousands of miles away from us is now fast and as easy as a b c. Do you not wonder at the communication facility called electronic mail. What of the little equipment we call cell phone which has become not only a vital possession of most of us but indispensable in keeping us in constant touch with the world?

5. Wealth Generation: Production and rational exploitation of raw materials and their processing into goods is the basis of industrial development. Numerous natural resources [living and non-living] such as plants and animals as well as minerals exist in the environment. It is science and technology that has enabled humans to exploit and utilize them to produce consumer goods and there-from generate wealth. Nigeria is said to be rich today because science and technology is being applied to exploit her mineral resources such as mineral oil. I have sometimes wondered what Nigeria's economy and indeed political life would have been like if S and T had not been applied to mine oil which threw up billions of dollars? Perhaps, the do-or-die syndrome in Nigerian politics may not exist.

That science and technology is at the heart of improvements in quality of life needs no further emphasis. What needs to be emphasized is that the knowledge, skills, abilities and attitudes must be made accessible to all from generation to generation. At the end of the regional workshop on “Popularisation of Science” held in Lusaka in 1985, one of the major barriers to science and technology progress was identified as *lack of science education*. What is science education?

What Science education For All means.

First what is education and education for all? **Education** in its broadest sense, encompasses all the processes individuals go through in life to develop and optimally utilize their potentials through the acquisition of knowledge, skills, abilities and attitudes that are necessary for effective living in society. It is a process that starts from birth and ends with death which means that education is a life long process. Every experience one goes through in life affords the person opportunity to advance in education that is to say, gain knowledge and skills to grapple with challenges of life. Education therefore is a vital aspect of human enterprise and cannot be left to chance. That is why societies and nations take time to organize their education system for maximum benefits.

Nigeria, like other nations recognizes the importance of education hence the history of education in the country records attempts by various succeeding governments to provide good education for her citizens. In 1975, Nigeria declared Universal Compulsory Primary Education. Secondary education was made tuition free while tertiary institutions enjoyed free tuition and bursary awards. Determined to use education to achieve development, Nigeria participated in World Conference on Education held in 1990 in Jomtein, Thailand. The conference ended with a declaration of **Education For All** [EFA], a global initiative of the United Nations directed at using education as the major instrument for sustainable development. The EFA document came out with guidelines, target areas as well as time frames to encourage nations to see to it that every citizen has access to basic education. Thus in 1999, the Federal Government embarked on Universal Basic Education [UBEC] covering primary and junior secondary school levels. The expectation is that a person who is functionally literate and numerate, will be able to meaningfully participate in social, economic and political affairs of his/her country. Unfortunately, this has not come to be. In spite of the recorded changes in educational policies, our education

has not succeeded in transforming our nation from undeveloped or developing to a developed country. Undaunted, Nigeria participated in EFA meeting in Senegal in 2000 where the international community where it outlined and reaffirmed its commitments to assist African countries' initiatives to achieve EFA. Determined to help developing countries to fast track development process, a set of goals referred to as Millennium Development Goals [MDGs] was agreed upon. The understanding is that each nation would study the target areas of which education is one and prepare a road map to achieve the goals. To this effect, Nigeria came to translate the MDG document into what is known as the National Economic Empowerment Development Strategy [NEEDS] which has become the driving force behind many reforms that are going on in Nigeria today including the sweeping ones in education sector. It is not within the ambit of this lecture to discuss and appraise the reforms. What you must keep in mind is that Nigeria's Universal Basic Education reforms aimed at providing every Nigerian with access to basic education accessible to every Nigerian, is in response to the U N Millennium Development Goals. It is useful at this point to explain what access means in education parlance.

Ordinarily, access refers to uninhibited availability of chances/ opportunities towards a goal. In education parlance, access to education as pursued by Universal Basic Education Commission means, not only enrolment at no financial cost to learners but also the provision of quality learning experiences, provision of learning materials and a conducive learning environment aimed at equipping learners for self actualisation. This means that when you provide opportunity for a child to enroll in school, you cannot claim that you have given the child access to formal education if you deny her good quality education, deny her of learning materials, of conducive and learner- friendly environment, of qualified and motivated teachers who are equity conscious. In sum, access to education implies enrolment, quality, participation and equity.

Let me at this point state that many countries of the world including Nigeria who are pursuing basic education for all have actually reported increase in school enrolment which is encouraging. From our definition of access, enrolment alone is not sufficient to indicate meaningful progress in education for all, since we know that in most of these countries, illiteracy rate is still high and the pace of development has remained slow.

Education statistics of Nigeria however, reports increase in enrollment at all levels of education as well as increase in literacy rate yet we are still far from being a developed nation. Certainly increase in enrolment and/or possession of literacy and numeracy skills on their own have not proved sufficient to bring about national development. After all, what divides the world today into "developed" and "developing" countries is the level of science and technology development. Of a truth, rapid and sustainable development of any country can only be achieved through scientific research, rational applications of science and technology knowledge and skills. But how will these be translated and made to reach and influence the life of citizens? It is only through **education** of which science education is a part. What exactly is science education? Is it a discipline to be studied like English or Mathematics or Geography?

Science education is an integrated field of study which considers both the subject matter of science disciplines such as Biology, Chemistry, Physics, Agriculture etc as well as the processes involved in the learning and teaching of science. It can be said to embody all education processes aimed at providing unlimited opportunities for learners to understand and utilize necessary knowledge, skills and attitudes required to operate effectively in a scientific and technological society. In other words, science education implies exposing learners, usually prospective teachers of science, to scientific and technological knowledge, to the nature of science and scientific processes, to scientific attitude as well as equipping them with professional skills of a science teacher. Thus a thin line exists between science education and education in science where the latter refers primarily to understanding and applying of scientific concepts and principles while the former includes the development and acquisition of processes/ procedures required to help others acquire scientific and technological knowledge for ready application to everyday living. This emphasis is on science educators training teachers effectively to teach the various basic and applied science disciplines in the manner that presents the subject matter of science, first as a process [characterized by skills] culminating in products [knowledge]. The goal is not educating every citizen in one or more science disciplines such as biology, chemistry, physics, agriculture etc. Rather, **science education for all** stresses that every member of a society gets exposed to some basic/simple and broad principles of nature and natural phenomena in ways that help him/her to understand and utilise such

knowledge in everyday living. It stresses that citizens be sufficiently able to appreciate/evaluate the advancements and impact of science in national development. It is the great value placed on this aspect of science education that has given rise to movements to actualize science education for all. Actually, it is in pursuit of this aspect of science education that the concept of “scientific literacy” evolved. What does scientific literacy mean?

Scientific literacy is a concept that has acquired shades of meaning and interpretations in literature. Suffice it to say that one acceptable meaning is that scientific literacy is the ability to understand and apply basic and broad science and technology principles and practices to everyday living, appreciate science and its role in society. To be scientifically literate is to appreciate and enjoy the works of science, its value, as well as its social and ethical implications. A scientifically literate person understands that eating groundnuts or melon or fatty food does not cause malaria, rather it is the parasites transmitted through mosquito bites that cause malaria. But must everyone be scientifically literate or be provided access to science education? The answer is YES and you can ask why?

Need to make Science education accessible to All :

First, it is by exposing everyone to science education that we hope to produce the required large pool of experts in science and technology to bring about the much needed socio-economic development of a nation. These experts are utilized in rational exploitation of natural resources to create wealth as well as in carrying on researches aimed at continually updating our knowledge of nature and environment so that we more accurately predict and control it. These experts can only be produced through a well organized and efficient science and technology education. But then, experts cannot operate the changes in a vacuum. They need the cooperation of an informed public. They need a community which can adapt itself to the changing values and challenges of life. Second, the interactions between science, technology and society are becoming more obvious. The applications of science and technology have become so enormous and compulsive that no one can comfortably and confidently operate in today’s world without smattering knowledge of science and technology. The benefits of science and technology in health, agriculture, information and communication advancements mentioned above

strongly suggests that it is only those who understand and appreciate science that will harness those benefits and thus will live a comfortable quality life.

Third, knowledge of science helps to dispel superstition and unfounded beliefs, myths and the like which retards progress in all aspects of life. For instance, females are circumcised in some societies based on unfounded belief that it will prevent promiscuity in women. Again, in some cultures, children and sometimes women are denied nutritious food such as eggs based on a myth that it will prevent them from being gluttonous.

Fourth, scientific and technological knowledge and skills are crucial for most of our actions and decisions as consumers and even voters. Actually, many decisions at the personal, community, governmental or international level these days involve science and its applications. For instance, citizens are often called upon to contribute/make choices that are capable of influencing the path and priorities of scientific and technological activities. What will be your direction in supporting or opposing scientific practices such as human cloning and genetic engineering, dumping of industrial wastes, population control, investment in solar energy, environmental protection etc if you lack basic knowledge concerning the issues? Meaningful and independent participation in modern democracies assumes ability to judge the evidence and arguments associated with the many socio-scientific issues that appear in political agenda. Surely, every citizen needs to be sufficiently informed and literate in broad principles and ethics of science and technological practices to effectively contribute to national development. In sum, in this era of democratization of decision making, everyone needs to have enough background to appreciate the issues at stake in any important decisions before and after they have been made.

Finally, providing science and technology education for every citizen is a fulfillment of fundamental human rights just as the case with EFA. Science and technology, like other areas of knowledge is a human cultural activity, into which every member must be introduced for completeness.

These and other reasons justify the need to provide everyone access to science education. You may be interested to know whether or not every Nigerian currently has access to science education. A glimpse into our education system will throw out some indicators of the state of science education in Nigeria. The indicators include that:

1. Pupils at pre-primary and primary levels of education are scarcely exposed to science education, even though a core curriculum for Primary science exists.
2. At the junior secondary school level Integrated Science is compulsory for all students. But when they advance to senior secondary level, where the sciences cease to be compulsory, majority of the students happily opt out of science except for biology which remains compulsory. Without recourse to education statistics, our individual experiences in most secondary schools bear evidence to low enrolment in science.
3. At tertiary education level it is the sciences that record short fall in admission and graduate the least number of students. Despite the introduction of General Studies programme in Science in tertiary institutions for non-Science students, the extent to which they become scientifically literate at the end is yet to be studied.
4. In the non-formal education, learners experience little or no exposure to science.
5. Primarily a significant proportion of Nigerian population have not enrolled in either formal or non-formal education signifying that they have not been exposed to any form of science education. .

A synthesis of these indicators strongly suggests that majority of Nigerian citizens do not have access to science education. Simple! The implication of this is that, if nothing is done, Nigeria will continue to

- *depend on foreign science experts,
- * lack science teachers at various levels of education,
- * operate with a citizenry that are illiterate consumers of science products,
- * have citizens unable to objectively contribute to decision making in matters of national interest.

What is Nigeria doing to avoid this? She appears committed to education for all citizens. She has made many pronouncements on the importance of science and formulated a National Policy on Science and Technology [2001] signifying her strong belief in science and technology as veritable tools to transform her economy and improve the quality of life of her citizens. Why then has science education continued to lag behind? What are the barriers/ obstacles to the realization of science education for all and how do the barriers operate?

Barriers to Science education for All

Barrier means impediment or obstacle such as any act, practice, process, fear, belief or value that overtly or covertly prevents one from attaining his/her set goals. For instance, the fear of corporal punishment such as flogging may cause a girl to drop out of school. That act constitutes a barrier to education. It has been possible to identify a number of barriers known to constitute barriers to the attainment of the goal of science education for all in Nigeria. These, I have grouped into FOUR categories- **nature of science, image of science and scientists, the education system, government's disposition.**

a) Nature of Science

The nature of science is that it seeks for explanations utilizing investigative methods that are objective and can even be replicated. The entire process demands rigor, patience, perseverance and honesty which cannot but yield credible results. The extent to which individuals possess these attributes or our culture nurtures the attributes is doubtful. Superstition is prevalent in our society. Illnesses, accidents, natural disasters are attributed to supernatural powers such as “*juju*”, “*ogbanje*” and the like. This position is in conflict with science education where persons are encouraged to seek explanations that are based on logical, objective and testable scientific principles and theories. The fact that explanations based on superstition and supernatural powers are rooted in cultural beliefs and make no intellectual demands on individuals to rationalize, makes this option to enjoy greater patronage than the option of scientific explanations. Thus, the nature of science can create barrier to promotion of science education for all.

b)Image of Science and Scientists

How does the public or society conceive/characterise science and scientists? How do scientists view themselves? Surveys of image of science and scientists among the general public and even children in Nigeria reveal that science is viewed as mystery, as esoteric, mystery, “*ogbara Igbo gharii*”, as activities that can only be carried out in laboratories by adults, as foreign and difficult knowledge only gifted persons can understand.[Njoku,2000]. In other words, science is known to carry the image of abstract, difficult and out-of-reach subjects which only the highly intelligent persons can master. Many scientists through their utterances and behaviour portray this same image

of science being very difficult and scientists being superior and specially gifted persons.. This image of science is false. Scientific activities are not mysterious but understandable being that it involves the simple process of objectively seeking answers to problems posed by nature involving activities which can be carried out, in or outside a laboratory. The subject matter of science may revolve around cultural problem such as science of food production or on “foreign” culture such as in science of test tube baby. Furthermore, the public image of scientists as elderly men who wear white overall coat and horn-rimmed spectacles, who spend many, many hours in their laboratories and worksites leaving them little time for social events and leisure, and get paid peanuts relative to other less demanding professions, is not attractive. Who wants to be that type of person? Surely, this negative image of science and scientist which thrives in the mind of the public, create obstacles to any effort made towards making science accessible to all.

c) The Education System

Analysis of the education system in Nigeria and its operation throws out conditions that wittingly or unwittingly constitute barriers to science education for all. First, is the late introduction of science in formal education. Unlike English, Mathematics, Religious Knowledge and other subjects which are introduced early in school, science does not get to be taught till secondary school. This practice gives children the impression that Science is something special/ extraordinary and perhaps not so important for life. The same thing applies at the Non-formal education level where learners scarcely get exposed to science education. Again, there is problem with the subject matter or curriculum of science. The curriculum of the science subjects especially at the secondary school level have been found to be overloaded with content that are largely irrelevant. That is to say, much of the subject matter does not add much value to the life of the learners. For example, learners find it difficult to understand why they have to learn balancing of chemical equation in chemistry or Refraction index in Physics or Amoeba in Biology or sines and cosines in Maths as they may not readily find applications of these in their daily lives. The fact is that much of the curricular content in school science is directed at producing professional scientists and technologists with the result that other learners find the science not only irrelevant but uninteresting. The non

scientists among you here who were exposed to some science at one time or another can easily recall some of the theories/ subject matter that they were forced to learn which is of no relevance in their lives today .

Compounding the matter is the poor teaching of science in our schools and colleges. You all know what I mean. The way we teach can motivate or turn off a learner. Teaching is not dictation of notes as is often the case. Teaching is simply, a process of carrying out series of planned activities and interactions with learners with sole aim of bringing about learning in the form of acquisition of knowledge, abilities, skills as well as changes in attitude. But because many teachers lack the necessary professional skills to bring this about, having not trained as teachers, their teaching is uninspiring and ineffective.

Students who are taught science by non- professional teachers, or poorly trained teachers, or poorly motivated teachers end up with negative attitude to science education.

Furthermore, the deplorable science learning environment with lack of science teaching and learning facilities in our schools add up to make science education unattractive. In short, the curriculum and teaching of science in Nigerian schools constitute impediments to science education for all.

d) Government's disposition

There is no denying the fact that the government of Nigeria is paying lip service to education. Education everywhere in the world is a social service which government must provide. Nigerian government has not succeeded in providing her citizens access to basic education either through formal or non-formal process. Sound basic education prepares learners to read, write and learn how to learn so that even when they have left school, they are able to access new knowledge available through various media. It is true that science is a fast growing area of knowledge but with sound basic education and a cultivation of reading culture, persons can easily update themselves in new science concepts that have relevance to their survival. In other words, the high rate of illiteracy makes it difficult to achieve science education for all.

Important to note is the lack of science education policy that provides the principles and guidelines for the teaching of science in Nigeria vis a vis the goals of science education, who are to be taught, what is to be taught, how it is to be taught and who is to teach. It is true that there is National Policy on Education [NPE] as well as National Policy on

Science and Technology [NPST]. While the NPE spelt out the general and specific goals, content and processes for various levels of education, the NPST defined the various aspects and roles of science and technology in national development noting how they could be realized. None of these two documents, though recognizing the role of science education provided any guide on goals and processes to be adopted in science and technology education. Consequently, the teaching of science and technology has emphasized the production of experts while neglecting the vast majority who have no intention to be experts but who will need science to effectively live in science and technology driven world. The argument is that the absence of a policy clearly stipulating the why, who and how of science education constitutes a barrier to making science education accessible to all. .

e) **Gender stereotyping in science education**

A lot has been said and written on the subject of gender. Indeed, literature abounds on gender as a major factor in science and technology all over the world. I will just mention a few, [Okeke [1987, 1990, 2002,...], Mulemwa [1991], Harding &McGregor [1996]. Permit me to digress a bit, to get us well informed about the word “**gender**”. Gender is a broad analytical concept which draws out women’s roles and responsibilities in relation to those of men. It is NOT synonymous with sex nor with women though there may be some relationship. **Sex** refers to those characteristics of males or females which are biologically determined such as possession of penis by males and vagina by females. No doubt every one knows those physiological features that characterize male and female humans. Gender, on the other hand, has nothing to do with physiological characters. **Gender** refers to the socially/culturally constructed characteristics and roles which are ascribed to males and females in any society. Males are assigned such attributes a bold, aggressive, logical in reasoning, intelligent, self confident, dominating/assertive, tactful, economical in use of words, etc. Females are assigned the opposite attributes such as fearful, timid, gentle, illogical in reasoning, dull, passive , submissive, tactless and talkative. To verify the truth in these assignments, we need to answer some relevant questions such as: Does every male in that society possess the characteristics assigned to males and vice versa? Are males and females born with those characteristics? In other words, are those characteristics genetically determined? The correct answer to each

question is emphatic NO! Surely, some men possess some of the characteristics ascribed to females and vice versa. There is sufficient evidence to the fact that these behaviours / attributes/ characteristics are not necessarily inborn but are largely learned in the course of socialising our young ones into what characteristic behaviours and roles the society expects of females and of males. How are they learned, you may ask? The learning is through messages and feedbacks received from parents and adults directing growing up children on what behaviours are considered by society as appropriate for females and for males. Lets take one example. By encouraging a boy to for or fight to recover his toy from another child, the boy is being taught and trained to be assertive, bold and aggressive. Similarly, by recovering for a girls or assisting her to recover her toy from another child, the girl is being taught to be dependent, docile and submissive. You may at this point begin to recount your own experiences as a growing up male or female. What is being said here is that, the differences in ways females and males are raised, the activities and roles each is allowed to engage in, the rules that govern their behaviours, the privileges enjoyed by each sex, as well as value placed on boy or girl child constitute the social determinants of gender and resultant stereotype beliefs of characteristics and capabilities of women and men. In short, as one grows, s/he is socialized by society to fit into the masculine or feminine mould that particular society has constructed, moulds which represent gender stereotypes. We therefore define **gender stereotyping** as a collection of commonly held beliefs of opinions about what are appropriate characteristics , behaviours and activities for males [masculine] and for females [feminine] in any society. In sum, gender behaviours, beliefs, values and roles unlike sex are learned through socialization. Gender and gender stereotyping permeate every aspect o human endeavour and come to mould and colour our thoughts and expectations of capabilities of individuals. The consequences of gender stereotyping cut across social, economic, political and educational development especially in the area of science and technology. A few examples will suffice to illustrate gender dimensions in science education which become barriers to science education for all. Firstly, science carries a masculine image both in curriculum. The curriculum is not gender fair since what is generally accepted as science and so the curriculum content reflect mainly the concerns of males. In science instruction, females suffer discrimination from the teachers overtly

and covertly, knowingly and unknowingly. There is a lot of literature on gender discriminations in science. Again, females are under represented in science and technology disciplines and careers as depicted in any relevant, sex-disaggregated data, confirming further that the field and anything related to science is for men and overambitious women. How these factors operate to keep women out of science is well documented in numerous publications such as [Alele-Williams [1987] and Okeke [2002]. What is being said is that, as long as we allow gender stereotyping to thrive in our science education programme, making science education accessible to all, will continue to elude us.

You have seen that there are obstacles/ barriers to science education for all, but we can do a number of things to break the barriers or eliminate many of the obstacles. Lets examine some workable strategies.

Strategies to break barriers to Science education for ALL

I will like to present only five of the workable strategies based on the already stated obstacles-- the image of science and scientists, science curricula, instructional process, gender-stereotyping, government commitment.

1. Recreate the image of science and scientists by

- Scientists and science educators engaging in advocacy activities that demystify and popularize science such as science fairs, science exhibitions, talks and debates
- Partnering with the media to disseminate information in simple language and local languages of the work of scientists and science educators
- Writing and publishing simple, well illustrated books aimed at giving the reading public opportunity to learn simple science for everyday living without necessarily enrolling in formal education

2. Review and modify science curricula at all levels of education

- to accomodate the interest of both science-inclined and non science-inclined learners in the choice of content or subject matter.
- to increase the number of concepts and principles that have great relevance and applicability in their everyday life.

- to suggest in the curriculum several and variety of learning activities that will interest learners while explaining concepts

3. **Teachers must engage in creative and effective teaching by**

- always considering the background/ entry behaviour as well as the goals of the learners in the instructional process.
- selecting and utilizing varied and appropriate methods of teaching providing examples that will help learners to see the relevance and application of science concepts and principles being taught.
- ensuring that the teacher-learner interactions are such that attract and sustain the interest of learners in science education.
- providing adequate and encouraging feedback to all learners

You will but agree with me, that this calls for professional training and re-training of science teachers/ lecturers.

4. **Address gender stereotyping squarely**

- through organizing gender-sensitivity workshops for scientists and science educators as well as parents to avoid gender stereotyping and discrimination;
- through total review of curricula, texts and other instructional materials to eliminate any sign of masculine images of science and scientists;
- deliberately engaging in activities that stimulate and sustain the interest of women and girls in science education such as role modeling and mentoring.

5. **Government is to enunciate appropriate science education policy to**

- stipulate goals and practices for meaningful science education,
- prescribe that science education be introduced at every level of education,
- provide for enabling learner- and teacher- friendly learning environment through the provision of requisite instructional facilities.

Above all government must committedly, pursue literacy for all so that every citizen can read and understand simple science knowledge and practice.

By now you must be wondering what I myself have done in my career to see to the implementation of any of these strategies, that is to say, my own contributions towards making science education accessible to all.

My own contributions towards making science education accessible to all.

As a science educator I cannot claim that I have done everything to make science education accessible to all, but I am proud to say that I have contributed significantly in making science education accessible to many. A display of my score card shows that:

- I have through formal teaching and supervision of undergraduate and post-graduate students in the Faculty of Education for 30 years trained thousands of science teachers who have become professionally qualified and empowered to make science education accessible to others. A good number of them are making waves in their career as lecturers, Professors, Heads of Departments, Deans of Faculty, Provosts of Colleges of Education etc. They have joined my vanguard in the promotion of science education for all.
- I have actively participated in the development and review of science education curricula in this University. For instance, when gender in science education became a burning issue, I got to be introduced into the Science Education program a course titled “Science for Disadvantaged Groups”. The content of the course, the organized learning experiences and classroom interactions revealed a lot to the students and modified their behaviours, attitudes and instructional approaches. The attitudinal changes were not confined to classrooms but extended to homes and to male- female relationships. My graduate students especially the male ones confess that their learning experiences in that course caused them to have change of attitude towards their wives and daughters in respect of their rights and gender equity.
- I have written and published books and numerous articles in international and local journals covering various aspects of science education especially in curriculum and teaching and evaluation. A good number of the publications deal

- with gender and science not only because of its importance in development but more because research has shown that those methods and strategies adopted to bring more women into science are particularly effective in increasing achievement and interest in science for other learners.
- I am an addicted member of one of the most virile professional association, **Science Teachers Association of Nigeria [STAN]** whose goals includes review of science curriculum, and the retraining of science teachers Nigeria to increase their effectiveness in promoting science education for all. I have contributed substantially in the various programmes of STAN including steering her affairs as one time National President, National Treasurer, Chairman of Biology Education panel, Leader of STAN Book Writing Team. Through my influence, STAN established, with me as Chairman, a panel on Gender which runs national workshops to sensitize teachers on interactions of gender in science education.
 - I have worked with international organizations and development partners such as UNESCO, UNICEF and Commonwealth agencies to promote science and technology education through research, organizing training and retraining workshops for education practitioners and policy makers on science education issues. These activities have taken me to various parts of the world as recorded in my academic profile.
 - Through the Carnegie Corporation award, I was privileged to spend 1989-90 as Distinguished International Visitor to Radcliffe College, Harvard University, Cambridge, USA. There, as a Bunting Institute Fellow, I interacted with other Fellows and this provided me with opportunities not only to share experiences on science education in Nigeria but also to participate in several conferences and workshops in USA. I enjoyed the rare privilege of delivering the 1990 Rama Mehta Lecture of Radcliffe College, titled “ **Gender, Science and Technology in Africa: A Challenge to Education**”
 - I have been heavily involved in advocacy matters on gender and girl-child education especially science education. I serve as a Consultant to Federal, State and Local Government agencies as well as NGO’s on Gender issues in Education, mobilizing and conducting workshops across the country. I also run an NGO,

“Women, Education and Development Volunteer, Nigeria [WEDEVON] which uses volunteers to promote women’s access to education and development especially in rural areas. The NGO’s activities of course include basic and health science.

Achieving science education for all is an enormous task which requires that all of us, science education experts, all teachers, parents and indeed, the entire public take up the responsibility in the interest of sustainable development. What can each one of you do in your varying capacities?

Making science education accessible to all: A collective responsibility.

Each of us has a role to play in making science education accessible to all.

As a **parent**, work to eliminate gender stereotyping in socialization process such as in the assignment of responsibilities and tasks, in stipulation of ground rules, in feedbacks, remunerations and recognition in your home. In other words, give equal education opportunity to girls and boys.

As a **teacher**, be sure you have professional training. Be gender-sensitive, consciously avoiding any form of gender discriminations that may disadvantage the females or males. Do not forget that the girls come into science classes already disadvantaged as a result of upbringing that restricted them from out of home experiences that serve as building blocks to understanding and appreciating science education. Vary teaching strategies to accommodate learning styles of different groups of students.

As **curriculum developers**, a painstaking and comprehensive review of science curricula at all levels of education must be undertaken. Modified science curricula necessarily include much of everyday science as required by majority of people as well as major science needed by those advancing in scientific studies. Of course, special attention must be paid to gender- inclusiveness. Encourage the publication of Primers with such titles as “What everyone must know about science”, “Science in a socio-cultural context” which can serve to inform readers of basic science principles and concepts and their applications to life.

As an **administrator** of higher level educational institution, you can succeed to make science education accessible through the general studies programme in science. You must not fail to recognise that the University is almost the last point of call in formal education

to make your students scientifically literate. The extent to which products of higher education institutions are scientifically literate needs to be ascertained. It is being suggested that departments of science education need to be more involved in the development of curricula and teaching of general studies [science unit] in higher education institutions. They will let their experiences as professional science teachers to bear on the teaching of general studies to the greater success of the programme.

As a **government official** or policy maker, you must necessarily work towards the formulation and execution of policies that are favourable to science education for all Nigerians. For example, the development of appropriate science curricula for Early Childhood education programme, for non-formal education sector, effective implementation of primary science curricula, the development and the teaching of science at all levels of education in the country for scientific literacy.

As **member of a community**, engage in advocacy and social mobilization to create value for science education utilizing various communication strategies and packages. Support professional associations such as STAN, Science Association of Nigeria, Nigerian Academy of Education, to build linkages and partnerships in ways that promote science education for all

SUMMARY AND CONCLUSION

I have in this lecture tried to get you to appreciate what science and science education is all about without attempting to make you scientists or science educators in one hour. I have not only refreshed your mind on the importance of science in development but tried to impress it on you that science education be considered a priority for all citizens. We together looked at what may be constituting barriers or obstacles to achieving science education for all with special mention of gender stereotyping. Workable strategies were suggested. I did not leave you ignorant of scratches I made in my career as attempts to liberalize science education. I also challenged you to see science education for all as a collective responsibility of all and apply yourself in your various capacities to make same accessible to all in the interest of All.

ACKNOWLEDGEMENTS

I cannot end this lecture without acknowledging some key persons/ organisations that influenced my academic career. They are:

1. My parents, Late Mr Timothy and Mrs Esther EZEJI who did not enjoy formal education but believed in it. They spared nothing to see that I and all my siblings including females attained our educational dreams. I remain grateful to all elder my siblings who nurtured me especially my elder brother, Sir Sidney Ezeji who in spite of his being the first son, opted to go to a Teacher training college when from Primary 5, I gained admission into secondary school.
2. My teachers in the mission schools I attended, Archdeacon Crowther Memorial Girls School, Elelenwa, and St Marks College, Awka who laid the foundation on which I have built to be what I am today. Of course, the one and only University of Nigeria, that excelled in instilling self confidence in me. After all “*A UNN Graduate is naturally ahead of all others*”. Kudos to my lecturers in Education and Biology with special mention of my two model lecturers, Professor O B Ukeje and Mr Ossie Mozie, of blessed memory, who nurtured in me the “ I can “ attitude.
3. The Science Teachers’ Association of Nigeria, that provided me with opportunities of refresher courses through conferences and workshops and also opportunities to respond to the myriad of problems and challenges facing science education in Nigeria.
4. My family, especially my dear husband, Professor Chukwuanugo S Okeke, who gave me unparalleled home support, academic support, financial support and every form of encouragement to have me blossom as a fulfilled woman, wife and mother. I appreciate my four great sons, two who are already resting in the Lord, for their fervent prayers for 7 whole years, that their mother’s promotion to Professor rank be concluded. Bless them!
5. The Almighty God who made heaven and earth. The Bible did tell us that it is not he that runneth or willeth but God who shows mercy. What I achieved is by His mercy. I have really enjoyed God’s favour in my life and I appreciate Him even more, for today’s event. **To God be the glory!!!!.**

Thank you for honouring the invitation to this lecture and for listening.

REFERENCES and FURTHER READING

- Akale, M A G (ed), [2000], *Enriching Science Technology and Mathematics Education*, Proceedings of the 41st Annual Conference of Science Teachers Association of Nigeria.
- Bajah S T [2002], “Sciencing with Children: A Solid Foundation for our Future Scientists”, *Innovative Faculty of Education Lecture Series, University of Ibadan*.
- Brenton Honeyman, [1998] “Non-Formal and Formal Learning Interactions: New Directions in Scientific and Technological Literacy” *Connect*, Vol. XXIII No 1, UNESCO International Science, Technology and Environmental Education Newsletter.
- Commonwealth Secretariat, [1985] *Popularisation of Science: Report of Commonwealth Regional Workshop in Lusaka*,
- Fensham, P J [2004], “Increasing the Relevance of Science and Technology Education for All Students”, *Science Education International – Journal of the International Council for Science Education*, Vol. 15, No1, March 2004.
- F.G.N. [1981] *National Policy on Education*, Federal Ministry of Education, Abuja
- F.G.N [1991] *National Policy on Science and Technology*, Federal Ministry of Science and Technology, Abuja.
- F.G.N. [2001] *Education For All in Nigeria: A Country Report on EFA since Dakar and National Plan of Action*, Federal Ministry of Education, Abuja
- F.G.N. [2004], *Universal Basic Education Programme: Annual Report*, Federal Ministry of Education, Abuja.
- Jenkins E W [1997],”Gender, Science and Technology Education” in *Connect*, Vol. XXII no 1, UNESCO International Science, Technology and Environmental Education Newsletter
- Jenkins E W& Sjoberg S, [2002] “Science and Technology Education: Current Challenges and Possible Solutions” *Innovations in Science and Technology Education*, Vol.VIII, UNESCO, Paris.
- MacLeod S [1986], *The Teaching of Science and Technology in an Interdisciplinary Context: Approaches to the Primary School*, UNESCO Document Series 19.
- Mulemwa J. [1991], *Science, Technology and Vocational Education of Girls in Africa: Guidelines for Programme Planning*, UNESCO Working Document.

Njoku Z C [2000], “Images of Females in Science: A Gender Analysis of Science and Technology Activities in Nigerian Primary Science Texts” *Journal of Primary Education*, Vol 1:1 p 3-12.

Okeke E A C & Rufai R [2003] *Evaluation of African Girls Education Initiative in Nigeria*, a UNICEF commissioned study, UNICEF, Abuja.

Okeke E A C & Njoku Z C [2001], *Recreating The Image of Science* paper presented at WOREC conference, Imo State University, Owerri.

Okeke E A C [1999] “Gender Issues in Education: Teachers’ Mediating Role” in Nzewi, U M (ed) *The Teacher: A Book of Reading*, Africana- Fep Publishers Ltd. Onitsha.

_____ [1990] *Gender, Science and Technology in Africa: A Challenge to Education*, Radcliffe College Rama Mehta Lecture, Harvard University Press.

_____ [1992] *Women in Science and Technology: The Nigerian Experience*, Science Teachers Assoc. of Nigeria [STAN] Position Paper no 2.

_____ [1981] “The Dynamics of Curriculum Revision” in Onwuka U (ed) *Curriculum Development in Africa*, Africana- Fep Publishers Ltd. Onitsha.

_____ [1996] “Women and Girls’ Participation in Science, Technology and Mathematics: Educators as Facilitators” in Badmus G A & Ocho L O (ed) *Science, Mathematics and Technology Education in Nigeria. The Nigerian Academy of Education*.

_____ [1994] “An Overview of Basic Biological Concepts for Today’s School Children in Nigeria” in McWethy P J (ed) *Basic Biological Concepts: What Should the World’s Children Know*, published by National Assoc. of Biology Teachers, USA.

_____ [2002] *Sustaining Students’ Interest in Science, Technology and Mathematics through JETS Programme* a presentation at National JETS competition.

_____ [2004] “Problems and Challenges of Science Education” in *Science Education and National Development*, A I C E Owerri publication.

_____ [2002] “Gender Equality in Education” in *Journal of the World Council for Curriculum and Instruction*, Vol. 3, 1.

_____ [2002] “The Imperatives of Professionalisation of Teaching in Nigeria” a presentation at Teachers’ Registration Council, South East Zonal Stakeholders Meeting.

_____ [2004] “The Teacher for Nation Building” in *Health and Movement Education Journal*, Vol. 8 no 1.

Microsoft Immersive Reader makes text more accessible. For higher-tech options, virtual tours (check out the many offered by museums and national parks), augmented reality or digital 3D are exciting possibilities. For older students, Trust suggests sending students out to find their own ways to consume information. 2. Multiple means of engagement. Looking at a screen all day may be hard for some kids, while others may need a more hands-on or project-based activity. When this is all over and students return to the classroom, says Trust, this effort will pay dividends. A lot of educators are now using tech in ways they were not comfortable with before. "Educators have been given a difficult challenge and they are going into these communities online and figuring it out," she says. Find, read and cite all the research you need on ResearchGate. Our objective has been to develop an instructional theory and corresponding curricular materials that make scientific inquiry accessible to a wide range of students, including younger and lower achieving students. We hypothesized that this could be achieved by recognizing the importance of metacognition and creating an instructional approach that develops students' metacognitive knowledge and skills through a process of scaffolded inquiry, reflection, and generalization. educators' responsibilities for ensuring equal educational opportunities for all students in their programs. strategies for accommodating students who have disabilities in science and mathematics classes. I hope that you find these materials useful in your efforts to ensure that all students have equal opportunities to learn, explore interests, and express ideas. Sheryl Burgstahler, Ph.D. Director, DO-IT. Science and math teachers share strategies for making these subjects accessible to students with disabilities. (15 minutes). STEM: Science, Technology, Engineering, Mathematics and the University of Washington. Real Connections: Making Distance Learning Accessible to Everyone. Learn issues to consider when designing courses to fully include students with disabilities. (12 minutes). Making high quality education accessible to all. Making high-quality education accessible to all. Researchers and educators gather at MIT to discuss how to meet the educational needs of a new learning society. Stefanie Koperniak | MIT Open Learning. Another example of an innovative education program with some "leapfrogging" characteristics is the Program in Data Science, created by CoLAB, a hub of disruptive innovation organizations in Uruguay. CoLAB also supports up to 500 students over the next four years to participate in a blended learning program in data science offered through the Uruguay Technological University (UTEC).