

SCIENCE WITHOUT WOMEN: A PARADOX

By

Prof. David N. Ezeh

*The Vice Chancellor of the University of Nigeria, Prof
Bartholomew Okolo,
The Deputy Vice Chancellors (Academic, Administration and
Enugu campus),
Other principal officers of the university,
The former 74 past inaugural lecturers of the university here
present,
Distinguished professors
Other academic and non-academic staff of the university
Ordained men and women of God
Lions and Lionesses,
Distinguished Ladies and Gentlemen.*

Preliminaries

May I first salute and welcome the Vice Chancellor of the University, Prof Bartholomew Okolo, through whose approval via the universities' senate ceremonies committee, I am given the rare opportunity to stand here before you today to make public a substantial aspect of my research efforts via an inaugural lecture; 22 and 13 years after my engagement as academic staff of the university of Nigeria and after my promotion to the rank of Professor of Science Education of the university respectively.

With all due humility and honour, I welcome and appreciate the physical presence of all of you here today and for opting to give audience to this my lecture in spite of your several official and private engagements. May, I therefore, request for your sustained attention and patience for the lecture as I do not intend to keep you here longer than necessary.

Introduction

Upon creation, God first made Adam. After a while, He said that “it is not good for the man (Adam) to be alone, I will make him a helper” (See Genesis 2¹⁸). Consequently, Eve, of the opposite sex, was added to him. But one is tempted to wonder: why a being of the opposite sex? Why did God not create another man to add to Adam if indeed the justification for creating Eve is to give Adam a helper?

Since in my faith God cannot be questioned, one can only hypothesize, for academic sake that perhaps the divine intention may have arisen out of His plans for co-habitation of beings of opposite sexes i.e. man and woman living and working together. Indeed, it may be to ensure the perpetuation of this pair that God ordered Adam and Eve to “...be fruitful and multiply; bring forth abundantly in the earth and multiply therein” (see Genesis 9⁷). And in strict obedience to the Divine order ‘to multiply,’ the estimated human population of the world has multiplied to about 6.83 trillion, made up of about 3.44 trillion males and 3.39 females (UNO, 2008).

Therefore, effective and efficient attainment of global sustainable development requires equitable harnessing and maximization of the human resources of the 6.83 trillion people irrespective of sex. In the view of Kornhauser (1999), women have high creative

power and equal intellectual assets with men and therefore should be equally empowered through education in science and technology to fast track sustainable development of the human society.

In tandem with this, international, intercontinental and national treaties, policies and programmes abound that are focussed on promoting gender equity in access to science and technology, two examples of which are:

- The proposals to the 1994/5 working group of the United Nations Commission on Science and Technology for Development (UNCSTD) which enjoined all governments to agree to adopt a Declaration of Intent on Gender, Science and Technology for Sustainable Development. The Declaration of Intent identified six basic principles of equity regarding gender and science (UNCSTD, 2012).
- Protocol to the African charter on Human and Peoples' Rights on the Rights of Women in Africa, which in its Article 12(2) specifies that States Parties shall take specific positive actions to promote education and training for women (and men) at all levels and in all disciplines, particularly in the fields of science and technology. (www.achpr.org/instruments/women-protocol/)

The common emphasis among these policy specifications is promotion of gender parity in the acquisition of scientific knowledge through education in science.

Conceptualising Science

The word Science is a derivative of the Latin word "*scientia*" meaning knowledge. Knowledge generally implies all the

information, facts, truths, and principles learned throughout time. This, however, does not suggest that all the learned information, facts truth and principles learned are science. Rather Science is a special type of discipline with peculiar characteristics, the prominent being the approach through which knowledge is pursued. This approach is commonly known as Scientific Method. In turn, Scientific Method is a logical, rational and systematic process by which knowledge in the discipline is pursued and conclusions about the world/nature around them derived. The steps are Observation, Hypothesis, Prediction, Experimentation and Conclusion

Science is therefore, both a process (scientific method) and a product (knowledge, facts, and principles). Both the process and the products of science are acquired through learning and therefore entail a specialised type of education.

What then is this special type of education; Education in Science or Science Education?

Education in Science and Science Education

The concept of Science Education though interchangeably used with Education in Science is clearly different. According to Dienne and Gbamanja (1990), specialists in the discipline of science who are deeply trained in the scientific concepts, facts, theories and techniques by which new information is uncovered in science are said to be educated in such science disciplines as Biology, Chemistry, Physics, Biochemistry and Integrated Science etc.

In the same vein, there are those who in addition to having been educated in science disciplines including exposure to a specified period of internship in pedagogy (i.e. science of teaching) specially related to the understanding of science, its teaching and learning. In this group are specialists in such single subjects as

Biology, Chemistry, and Physics etc in combination with education. These are specialists in Science Education and are therefore known as Science Educators; so called because they have gone through the professional programme of science education. Those single honours graduates in any of the science subjects who subsequently decide to undertake a Post Graduate Diploma in Education (PGDE) are also known as Science Educators. It is to the science educators that the responsibility of transferring scientific knowledge to the learners squarely and professionally belongs.

On the other hand, those involved in and or engaged in teaching science without any strong background in education disciplines, including sufficient exposure to a specified period of supervised internship in science teaching, are regarded as non-professionals or as auxiliary science teachers i.e. science teacher supporters. These are not trained science educators and therefore are either unlikely to achieve the desired science teaching outcome or achieve minimal result with more difficulty than the science educator.

A Professor of Biology in California Institute of Technology who later underwent a professional training in Science Education acknowledged and extolled the monumental importance of pedagogy if effective teaching of science is to take place, thus:

... it is also the case that scientific training often includes little or no focus on science education itself...it is simply assumed that a PhD in experimental science is adequate preparation for ones eventual educational responsibilities...I can assure you that this is not the case. I knew essentially nothing about education in general, or science education in particular. Many of the

assumptions I had made about the change process, as well as what good science education looked like, were flat wrong. I also had little or no real understanding of the structure of school districts, teacher capabilities, or the effort really required to produce lasting change in public science education (Bower, 2005).

Implied in the above exposition is that effective and meaningful teaching of science, and indeed any other discipline, generally requires much more than the mere generation and ‘dishing out’ of scientific facts to the learners as is often the case. Teaching, at all levels, is a profession requiring intensive and extended period of training that exposes the trainees not only to the psychology, sociology, history of education etc. of the learners but also to the ‘what’, ‘where’ and ‘how’ best of the classroom communication of the would-be teachers through a thoroughly supervised internship.

Differentiating Sex and Gender

In everyday English language, sex and gender are often used interchangeably. However, the two terms or expressions are distinguishable.

Sex is a natural condition, genetically determined and defined by the gonads, or potential gonads. It is a biological and physical state of organisms that refers to the fixed genetic and anatomical characteristics that define humans into two general and opposite groups. The two sex general groups are male and female and are differentiated by chromosomes, hormonal profiles, internal and external sex organs. It is generally assigned at birth by external genital appearance, due to the common assumption that this represents chromosomal or internal anatomic status. Between the two sex groups are however organisms that possess

characteristics of both men and women. These are known as intersex or hermaphrodites. Again there are transsexuals meaning a situation in which an organism changes the original sex to the opposite one i.e. from man to woman or woman to man.

Gender on the other hand comes from the Latin word *genus*, and it conveys the meaning of kind or race. It is nurtured, and therefore, subject to cultural influences and interpretation as well as limitations. Gender refers to one's subjective feeling of 'maleness' and 'femaleness' irrespective of one's sex. It is generally classified into masculine or feminine and concerned with the attitude(s) that describes males and females in the social and cultural context. It has to do with the peculiar responsibilities and roles of men and women that are established in the families, societies and cultures. Gender describes the personality traits, attitudes, behaviours, values, relative power, influence, roles and expectation (femininity and masculinity) that society ascribes to the two sexes on a differential basis.

The concept of gender is vital because it reveals how women's subordination (or men's domination) is socially constructed. As such, the subordination can be changed or ended. It is not biologically predetermined neither is it fixed forever. According to Nobelius, (2004), what it means to be a 'real man' in any culture requires male sex plus what our various cultures define as masculine characteristics and behaviours, likewise a 'real woman' needs female sex and feminine characteristics. Therefore, to summarise:

'Man' = male sex + masculine social role

(A 'real man', 'masculine' or 'manly')

'Woman' = female sex + feminine social role

(A 'real woman', 'feminine' or 'womanly')

Science Education, Women and Development

The role of science education is to inculcate scientific literacy among its learners. Scientific literacy is the development of the ability to creatively utilise science knowledge in everyday life to solve problems, make decisions and therefore improve the quality of life. This is because human beings are handicapped without the presence of science which gives rise to technology. The application of science and technology positively transforms human society through dramatic advances in almost all fields.

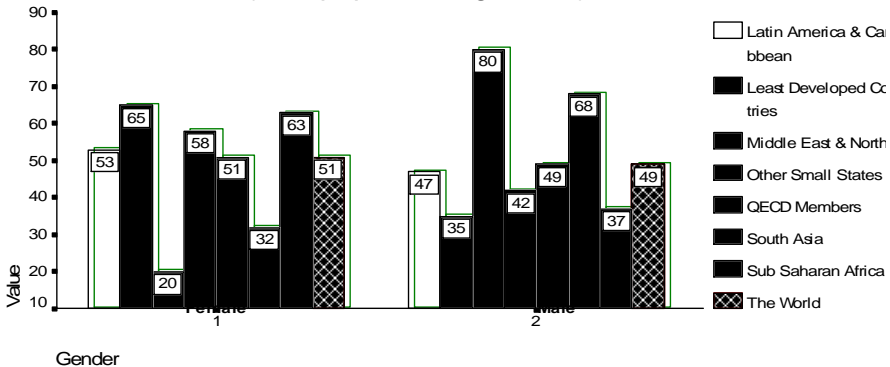
Further, the basic unit of human society is the family. A family is composed of a group of people who are related by birth or marriage, or even adoption. In most cases, a family is initiated through marriage between at least a man and a woman. In a family, there are shared responsibilities between the man and the woman for the smooth running of the home. The man generally has the leadership role, while that of the woman:

... is like the merchant ships, bringing her food from afar. She gets up while it is still dark; she provides food for her family and portions for her servant girls. She considers a field and buys it; out of her earnings she plants a vineyard. She sets about her work vigorously; her arms are strong for her tasks. She sees that her trading is profitable, and her lamp does not go out at night. (Proverbs 31:14-18).

World Bank (2010) also specifies that 51% of the women participate in labour against 49% of the men. It is shown in Figure 1 below that out of the seven of the World Bank's groupings of the countries in the world, it is only in Middle East/North and South Asia that the proportion of men that

participate in labour is higher than that of the women, that is, 80% and 68% respectively. In the ‘least developed nations’ group, women constitute as high as 65% of the population participating in labour.

World Labour participation rate By Gender
(% of population ages 15+)



The foregoing likely implies, among other things, that from creation, women were not only charged with the responsibility of providing the family food. They are to work more for the overall development of the family, and therefore, the larger society. The capacity, i.e. the knowledge and skills for this responsibility, is initially transmitted informally from mothers and other elders to the younger females at home, and later in life through formal education at which they may specialize in various areas of study.

Formal education for women is, therefore, indispensable for the development of the human society. No wonder a Ghanaian scholar, Dr. James Emmanuel Kwegyir-Aggrey, once said that “If you educate a man you educate an individual, but if you educate a woman you educate a family (nation)” (Brimmer, 2010). This must be because women education impacts positively on the health of the children, and by necessary implication, on that of the adults, and adult fertility. The fact that two of the eight Millennium Development Goals (3 & 5) focus specifically on women lends

credence to the crucial role women play in some very important national development sub-sectors in which they actively participate. Few examples are:

Agriculture

Women play a significant role in agriculture, the world over. About 70% of the agricultural workers, 80% of food producers, and 10% of those who process basic foodstuffs are women and they also undertake 60 to 90% of the rural marketing; thus making up more than two-third of the workforce in agricultural production (FAO, 1985). In West Africa for instance, up to 80% of the labour force in all trade is female (Roodkowsky, 1979).

Medicine

Women have played in the past and continue to play a very integral part in the medical field. Some of the important roles women play in medicine are wet nurses, mid wives and caring for one another during pregnancy and in an ante-natal capacity throughout time. Traditionally, in most families women are the first port of call for most people who are sick as they offer advice, provide such healthy remedies as first aid care/treatment, and even hospitalization in most cases.

Industry

Throughout the world, women make a vital contribution to industrial output. Women have traditionally played an important role in the SME sector, as owners, managers and workers. They dominate three important subsectors, making over 80 per cent of the employees in textile, clothing and leather production, 75 per cent in food, beverages and tobacco production, and over 60 per cent in wood and wood processing. Over 200 million women are employed across all industry sectors, with half of this number in developing countries (www.unido.co). Their work not only sus-

tains their families but also constitute a major contribution to socio-economic progress.

As women play these major roles and more in the science related sectors of national development, they need the acquisition of abundant knowledge of Science. In other words, women and girls ought not to only be proportionately represented in active participation in the study of sciences but should also be encouraged to develop higher disposition(s) towards achieving higher in the discipline, if sustainable development of the world is to be attained. But in reality, what is the actual state-of-the-art?

Evidences of the State-of-The-Art

Three indicators of the state-of-the-art of formal education in science are hereunder considered. These are:

Disposition

This is the conscious inclination or propensity to behave in a certain manner and is often a function of *attitude* and *interest* among other related human personality constructs. While attitude is the inclination or predisposition to respond overtly to a certain idea, object, person or situation, interest is concerned with personal feelings - likes and dislikes or affinities and aversions to a “thing”. The source of difference between attitude and interest is on the “thing”. The “thing” for interest focuses strictly on activity; while for attitude, the “thing” can be anything but activity.

Few evidences of disposition to Science are:

- Nearly 90% of 18-24 year-olds and two thirds of the British public were unable to name a single famous female scientist.
- There is a decline in pupils' attitudes towards science starting in the primary phase and continuing through to undergraduate studies. In particular, between boys and girls, this decline is

more pronounced with the girls in physics and chemistry, but far less in biology (Head, 1995).

- Girls have a negative attitude towards science laboratory work (Okebukola, 1985).
- In Integrated Science, the foundation science subject for lower forms of secondary schools in some countries including Nigeria, there is no difference between the level of interest exhibited by boys and girls in the subject (Ezeh, 1993).
- Generally, boys have more positive attitude in all types of science than girls (Weinberg, 1995).
- Biology is broadly popular among boys and girls sometimes equally so or with the girls showing more interest (Prokop, Prokop, & Tunnicliffe, 2007).
- Chemistry and Physics are more popular among boys than with girls, with Physics enjoying very low rating among girls. (Gosh, 20102).

Enrolment

This is the number of students who are formally registered for a named programme in a specified period usually in a formal institution. Below are few evidences of status of enrolment in sciences:

- Enrolments in science and technology courses in higher education ... relative to males have been found by several recent reports to be poorer for girls. (UNESCO, 2009).
- In the United States:

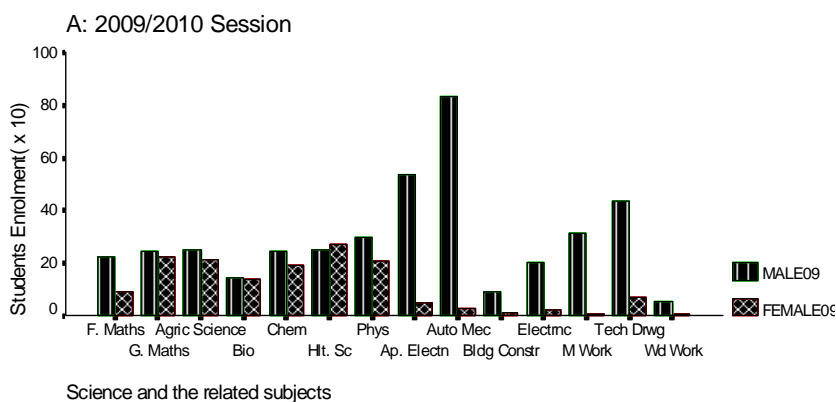
- ✓ In 2000-2001 only 17% of University undergraduate are science majors. (Billings, 2003).
- ✓ Male high school students continued to take science Advanced Placement subject tests in larger percentages than female students and tended to score higher (National Science Foundation, 2012).
- In the United Kingdom, enrolment in the sciences is not only low and declining, but proportionately more women than men drop out, fail courses or choose to major in another subject other than science (Selby, 1997).
- In New Zealand women account for a mere 20% of undergraduates in information technology and the sciences (Brook et al., 2000).
- In sub-Saharan Africa,
 - ✓ 42 million children were out of school out of which about 60% are girls (UNESCO, NESIS & ADEA, 2000).
 - ✓ Participation at tertiary education reveals that average enrolment for science education in tertiary education was 5.1 % for male and 2.8% for females (UNESCO, 1999a).
 - ✓ Only 12% of girls elect to study physics, chemistry, and biology in Africa (Andam, 1990).
 - ✓
In Kenya, by 2002-2003 to 2004-2005 academic years, out of the 1,815 science, mathematics and technology students enrolled in bachelor of Science education programmes, only 470 or 25.90 percent were female,

representing only 17.52 percent of the female students enrolled (Bunyi, 2006).

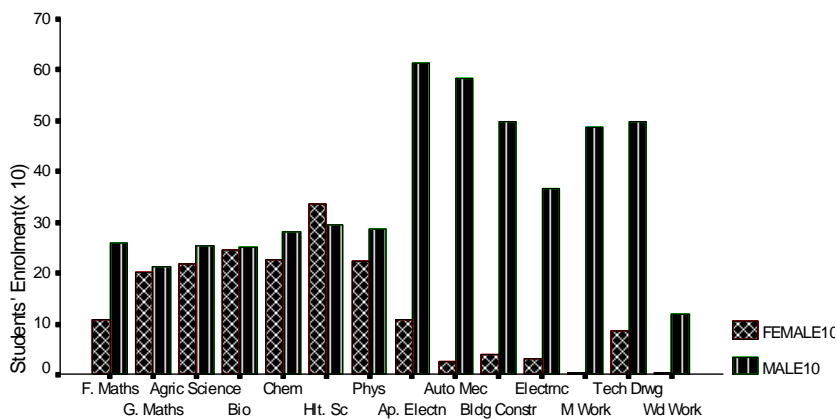
In Nigeria, at the:

- Secondary school level, evidences as shown below indicate that the enrolments of male students in the West African School Certificate Examinations (WASCE) for 3 continuous years outnumber those of the females in most of the science and technology based subjects with the widest gap being in Auto Mechanic across the three years. It is only in Health (or Nursing) science that marginal differences are observed in favour of the females in the three years under consideration (WAEC, 2009, 2010, 2011).

Students' Enrolment in WASCE in Science and the Related Subjects (by Gender)

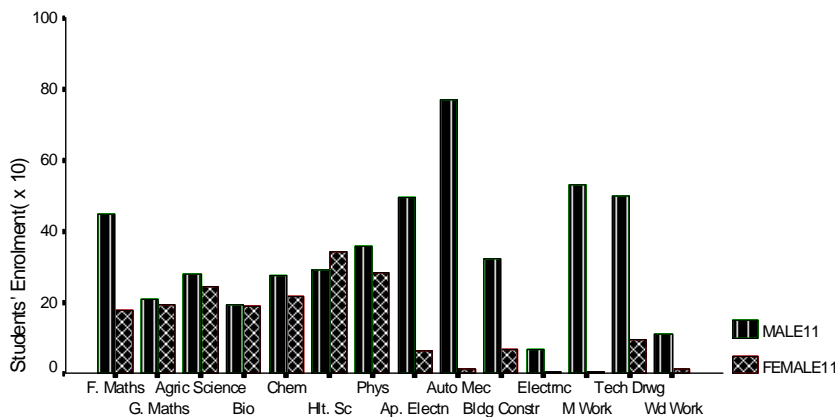


B: 2010/2011 Session



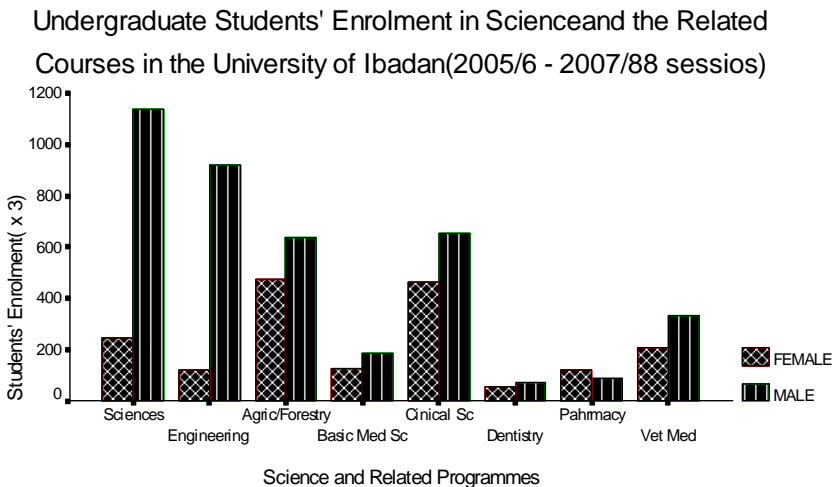
Science and the related subjects

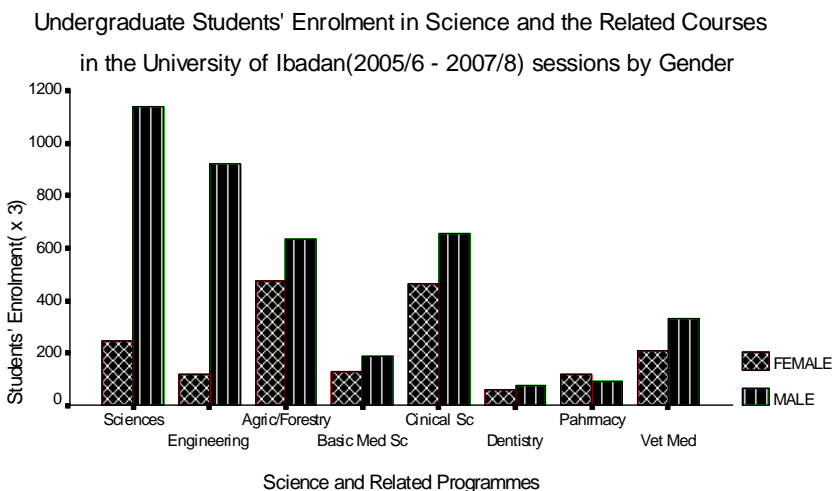
C: 2011/12 Session



Science and the related subjects

- Colleges of Education and Polytechnics, males outnumber the females in S&T as their enrolments are 81% and 60% respectively programmes (Egunjobi, 2008).
- In the 1999-2000 sessions, there were zero enrollments for females in technical courses such as mechanical engineering, plumbing, fabrication and welding in Nigerian Universities while female students constituted only 27 percent of those in science programs in the universities (Federal Ministry of Education, 2005).
- Universities as typified by two first generation universities in Nigeria-University of Ibadan (Odejide, 2007) and Nigeria (UNN, 2010-2011), the pattern of enrolment in various Undergraduate Science and the related programmes courses are gender skewed in favour of the males except in Health Sciences and Pharmacy in UNN and UI respectively as shown below:





Achievement in Science

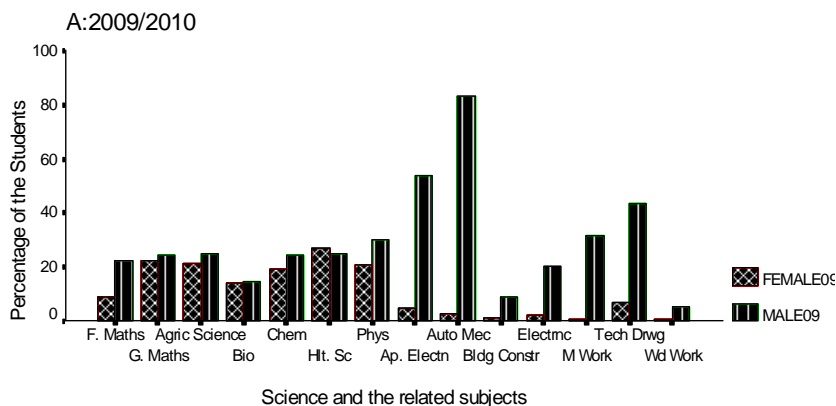
This is the proportion of the specified science contents learnt by the students after being exposed to it within a specified period. Some evidence of status of achievement by gender are as shown:

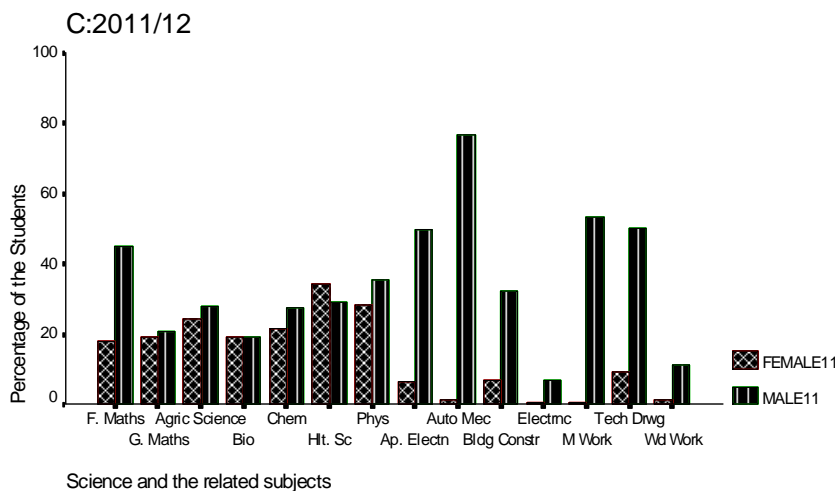
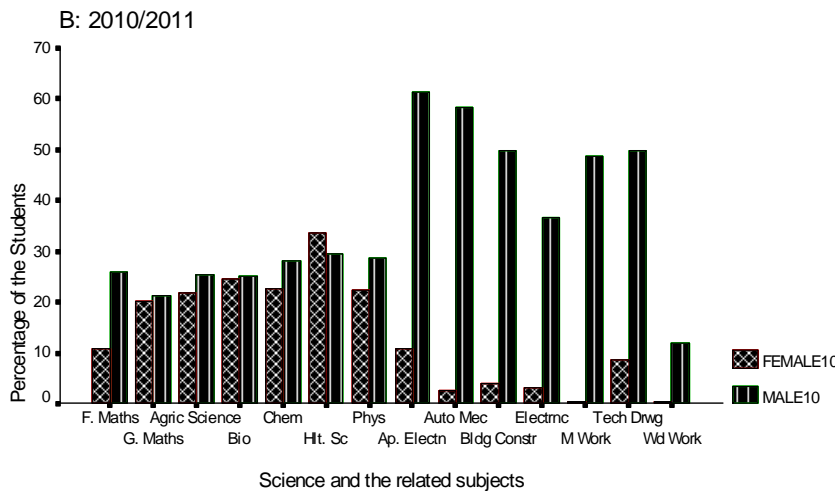
- Achievement in science and technology courses by females in higher education institutions relative to males has been found by several recent reports to be poorer for girls (UNESCO, 2009).
- 95% of all Nobel Prize winners in Chemistry, Physics, Medicine, have been male ([www. feministletters.wordpress.com/.](http://www.feministletters.wordpress.com/))
- In the United States,
 - ✓ Results students' achievement in science in grades 4, 8, and 12 reveal that males continue to outperform females in science achievement. Females at all levels have made relatively little gains in their average science achievement scores since 1996 (NAEP, 2005).

- ✓ Males continue to surpass females in the number of undergraduate degrees awarded in science and engineering fields. In particular, computer science, physical science, and engineering show the greatest differences with males attaining more baccalaureate degrees in these fields. (National Science Foundation, 2005).
- Israeli high school boys' achievement in science is significantly better than that of girls. Specifically, the achievements of boys in earth science, biology, chemistry and physics were significantly better than the achievement of the girls. (Levin, Sabar & Libman, 2006).
- Among Australian secondary school students, boys' achievement in biology, physics and chemistry was significantly better than girls (Young and Fraser 1994).
- In England and Wales, the Assessment of Performance Unit (APU) data for thirteen year old pupils indicated that boys outperformed girls in the use of graphs, tables and charts, using apparatus and measuring instruments, interpretation of data and application of physics and chemistry concepts (Murphy and Qualter, 1990).
- In sub-Saharan Africa girls scored significantly lower than boys in all science/math subjects in the secondary schools that participated in the first phase of FEMSA (FEMSA, 1997-10, pp. 11-13).
- Female education and training in Africa is generally characterized by lower performance and achievement levels than those of boys, especially in mathematics, science and other technical subjects (Gachukia & Kabira, 1991).

- In Tanzania women representation in the disciplines of sciences, mathematics and technology is generally low in access, participation and performance. Fewer girls choose SMT subjects and the overall performance of girls is much worse than that of the boys (Masanja, 2007).
- In the West African School Certificate results in Nigeria, males outperform the females in most science and the related subjects. In 2009, 2010 and 2011 for instance, male students consistently outperformed the females in these subjects except in the Health Science as shown graphically below:

Proportion by Gender of Nigerian Students Scoring Grades 1-6 in WASCE in
Science and the Related Subjects in 2009/10 to 2011/12 Sessions





As shown above, the differences by gender in their achievement in these subjects are narrower in General Mathematics and the

basic sciences of Agricultural Science, Biology, Chemistry and Physics and widens in those subjects that require the application of General Mathematics and such basic Sciences as Further mathematics, Auto Mechanics, Building Construction, Electronics, Metal Work, Technical Drawing and Wood Work.

The foregoing are few evidences of general imbalance in disposition to, enrolment and achievement in science against the females relative to the males, particularly among the developing countries of the world. Concerned about the obvious negative consequences of the ugly status of education science, science education researchers in particular directed their research efforts towards evolving strategies that would promote gender equity in students' positive disposition towards science and eliminate gender disparity in students' enrolment and achievement in the discipline.

Some of My Gender Based Research Outputs

Some of the gender-based research outputs, sole, joint or supervised are hereunder summarised and presented in four broad clusters as follows:

- ❖ Survey of the *status quo*
- ❖ Gender sensitivity of Science Instructional Resources
- ❖ Main effect and Interaction of Gender and Instructional approaches on Science Achievement
- ❖ Determinants of Gender Equity in Achievement in Science

1. Survey of the *status quo*

(a) *Determinants of JSS Students level of Acquisition of Science Process Skills.* (Eya, 2007)-- My PG supervisee

The study was informed by the need to provide baseline data for adequate human capacity building for technology development, an assessment of the level of scientific process skills possessed by secondary school students in which their gender was an independent variable. The result showed that the male students are superior to the females in observation, measurement, classification, inferring, experimentation and interpretation process skills.

- (a) *Female Farmers' Access to Technological Inputs in Nsukka* (Ezeh, and Okoli, 1995)

The study was informed by the hypothesized trend that even though among the farmers of some parts of the South Eastern Nigeria, female farmers are more involved in most agricultural activities than the males, yet they have no access to relevant technological farm inputs. Results of the study showed that the agro-inputs available to the female farmers are mainly the low or crude inputs that direct expenditure of human energy such as cutlasses, hoes, wedding knives, axe etc.

2. Gender Sensitivity of Science Instructional Resources

- (a) *Development and Validation of Integrated Science Achievement Test : Ezeh, (1997).*)

The need to validate the speculation that items in the assessment instruments in science discriminate against the female students motivated this study, which adopted the recommended conventional instrumentation procedure in attempting to develop a gender fair achievement test in Integrated Science. A 66 item Integrated Science Achievement Test (ISAT) that has high psychometric

qualities that discriminate against its female users with evolved.

In spite of the high psychometric qualities of the newly developed ISAT, it was found to be discriminatory against the female students with mean score of 62.81 as against 68.19 for the males.

- (b) *Effects of Gender Sensitization of Science Teachers on Gender Gap in Science Achievement and Interest among students*. Nworgu,(2004)---My Ph.D. supervisee

The concern to reduce the gender gap in achievement and interest in science among students informed the study aimed at developing a gender sensitive package (GSP) which effect on these variables were explored. Results among others show that GSP:

- Reduce gender gap in achievement in science even though male students yet maintained higher achievement mean score than their female counterparts
- Reduce gender gap in interest in science even with the female student having higher mean interest rating than the males.

- (c) *Gender Sensitivity of Recommended Chemistry Textbooks for Senior Secondary Schools in Nigeria* Raina, (2012) -- My Ph.D. supervisee

The incessant call by stakeholders in Science Education to evolve strategies that would entrench gender balance in secondary school students' achievement in the sciences informed this study that was aimed at examining gender sensitivity of chemistry textbooks used in Nigerian Secondary schools. Results among others show that:

- Only one out of the four chemistry textbooks used in the study had up to 44% female human images while the other three had human images less than 10%.
- The percentage of female human images in the other three textbooks was 25 of the total images while female images in active roles is between 0 to 5%.
- The scanty female images are presented in jobs in which they are merely assisting the males' in science activities.

(d) Development and Validation of an Instrument for the Assessment of Science Process Skills Acquisition in Practical Chemistry. Ugwu, (2009) - My Ph.D. supervisee

The supportive evidence of gender imbalance against the females in performance in Practical Chemistry attributed to gender bias of the practical chemistry methods necessitated the need for this study aimed at evolving gender fair instruments for the assessment of students' practical skills acquisition in chemistry. The two instruments that resulted from the study--- the Qualitative Chemistry Scale and the Quantitative Chemistry Scale respectively showed that:

- Seven skills of observation, classification, Recording, Measurement, Controlling variables, Experimenting or Manipulating, Communication, Inference, and Interpretation of data and Prediction in the qualitative sub-scale are gender insensitive. While Skill of controlling variables discriminates against the males, skills of communication and interpretation of data discriminate against the females.

- All the 7 items in the quantitative sub-scale i.e. observation, classification, Measurement, Controlling variables, Experimenting, Communication and Interpretation were found to be gender insensitive.

3. Main effect and Interaction of Gender and Instructional approaches on Science Achievement

Science teachers' lack of knowledge of more effective strategy than expository for enhancement of science teaching and learning that results in consistent low disposition and achievement in the subject spurred the studies in this group.

(a) *Effect of Self-Regulation Process on Secondary School Students Achievement in Quantitative Chemical Analysis* Ezeh & Opara (1999)

- Without the self-regulation process, male students significantly outperformed the females with mean score of 40.6 and 38.21 respectively.
- When the self-regulation process is applied in teaching, the overall mean score of the students (without distinguishing males from the females) is 49.39 as opposed to the mean score of 29.32 of the students who were taught the conventional (lecture) method.
- The female students in the self-regulation group significantly performed higher than the males in the same group with mean score of 51.40 and 47.21 respectively.
- The male students in the conventional (lecture) method, with a mean score of 34.00, performed significantly higher than 25.01 scored by the self-regulation group.

Therefore, the self regulation process differentially enhances the achievement of female students in quantitative chemical analysis.

b. Effect of Mind Mapping Teaching Strategy on Students' Interest, Retention and Achievement in Secondary School Chemistry: Okeke (2011) –My Ph.D. supervisee

Results of the study among others showed that Mind Mapping Teaching Strategy (MMTS), a constructivist based teaching strategy, enhances the achievement, interest and retention of the female students in chemistry more than those of the males.

4. Determinants of Gender Equity in Achievement in Science

(a) Access to Science Equipment and School Related Variables as Determinants of Achievement in Integrated Science Among Junior Secondary School Girls. Ezeh, (2000)

Of the variables of access to Science equipment and school related variables it was access to science equipment, and such aspects of school related variables of school ownership school type that determine girls' achievement in integrated science. Specifically it was found that girls in the:

- Schools with sufficient Science equipment perform better than those without or less science equipment.
- Federal Government owned colleges outperformed those in both state and privately owned ones.
- Girls-only type schools performed higher than those in mixed type schools.

(b)Diagnosis of the students Difficulties in the Application of IUPAC System of Nomenclature in Inorganic Chemistry Ezeh, & Eze, (1997)

Observation of sex differential performance in chemistry against the female students at about the time the system of nomenclature in chemistry (IUPAC) was newly introduced gave rise to the hypothesis that the difficulties encountered in the newly introduced system of nomenclature were to be responsible.

Results of the study show that the extent of the problems encountered in the newly introduced system of nomenclature was independent of the students' sex and, therefore, could not account for the differential performance against the females in the subject.

(c). Gender and School Location as Factors of Interest in Integrated Science: Ezeh (1992)

The introduction of Integrated Science as a replacement of General Science for the lower forms of secondary school in Nigeria stimulated intense research efforts targeted at generating solutions that would forestall the observed gender biased nature of the old General Science programme. This study is one of such efforts the results of which showed that:

- The mean interest rating in integrated science of the male students (45.73) is generally higher than that of the female (39.03).
- There is interaction effect of gender and school location on the students' mean interest rating in the subject i.e. while the mean interest rating in integrated science of the male students in urban located schools is higher (58.63) than that

of their female counterparts in urban located schools (39.75), that of the female students in rural located schools (38.31) is higher than that of their male counterparts in rural located schools (26.83).

(d) *Determinants of gender equity in enrolment, achievement and attitude towards science among Nigerian Secondary School Students: a case study of Anambra and Enugu States* (Ezeh, (1998).

The study was targeted at ascertaining the extent to which the Nigerian government has attained the universal quest for entrenchment of gender equity in positive attitude to enrolment and achievement in science. Results show that in the two states under consideration:

- Females' enrolment in science (125,141) is higher than that of the males (94,650).
- The attitude to and achievement in science of the males is respectively higher than those of the females.
- Belief that science influences marriageability, parental encouragement to study science and belief in the stereotype of science are the main factors that influence gender inequity in attitude to and achievement in science.

(c) *Socio-Cultural and School Related Determinants of Achievement in and Attitude to Integrated Science among Junior Secondary School Girls in Enugu State: Ezeh, Ezeani, and Ezeani,(1998).*

The need to nip in the bud the observed girls' underachievement in the sciences informed this study designed to identify some of the socio-cultural and school determinants of their achievement in and attitude to integrated science at the lower form of secondary

school. The results of the study, shown below, are the percentage contribution of each of the socio-cultural and school related factors to the students' negative attitude to and underachievement in science:

Socio-Cultural Factors	% Contribution	
	<u>Achievement</u>	<u>Attitude</u>
Belief in masculine image of science	7.79	9.99
Belief in negative role of science in marriage	3.42	1.49
Belief in negative role of science in religion	2.14	0.53
Parental encouragement to study science	1.27	0.09
Ethnic language	0.81	0.06
Parental economic status	0.80	0.01

School Related Factors	% Contribution	
	<u>Achievement</u>	<u>Attitude</u>
School ownership	16.63	1.11
School type	1.45	0.68
School performance in JSSCE	0.86	0.52
School location	0.26	0.41
School science teacher's sex	0.24	0.25
Class size	0.06	0.24
Type of studentship	0.06	0.19
Science equipment availability	0.03	0.13

Each of the socio-cultural factors influences girls' negative attitude to and achievement in science with the belief in masculine image of science exerting the highest influence and ethnic language of the students the least on the two measures respectively. Influence of each of the socio-cultural factors is higher on the students' attitude to science than their achievement in science, except for students' belief in masculine image of

science that exerts higher influence on achievement in science more than their attitude to science

The 8 school-related factors considered influence girls' negative attitude to and achievement in science. Class size exerts the highest influence on the students' negative attitude to science, and school ownership the highest on underachievement. Influence of class size, science teachers' gender, type of studentship and science equipment availability is respectively higher on the students' negative attitude to science than on their achievement in the subject. On the other hand, school ownership, School performance in external examination, school type, school and location exert more influence on students' achievement in science than their attitude to science.

Results of these gender-based research studies reveal that even though at the lower levels of education females enrol more than males, the trend reverses in favour of the males as their class level progresses. Again, there is a general trend of underachievement of females relative to the males in the sciences. Such inputs relevant to effective teaching and learning of science as instructional materials, teaching and methods and strategies, location of school related and socio-cultural variables etc singly and/or in combination with one another influence male superiority over the females in disposition and achievement in the sciences.

Consequences

The observed general gender gap in disposition, enrolment and achievement against females in science cumulatively widens from the primary through secondary to the tertiary level of education. This accounts for the relatively low proportion and underrepresentation of female graduates in science and its related discipline. Bickerstaff (2006) describes this situation as a:

... 'leaky pipeline' carrying students from secondary school through university...this pipeline leaks students at various stages: students who express interest in science careers sometimes change their minds when applying to colleges and universities and select other areas of study. Others begin their post-secondary education in a STEM program, but change majors before graduation. Finally, some students leave the pipeline after graduating with a STEM degree when they select another field as a career. One interesting feature of these leaks is that women leak out more than men do. The effect of differential leaking is to create a sex-based filter that removes one sex from the stream and leaves the other to arrive at the end of the pipe-line. No one in a position of power along the pipeline has consciously decided to filter women out of the STEM stream, but the cumulative effect of many separate but related factors results in the sex imbalance in STEM that is observed today (Blickenstaff, 2006).

In other words, because women are not commensurately benefitting from science education programme, they cannot adequately participate in how the science and technology sectors are being designed and how they will affect the life of a country, their known involvement in activities relevant to development of national economy notwithstanding.

The Paradox

Science and the related disciplines are known to be indispensable for exploration, exploitation and harnessing of the natural resources of the environment through which socio-economic and techno-scientific advancement needed for modern development is attained. In most countries of the world, particularly the

developing ones, more women than men are involved in the activities basic/fundamental for sustainable development. Therefore, women are expected to have favourable differential access to education in science commensurate with their extent of involvement in developmental activities. The implication of the foregoing, among others, is that national programmes designed to facilitate sustainable development, including education in science, ought to preferentially target the women.

On the other hand, the state-of-the-art is contrary to this expectation. Science is generally seen, in the developing nations, as a masculine discipline that has little or nothing to do with the female folk as the latter generally exhibit apathy to and low performance in science relative to the males. In other words, science is so much seen as an exclusive domain of the males to such extent that a Brazilian man unable to countenance the 'unbelievable' fact that her scientist wife enrolled and later bagged a Ph.D. in science unknown to the man disrupted a graduation party organised by her friends for that attainment and subsequently filed a divorce suit (Etzkowitz, 2007).

It is therefore conclusive from the foregoing that even though women have much need for higher positive disposition to and achievement in science than the males, as they are more involved in sustainable development activities; in practice they (the women) have lower disposition to and achievement in the sciences than their male counterparts who are generally less involved in developmental activities. This is a typical case of two faces of opposites- indeed a paradox.

Towards Resolution of the Paradox

A meaningful attempt at resolving this evident paradox of gender disparity in access to science against women in spite of the latter's involvement in science related development sectors should start with identifying the possible causes of the observed imbalance in science against women, some of which include:

Nature and Nurture

One of the active debates in the literature of science education has been on whether or not *nature* or *nurture* accounts for the cause of gender difference in the sciences.

The proponents of nature as the cause of gender difference in science hold the view that due to physical development of their brains, males have better developed visual spatial ability than females resulting in the latter's genetic deficit in the basic intellectual equipment required for learning science. This school of thought, therefore, attributes gender inequity in academic performance in science to genetics or nature or biological deficiency of the females.

On the other hand, the proponents of nurture as the cause of gender difference posit that there is a clear and compelling evidence that women, like men, flourish in science when they are given the supportive environment. They disagree with the genetic deficit predisposition and insist that the sexes are equal in their intellectual abilities. In their view, any biological differences between the two sexes are vastly outweighed by social pressures and discrimination that discourage the females from pursuing science. According to them, scientists are made not born. They insist that acquisition of scientific knowledge requires years of education and training (i.e. to be made), and because females do not have 'cognitively stimulating environment' due to cultural constraints, they tend to lag behind in science. As a result, they conclude that gender difference in science and mathematics is basically nurture induced.

It is however my view that both nurture and nature are important in the study of science. They both influence human behaviour differently. While nurture seems to be stronger in determining

such specific behaviours as whether to go to school at all, smoke, go to party, etc.; nature seems to provide the framework for such behaviour and limits for physical growth, as well as personality traits. Nurture then takes over from there to determine the ultimate behaviours. Throughout most of life, I would say that it is nurture which determines most human behaviour.

The Early Childhood Socialization Process

In Africa for instance, boys particularly are more encouraged to be physically active and to learn how to be self confident and address their own problems whereas girls are brought up to be obedient, tender and conscientious. Boys, therefore, tend to be groomed to be independent while girls are groomed to be subservient and affectionate. Through these practices, such important skills and attitudes required in learning science as discussion, problem solving, manipulation, endurance, inquisitiveness etc. are acquired early enough by boys and this unconsciously lays a more conducive and solid science learning foundation for boys in science even before they are introduced to the formal learning of science in school, unlike the girls.

Family Expectations and Roles Assignment

Generally, family expectations and roles assignment, particularly for girls, have been a disincentive for their education in science. Girls tend to be assigned roles in the family that are time consuming, leaving them with not much time for private study. This tends to have long-term influence on the girls' future career. Girls contemplating a career in science may therefore find the choice of time for family attention versus that for career in science a major dilemma; and often, that of the family overrides.

Gender Stereotype

Gender stereotype is one of the glaring causes of gender inequity in science against females. This is the practice of attributing roles,

behaviours and aspirations to individuals or groups solely on the basis of gender. Discriminations based on gender stereotype surface in many ways in the school(s), in such situation as teachers' samples of grouping of the students' activity or assignments, the content of compliments and criticism, the treatment of females in textbooks and curriculum materials, differential treatment of males and females in the classroom based on mistaken beliefs about attitudes and cognitive abilities etc.

Generally, the traditional gender stereotypes encourage females to adopt self-conceptions and values that reduce the importance of interest and achievement in science. Unlike boys, these self-conceptions among females lead to a pattern of internalized helplessness with respect to science, with failure credited to lack of ability and success to luck (Smith, 1992; Adams, 1996).

In Botswana, for instance, boys are still deliberately channelled into the so-called masculine areas such as mathematics, science and technology, while girls are concentrated in the so-called feminine disciplines like home economics, language and teaching (Duncan, 1989).

Teachers' Prejudicial Classroom Behaviour

There is a strong prejudicial belief among some teachers that mathematics and science subjects are a male preserve. Many teachers, including women teachers, just do not believe that girls have the ability to study mathematics and science, resulting in such teachers having low expectations of girls' ability to perform well in science. That is, teachers generally tend to accept the situation of low disposition to and achievement in science by the females as normal, and therefore, do not even see any justification in attempting to explore strategies of improving the status of science performance. For instance, poor expectation of

girls' performance in the mathematics and science subjects is seen as 'normal' while boy's high performance is extolled as exemplified by a science teacher's comments after a science exercise on female and male students' results as:

Ngozi Nwosu, 38%. Wahoo! You have really made an effort during this test! (i.e. it is normal if girls fail in science examinations)

John Eze, 74%. Hey, my brother! You did not try enough! You must really work harder next term! (i.e. it is highly unacceptable if a male student's performance is above average).

This is a typical case of prejudice by a science teacher against girls' achievement in science; and rather than praising and encouraging such a girl, publicly discourages her.

Similarly, teachers often direct more challenging, high order questions to males, while only simple recall type of questions are directed prejudicially to the females. Prejudicial treatments as these reinforce and confirm in the minds of both boys and girls, albeit subliminally, the wrong notion '*that science is for boys only.*' Boys therefore, over time, develop at these subjects which they consider a male domain while girls see themselves as intruders and therefore shy away from any active participation during science for fear of being taunted by their teachers and male classmates.

Low Confidence of Females in the Discipline of Sciences

Self confidence, a belief in one's own ability, is one of the known correlates of success in science and its lack a major source of gender difference in the discipline. Perhaps, arising from the primary and secondary socialization processes of the youth, particularly in Africa, science-related tasks are seen as being exclusive for the males. The females imbibe this impression and

would have little or nothing to do with these tasks and through that, they (females) develop low self confidence in science.

Gender Bias Nature of Science Textual Materials

Textbooks and other science instructional materials constitute a source of gender inequity in science. Most published science textbooks depict both males and females in sexually stereotyped positions. Majority of human images in science textbooks reflect copious gender bias in favour of males. In most cases, not only are girls and women images and pictures marginally represented in science textbooks, but also the very scanty female ones frequently show them as passive observers of science activities being carried out by boys. There is also the tendency to present women in such texts in such non-scientific roles, primarily as mothers, homemakers, and care givers with limited role as science professionals.

Role Models

Men make up the majority of scientists and engineers in most industrialized countries, though, the percentages vary from one country to another. In other words, there are few female role models in science for younger female science students to look up to as models. This is because low proportion of women in science and technology sends a signal to younger girls that science is not meant for them and therefore must be avoided at all cost.

Sex Role Identity

Boys and girls begin learning how to be men and women almost as soon as they are born. Older members of the society teach children how to be a 'grown up' through explicit lessons and daily interactions with them. This practice is extended to the schools where boys and girls separate into 'opposite sides' both in the classroom and on the playground. Teachers often re-enforce this segregation by seating girls on one side of the

classroom and boys on the other, or by setting up class competitions of boys vs. girls. The idea that boys and girls are made to sit on opposite sides seems to send a signal to them that there is appropriate career goals and aspirations according to one's gender. It is this type of early indoctrination at the girls' primary socialization stage that is built up to create the strong impression among some African women that women's ultimate role is basically to produce children and take care of the home, and that any involvement in a profession, such as science, is unheard of and anti-woman.

The Way Forward

In this section, some suggestions that would promote females' attainment of parity with or possibly surpass their male counterparts in access to the sciences are hereunder proffered.

De-masculinising Science Teaching Environment

It is a common knowledge that science teaching is predominantly dominated by male teachers, just as science instructional strategies and contents reflect male experiences. These tend to create the impression, among the students, that science is a male affair and that science is not for the females as they have no need for knowledge of science. In other words, they (the females) should have little or no business getting involved in learning the science. Accordingly, female students feel unwanted and would not take the business of studying sciences serious.

To avert and correct this impression, science teaching environment, resources and contents should be de-masculinised and made to be gender neutral by:

- making available female science teachers in schools through the provision of various forms of attractive incentives in form of special scholarship to pre-service

female science teachers;

- science teachers creating examples by giving assignments to the students that emphasize the ways that science can equally improve the quality of life of both males and females;
- Using gender balanced cooperative groups in class and avoiding dividing students by sex in seating arrangements in science class or laboratories, and for class competitions or examinations;

Reviewing Science Curriculum to Accommodate Women Needs and Experiences:

There is a need to review the existing science curriculum so as to commensurately accommodate science learning experiences that are meaningful, practical and relevant not only to the immediate growing needs of both males and females but also to ensure gender balanced lifelong aspirations and engagements. Instances of such engagements and concerns include the on-the-spot quick-thinking arithmetic acumen of market men and women in computing costs etc., the chemistry associated with soup making and illicit gin production, the kind of geometry involved in hair styles, basket weaving, pot making, bead work, cloth weaving. These have the potential of early exposure of the applications of science concepts to life learning and life skills and thereby engendering and sustaining their interests, particularly those of the females, in science.

Creating Classroom Environment of Self-Confidence for Girls

Communicating loudly and clearly that both boys and girls are equally endowed and therefore equally expected to do well in Mathematics and science courses by teachers has the potential of motivating science and mathematics female students. Science

teachers should, therefore, adopt the habit of equally praising and verbalizing their expectations of both male and female students as this is critical in fostering self-confidence, particularly among the former. Instances include but not limited to giving regular feedbacks in the form of un-stereotyped comments, thereby highlighting female students' confidence in terms of mastery of the content of science. Teachers can also encourage participation and foster self-confidence by giving consistent positive reinforcement for their responses to questions in science classrooms.

Involving Female Scientist Role Models as Guest Speakers

Involving successful female scientists as guest speaker role models is a potential strategy of promoting girls education in Mathematics and Science. Schools should invite women who have excelled in the field of science and technology to their schools or classrooms to talk about their experiences in Science and Mathematics.

For example, in Nigeria, accomplished female mathematics educators like the former Vice Chancellor of University of Benin, Professor Alele-Garce Williams, among several others; and in Kenya, the Kenyan first African woman to win a Nobel Peace Prize for her work on science-environmental issues and human rights, Dr. Wangari Maathai, can be invited to the schools to talk about science, mathematics and environment. The use of women as resource persons can serve as effective role models and psychosocial therapy boosting female students' self-esteem, helping to raise the aspiration, motivation and academic levels of female science students.

Networking among Female Scientists

Networking is a means through which people communicate, share ideas and information and give support and direction to each

other. Networking promotes bonds with people among professionals, both within and outside the work environment. It also creates new opportunities and makes it easier for the exchange of ideas, knowledge and information.

The participation of women in the Mathematics and Science Education networking, involving accomplished men scientists and science educators, would be of great benefit in educating the females that science can equally be studied and its knowledge equally applied by both the males and females. This would go a long way in correcting the old impression among the females that science is exclusively a male affair with little or nothing to do them.

Female science teachers in Nigeria, for instance, can develop such a local network by being members of such science based association as the Science Teachers Association of Nigeria (STAN), Mathematical Association of Nigeria (MAN) etc. through which they could participate and socialise with other male and female colleagues in the association's local, regional and national conferences and workshops.

Evolving Gender-based Affirmative Action

Gender-based affirmative action is a policy or programme aimed at countering discrimination against minorities, in this case, girls and women. Specifically, it suggests providing females opting to pursue science and the related courses in the tertiary institutions preferential admission opportunity such as having a lower cut off marks than their male counterparts. This suggestion is justifiable and plausible in such an educational system as in Nigeria where there is an extant admission policy of quota system that permits admissions into the universities to "reflect the federal character" of Nigeria. In this system, there are admissions quotas for Educational Less Developed States (ELDS), Locality, and

Discretion i.e. admission under these categories are not based on the students performance ranking in the entrance examination but within each of these subgroups.

Therefore, given the current general dismal picture of females underrepresentation in science and mathematics education, introducing preferential admission policies that would favour preferential admission into science and science-based programmes in Nigerian tertiary institutions seems to be an immediate option if not an all time remedy towards maintaining a gender equity in science education.

Introduction of Science and Mathematics Pre-Entry Programme (SMPEP)

As a long-term intervention strategy towards balancing the evident gender imbalance in science and technology education at the tertiary education against the females in the developing countries, Science and Mathematics Pre-Entry Programme (SMPEP) should be introduced so as to increase their access to science and technology programmes. The emphasis of the programme should be to provide bridging courses for female students who would not qualify to enter university, so as to enable them qualify and join science and mathematics oriented courses.

A similar approach has been adopted in the university of Dar es Sal, Tanzania that has been operating a Pre-entry Programme (PEP) in science and mathematics for female students since 1997. The emphasis of the programme has been to provide bridging courses for female students who do not qualify to enter university, to enable them qualify and join science and mathematics oriented courses. It was introduced first as a pilot scheme under a Teacher Education Assistance in Mathematics and Science (TEAMS) project managed collaboratively by the

Faculty of Education and the Faculty of Science. This had led to significant increase in female access to science and technology in Tanzania (Luhanga and Mashalla, 2005).

Summary and Conclusion

Science through technology drives national development. Thus, the level of scientific literacy of a nation, estimated by the proportion of her scientific literate citizens, is a measure of her development. The corollary, therefore, is that the higher the proportion of the scientific literate citizens of a nation the higher the national development and vice versa. Therefore, for a sustainable global development, the expectation is that there ought to be universal scientific literacy through universal education in science without discrimination of any kind.

It is however unfortunate that while most of the sustainable development activities, particularly in the developing countries are predominantly undertaken by girls and women, they do not benefit commensurately from science and technology education. It is known that there is a “gender gap” in disposition and achievement in the sciences, against the women even up to the university level. Literature and research seem to conclude that there are no biological, neurological, or genetic factors at work in the creation of scientific gender disparity. Rather several factors combine to make it more difficult for women to train and maintain a high-achieving scientific career.

Gender inequality in science has several obvious negative consequences for the women affected, for the scientific community in particular and for nations in general. On a larger level, excluding women from science in the classroom sets the stage for a huge decline in scientific literacy which is most needed for sustainable socio-economic development of a nation.

Though the problem of disparity in access to science against the female folk may be said to have its most profound effects on the sustainable development of nations, addressing the issue requires a mix of approaches at every stage of education. Younger students must be introduced to the subjects of mathematics and science in a way that makes it so clear and relevant to their daily experiences that they can, and should, strive to attain excellence in the subject. This will help to eliminate the stigma of mathematics and science as being too difficult or irrelevant. At the tertiary education levels such as the colleges of education, polytechnics and university levels, a well-designed curriculum with emphasis on the scientific components of a general education will help students of all backgrounds to explore their general disposition towards science, and ultimately, promote their performance in the discipline.

Thanks a Lot

Let me say “thanks a lot” to some individuals, both the living and the dead, who were instruments in the hands of the Almighty God in facilitating my academic career up to this point.

First, may I profusely thank the administration of the University of Nigeria led by the Vice Chancellor, Prof. Batho Okolo, for the sustained efforts in the transformation of the physical environment of the university and in reviving quality academic culture in the university, aspects of which include the institutionalisation and ‘conscientization’ of the academic staff for inaugural lectures as a monthly routine. In the recent past, inaugural lectures used to be rare events in this university. But today, its awareness profile among the academic staff is so high that the waiting period in the queue of prospective inaugural lectures is over twelve months. Indeed, it is likely that by the first quarter of this 2013, the booking for 2014 inaugural lectures will have been filled.

To my parents, Chief Gabriel Onoyima Eze, and Ma Josephine Nneze Eze, both of blessed memory, I thank immensely for their sustained determination to have ‘forced’ me back to primary school immediately after the Nigeria-Biafra war in 1970, without which I would have ended up as somebody else but a Professor.

As some of you here are aware, my town Obollo was the first Biafra town to be ‘captured’ by the Nigerian soldiers, thereby making us the first set of Biafran refugees at Ihe-Awgu. At Ihe, I was made to join my elder brothers in the family businesses of serving as lorry conductors in my father’s lorry and trading in crayfish and snuff, depending on market days. When the Nigerian soldiers closed up to Agbogugu, a town before Ihe on moving from Enugu to Awgu, my parents again moved the family to Ishiagu close to Afikpo road where we camped as refugees in a primary school building for about one year and three months. It was at this time that two of my elder brothers, A.U. Ezeh (Dr A.U.Ezeh) and Paul Okoye Ezeh (now late) joined the Biafran Army. My father had to bring the remaining members of the family, through bush pathways and deep rivers and streams on foot, to Mbu Akpoti, a town near Obollo Eke that was relatively safer, as it was occupied by neither the Nigerian nor Biafran army. It was from Mbu Akpoti that I joined my peers at Obollo Eke to the mammy market as cigarette seller. From cigarette trading, I graduated into a ‘big’ articles trader, so big that even after the war in 1970; I combined the trade with my education as a primary six pupil. I became so engrossed with the business that I even refused to procure the entrance form to secondary school because I preferred being a businessman to going to school. My parents had to collude with my eldest sister, Nnemuroha Teresa Eze, to seize my articles of trade with the promise to release same to me after sitting for the secondary school entrance examination, which of course never happened even after sitting and passing the

examination. That was how I eventually found myself in a secondary school that sowed the seed that germinated to my qualifying to stand and deliver this inaugural lecture here, before you, today.

I will forever remember and remain grateful to Prof Lawrence Offie Ocho for his role in ‘saving’ me from ending up as a rural school principal. As the Provost of the then College of Education Eha-Amufu, on hearing from Ichie Emmanuel Eze, a staff of the college Library (who would later become a close friend) that there was a young man who made a First Class in Chemistry Education and who was teaching in a remote secondary school, he invited me to the College. On my arrival in his office, he chatted briefly with me to validate the credentials he heard I possessed. He then convened an emergency Panel that interviewed and employed me on the spot as a pioneer Head of Department of Integrated Science.

My mind is still fresh with my experience when I first applied for postgraduate admission to this university. As a fresh graduate from the University of Lagos, I applied for postgraduate (Masters) admission to the University of Nigeria. For whatever reason unknown to me, I was not recommended to the postgraduate school for admission by the then Department of Education, the class of my Bachelors degree notwithstanding. As I was sobbing along the corridor of the department, it was a young man whom I never met in my life then who saw me and took the pains of finding out why I was in that mode. After carefully narrating the misfortune of my not being offered admission despite my having a First Class Honours, he took me to Prof Jones Nwaogu, the then Head of Department, who after listening to the young academic, sought for my file among the heap of the files of the candidates rejected for admission based on lack of facility. On locating my file and seeing that my first

degree result was the best of all that applied for postgraduate admission that year, he substituted my name with one out of those already recommended for admission. This is or was the genesis of my long-time strong mutual relationship with Prof B.G. Nworgu, whom I later learnt was a roommate of my elder brother, Dr A.U Ezeh, at the then Alvan Ikoku College of Education, Owerri. Prof., I and my family will ever be grateful to you for this gesture of sowing the seed that sprouted into giving me the qualification to standing here and give this lecture today. I thank God that this relationship has been sustained and nourished till date. The birth of the 33 year old National association, the Association for Promoting Quality Education in Nigeria (APQEN) is one of the several products of this relationship.

To Prof. Violet Harbor-Peters of blessed memory (may her soul rest in peace) my supervisor at both the Masters and Ph.D. levels, I owe much appreciation; not just for being my supervisor or for the special method of postgraduate supervision via group seminar involving all her PG students that groomed and instilled confidence for public academic presentation among the students, but also for her pioneering role in my appointment as a temporary lecturer in the then Department of Education of this university when I was yet a postgraduate student.

It was Prof. Anthony Ali, the most senior academic in the Department of Science Education as at today, and whom I regard as the father of science education, that encouraged and almost 'forced' me to apply for the assessment for the professorial rank from my then comfortable senior lecturer status, at a period I thought I was relatively young both chronologically and in the faculty. But for God working through him in this manner, perhaps, my promotion to the standing of a Professor may have come much later than it did. For this selfless encouragement and guidance which he is known to be extending to many other

younger academics in the faculty, I am and will forever remain eternally appreciative.

The role Prof Osita Ogbu played in my academic career is so significant that it needs to be mentioned in a forum of this nature. Through my very close friend, late Dr. Ernest Okoli (may his soul rest in peace), Prof Ogbu ‘discovered’ me and trial-tested my research competence, by exposing me to IDRC mini grant to execute a research in a discipline other than mine. Following his high impression of the report of the study, which is published in *Technology Policy and Practice in Africa*, he developed so much trust and confidence in my research skills and competence. This convinced him not only to expose me to several international research funding agencies but subsequently also to consider me fit to direct most funded researches for ADSI of which he is the Executive Director.

To Obioma Eze, my divinely chosen life partner and love of my heart, whom when seen in my company by some, is mistaken as either my twin sister or younger sister (since in their views we look alike), I am bereft of words to express the magnitude of my appreciation: for all her consistent and persistent encouragement to me to forge ahead with my academic career, even when she was yet to obtain her Bachelors. My prayer is for the Architect and Keeper of Life to give us longevity so that you reap the fruit of your selfless sacrifices and commitment in instilling sound morality and discipline to our five lovely and lovable children: **Chinedu** – an Abuja-based lawyer; **Nnamdi** - the Economist; **Nkemdilim**.- the Computer Scientist, **Chidinmma** – the budding journalist/newscaster; and **Nebechi** - whose career is being fashioned by Him, the Maker of all things visible and invisible.

To all my brothers, sisters, in-laws, colleagues in the Faculty of Education, friends and well wishers, too numerous to mention

individually due to time and space constraint, I thank immensely and pray for God's blessing. I also wish to say a tremendous 'Thank You' to all of you here for sacrificing time to be here to listen to my lecture.

Finally, to the Almighty God, the omnipotent and author of life, I say may Honour, Adoration and Glory be His now and perpetually remain with Him.

REFERENCES

- Adams, (1996). Is homophobia associated with homosexual arousal? *Journal of Abnormal Psychology*. 105(3):440-5.
- Andam, A. A. (1990). "Remedial strategies to overcome gender stereotyping in science education in Ghana." . In L. L. B. Border & N. Van Note Chism (eds.). *Teaching diversity*. San Francisco: Jossey-Bass.
- Billings, D. 2000."Women's ways of Knowing and the Digital Divide." *Presented in an interactive paper presentation*.
- Blickenstaff, J.C.(2006). Women and science careers: leaky pipeline or gender filter? *Gender and Education*
- Bower, M.J.(2005). Scientists and Science Education Reform: Myths, Methods, and
- Brimmer, E.(2010). Women as Agents of Change: Advancing the Role of Women in Politics and Civil Society. From: www.state.gov/p/io/rm/2010/142907.htm
- Brook, P., S. Mann and A. Virtue. 2000. "Aberrant Behaviour." *Proceedings of the 13th Annual conference of the*

National Advisory Committee on Computing Qualifications (NACCCQ) conference. Wellington, New Zealand, 29-36.

Bunyi, G. W. (2006). *Gender Equity in Higher Education in Kenya.* A background paper prepared for the Public Universities Inspection Board, Nairobi, Kenya.

Dienye, N.E. and Gbamanja, S.P.T (1990). *Science Education Theory and Practice*; Owerri, Totan Publishers

Duncan, W. A. (1989). *Endangering school learning: Science, attitudes and achievement among girls and boys in Botswana.* Stockholm: University of Stockholm.

Egunjobi, O. A. (2008) Women in Academics: The untold story of Gender Inequality and Discrimination against Women in the Ivory Tower. Lead Paper presented at the seminar organized by the National Association of women in Academics (NAWACS), University of Ado-Ekiti Chapter, Ado-Ekiti

Ejifugha, A.U;Ogueri, E.; and Ogueri, E.(2011).*Gender Equity In Science Teacher Education For Sustainable Development An Emerging Perspective.* Being A Paper Presented At The First International Technology, Education And Environment Conference Held At Federal College Of Education (Technical), Omoku-Rivers State, Nigeria On September 5th – 8th, 2011.

Elan, S.(2012). Study: Women encounter inequality in science & technology fields .www. <http://elsevierconnect.com>

- Etzkowitz H.(2007;Editorial). The “Athena Paradox:” Bridging the Gender Gap in Science. *Journal of Technology Management Innovation*, Vol. 2, Issue 1.
- Eya, M. (2007). Determinants of JSS Students level of Acquisition of Science Process Skills. *M.Ed.* Thesis, University of Nigeria, Nsukka.
- Ezeh, D.N. (1997). Development and Validation of Integrated Science Achievement Test; *Journal of Science and Technical Education*, 6(1&2), (137-147).
- Ezeh, D.N. (1992). Gender and School Location As Factors of Interest in Integrated Science; in G.C. Obodo (Ed) *Science and Mathematics Education in Nigeria*; Enugu, Utuo Publishers ;(Academic Forum’s Conference Proceeding).
- Ezeh, D. N.(1998). *Determinants of Gender Equity in Enrolment, Achievement, and Attitude Towards Science Among Nigerian Secondary School Students: A Case Study of Anambra and Enugu States.*(A research report funded and submitted to the International Development Research Center; IDRC; Dakar, Senegal
- Ezeh, D.N.(1998). Access to Science Equipment and School-Related Variables as Determinants of Achievement In Integrated Science Among Junior Secondary School Girls. *Information Technology and Education*
- Ezeh, D.N; Ezeani, E.O.and Ezeani, C.N. (1998). *Socio-cultural and School-related Determinants of Achievement in*

and Attitude to Integrated Science Among Junior Secondary School Girls in Enugu State, Nigeria; Nairobi; Academy Science Publishers.

Ezeh, D.N. & Eze, C.U. (1997). Diagnosis of Students Difficulties in the Application of the IUPAC System of Nomenclature in Organic Chemistry, *Technology and Research Journal*, 1(1). (35-42).

Ezeh, D.N. and Okoli E.C. (1995). Female Farmers Access to Technological Inputs in Nsukka in Ogbu, O.M; Onyeninka B.O. and Miawa, H.M. (eds.) *Technology Policy and Practice in Africa;* Ottawa, International Development Research Centre.

Ezeh, D.N and Opara, M.F.C.(1999). Effects of Self- regulation Process on Secondary School Students Achievement in Quantitative Chemical Analysis; Accepted for publication in the *Journal of Science and Science Teaching* 2(1).

Ezeh, D.N. & Ugwu, A.N.(2001). Development and Validation of Chemistry Process Skills in Quantitative Analysis Assessment Instrument. *Journal of Mathematical Sciences Education*. 1(1).20-28.

FEMSA (1997-1 to 19). FEMSA's Dissemination reports [Report]. Nairobi: FAWE.

Federal Ministry of Education (2005) Statistics of Education in Nigeria: 1999-2005. Abuja, Statistics and NEMIS Branch, Federal Ministry of Education Nigeria.

- FEMSA (1997-10 to 19). FEMSA's Dissemination reports
Nairobi, FAWE
- Food and Agricultural Organization, (FAO) (1983). *Forest
Destruction and Agriculture in Nigeria*; Rome.
- Gachukia, E, & Kabira, W. N. (1991). The identification of
elements in African culture hampering the integration
of women in development process. OAU/UNESCO.
- Ghosh, P. (2012). State schools failing girls who want to study
physics. Retrieved from:
www.bbc.co.uk/news/education-19603399
- Head,J.(1995). The personal response to science Cambridge:
Cambridge university press, UK.
- Kornhauser, A. (1999). The role of women in science for
sustainable human development. Retrieved
from:[www.unesco.org/science/wcs/abstracts/thematic
_keynotes.htm](http://www.unesco.org/science/wcs/abstracts/thematic_keynotes.htm)
- Kwegyir-Aggrey J. E. (1875-1927), Retrieved from:
<http://www.afriprov.org/index.php/african-proverb>).
- Levin,T. Sabar, N. & Libman, Z (2006).Achievements and
Attitudinal Patterns Of Boys And Girls in Science
Madness; National Academy of Science, N.W,
Washington
- Luhanga, M.L. and Mashalla, Y.J.S. (2005). Reforms and
Innovations in Higher Education: A Reflection on the
Initiatives and Lessons at the University of Dar es
Salaam in Tanzania, 1994-2004, Paper prepared for the

Nuffic Conference 'A Changing Landscape', The Hague, 23-25 Ma.

Malcom, S. (1999). Promoting science learning for girls and women: Policies for human resources development. www.unesco.org/science/wcs/abstracts/thematic_keynotes.htm

Masanja, Verdiana, (2007). *The Female Education in Mathematics and Science in Africa (FEMSA) Tanzania Project: Tanzania Country Report. FEMSA*

Murphy, P. and Qualter, A. (1990). Constructing gender-fair science activities and assessments. Contributions-GASAT, National Assessment of Educational Progress (NAEP). (2005). *The Nation's Report Card: Science*. Retrieved August 8, 2008, from: http://nationsreportcard.gov/science_2005.

National Assessment of Educational Progress (NAEP). (2005). *The Nation's Report Card: Science*. Retrieved August 8. From: http://nationsreportcard.gov/science_2005.

National Science Foundation, (2005). *Women, Minorities and Persons with Disabilities in Science and Engineering*, Government Printing Office, Washington D.C.

National Science Foundation, (2012). *Science and Engineering Indicators*. Retrieved from: <http://www.nsf.gov/statistics/seind12/c2/c2s2.htm#s1>

Nobelius, A. (2004). What is the difference between sex and gender? Retrieved from: webmaster@med.monash.edu.au

- Nworgu, L.N.(2004).Effect of Gender Sensitization of Science Teachers of Gender Gap in Science Achievement and Interest among Students . Ph.D. Thesis, University of Nigeria, Nsukka.
- Odejide, A. (2007). "“What can a woman do?’ Being Women in a Nigerian University". *Feminist Africa*, 8: 42-59..
- Okafor, T.U.(2009). Readability and Content Evaluation of Recommended Physics Textbooks in Anambra State Secondary School. Ph.D. Thesis, University of Nigeria, Nsukka
- Okebukola,P.A.(1985).Science Laboratory Behaviour Strategies Of Students Relative To Performance In And Attitude Toward Laboratory Work. *Journal Of Research In Science Teaching*, 22(3),221-232.
- Okeke, O.J.(2011). Effect of Mind aping Teaching Strategy of Students’ Interest, Retention and Achievement in Senior Secondary School Chemistry. Ph.D. Thesis, University of Nigeria, Nsukka.
- Prokop, P., Prokop, M., & Tunnicliffe, S.D. (2007). Is biology boring? Student attitudes toward biology. *Journal of Biological Education*, 42(1), 36-39.
- Raina, A.O.(2012). Gender Sensitivity of Recommended Chemistry Textbooks for Senior Secondary School in Nigeria. . Ph.D. Thesis, University of Nigeria, Nsukka.

- Smith, Carl B.(1992). *What Makes Our Kids Underachievers?*
Indiana University School of Education May 24,
1996.
- Selby, L.M.(1997). A Critical Analysis of Factors Affecting the
Participation of Women in Tertiary Level Computer
Science and Information technology Courses. Doctoral
Thesis, Science and Mathematics Education, Curtin
University, Western Australia.
- Ugwu. A. N.(2009). Development and Validation of an
Instrument for the Assessment of Science Process
Skills Acquisition in Practical Chemistry. Ph.D.
Thesis, University of Nigeria, Nsukka.
- UNESCO (1997). Regional Training Seminar On Guidance and
Counselling, Module 5: Gender Sensitivity.
- UNESCO (1999a). UNESCO statistical yearbook 1999. Paris:
UNESCO
- UNESCO (2001). Education for all assessment thematic paper:
girls' education. Paris: UNESCO.
- UNESCO (2009). First International Conference On Girls And
Women In Science And Technology In Africa,
Bamako, Mali, 13-15 July, 2009 *Vol. 17, No. 4,*
October 2005, pp. 369–386
- UNCSTD (2012).UN Commission on Science and Technology:
Background Guide

University of Nigeria Nsukka, UNN (2012). *Annual Report, 2010-2011*, University of Nigeria, Press.

UNO(2008). Millennium Development Goals Reports. Retrieved from: <http://www.un.org/millenniumgoals/reports.shtml>

WAEC (2009, 2010, 2011). *Chief Examiners Report*.

Weinberger, C. W. (1995). "U.S. Defense Strategy," *Foreign Affairs* 64:4 (1986): p. 682.

World Bank, (2010). *Labour participation rate, female (% of female population ages 15+)*. Retrieved from <http://data.worldbank.org/topic/social-development>.

www.achpr.org/instruments/women-protocol/: *Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa*.

www.feministletters.wordpress.com/. *Feminist Letters*

Young, D.J. and Fraser, B.J. (1994). Gender differences in science achievement: Do school effects make difference? *Journal of Research in Science Teaching*, 31 (8), 857-871.