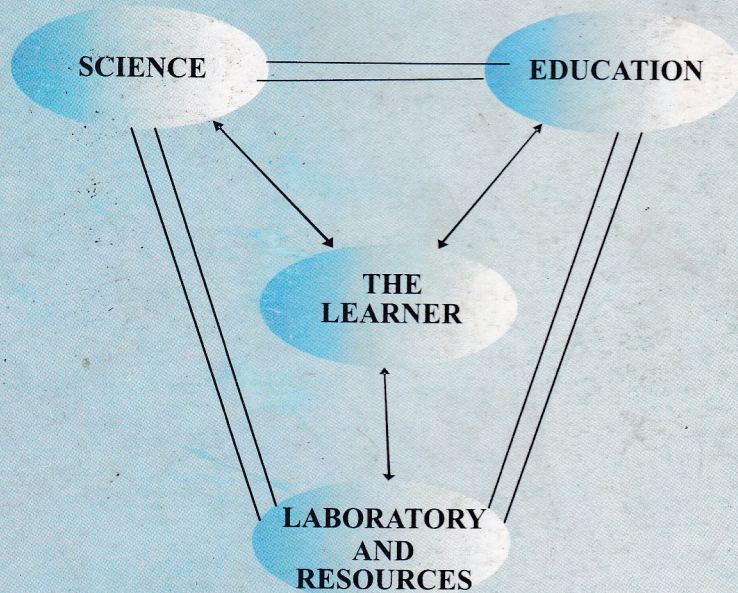




# 36<sup>th</sup> INAUGURAL LECTURE SERIES

## THE ORDEAL OF SCIENCE TEACHING IN THE CONTEMPORARY SOCIETY: A NEED FOR PARADIGM SHIFT FOR THE NEW GENERATION



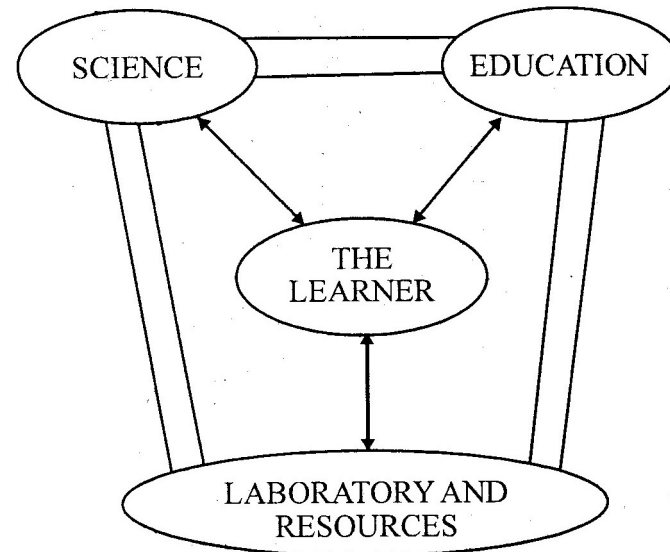
FIDELIS ATING ONWIODUOKIT mnae, mnsta, mstan, fiia, Jp

THURSDAY, JANUARY 31, 2013



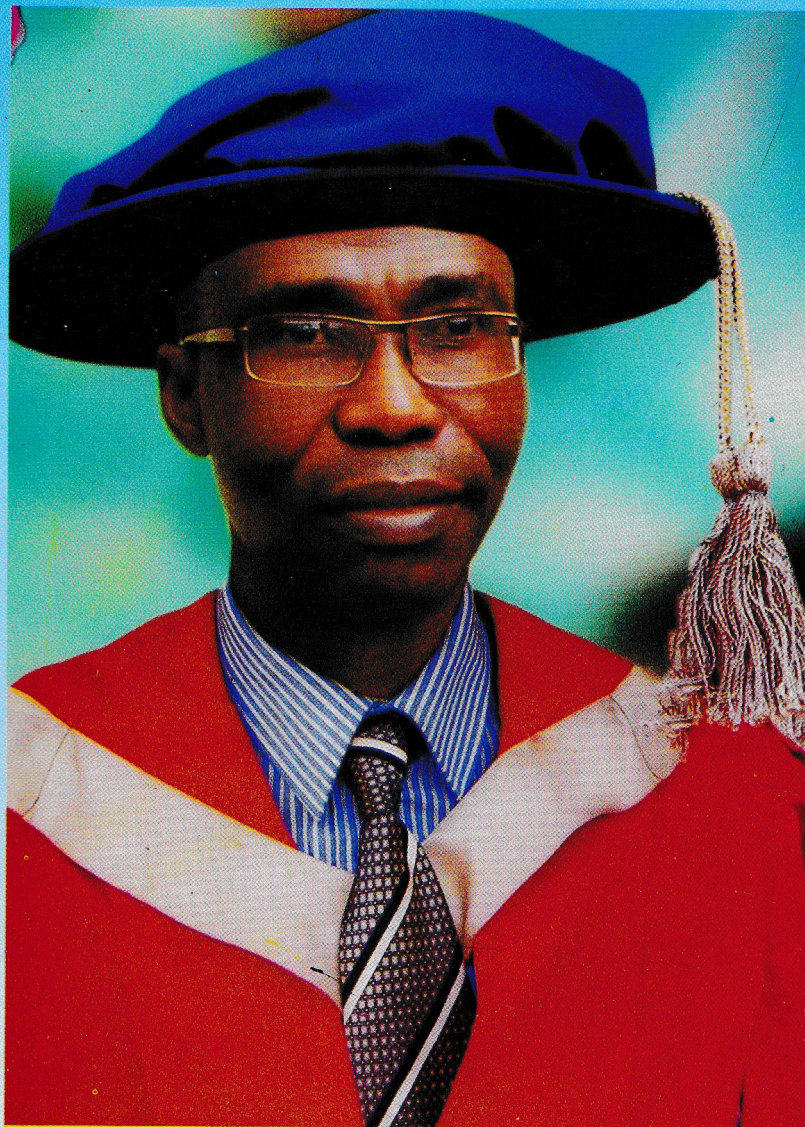
# 36<sup>th</sup> INAUGURAL LECTURE

## THE ORDEAL OF SCIENCE TEACHING IN THE CONTEMPORARY SOCIETY: A NEED FOR PARADIGM SHIFT FOR THE NEW GENERATION



FIDELIS ATING ONWIODUOKIT mnae, mnsta, mstan, fiia, Jp

THURSDAY, JANUARY 31, 2013



**FIDELIS ATING ONWIODUOKIT**

**mnae, mnsta, mstan, Jp, B.Ed Sc. (Benin), M.Ed, Ph.D (Ibadan)**

**Professor Of Science Education (Physics)**

**University Of Uyo, Uyo**

© Professor Fidelis Ating Onwioduokit

Published by:

University of Uyo Press Ltd  
University of Uyo  
Nigeria

Published 2013

ISBN: 978-026-937-1

Printed by:

Abaam Publishing Co.  
G72 Ewet Housing Estate  
Uyo, Nigeria  
08023108979

All right reserved. No part of this work may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright owner.

## TABLE OF CONTENTS

Table of contents	-	-	-	-	iv
Dedication	-	-	-	-	v
Profile	-	-	-	-	vii
Acknowledgements	-	-	-	-	xiii
1.	Introduction	-	-	-	1
2	Concept of concepts	-	-	-	1
3	Science teaching in Nigeria	-	-	-	9
4	Global trend in Science teaching	-	-	-	11
5	The Ordeal of Science teaching	-	-	-	13
6	The Aftermath of current practices of science teaching	-	-	-	21
7	Some personal works done in Science teaching	-	-	-	24
8	The need for Paradigm shift	-	-	-	58
9	The New Paradigm	-	-	-	59
11	Conclusion	-	-	-	60
12	References	-	-	-	62

## DEDICATION

This lecture is dedicated to the Almighty God;  
my late father of the blessed memory  
(Teacher Gabriel Onwioduokit); my mother and  
My nuclear family.

# UNIVERSITY OF UYO

## THE ORDEAL OF SCIENCE TEACHING IN THE CONTEMPORARY SOCIETY: A NEED FOR PARADIGM SHIFT FOR THE NEW GENERATION

BY

**Professor Fidelis Ating Onwioduokit**  
mnae, mnsta, mstan, fiia JP

- Professor of Science Education (Physics)
- Member, American National Science Teachers Association
- Member, Science Teachers Association of Nigeria
- Member, Nigerian Academy of Education
- Fellow of the Institute of Industrial Administration
- Member, National Association of Science Education Research

**THE 36<sup>TH</sup> INAUGURAL LECTURE DELIVERED  
IN THE UNIVERSITY OF UYO ON THURSDAY,**

**JANUARY 31, 2013**

# *Profile*

of

Professor Fidelis Onwioduokit, mnae, mnsta, mstan,  
B.Ed Sc. (Benin), M.Ed, Ph.D (Ibadan)

Fidelis Ating Onwioduokit, a Professor of Science Education with specialization in Physics, a member of the National Science Teachers' Association of America, member Science Teachers Association of Nigeria, member Nigerian Academy of Education (the highest professional organization in the field of Education), fellow of the Institute of Industrial Administration, member National Association of Science Education Research, former Director of General Studies, University of Uyo and a Senior Pastor in the Redeemed Christian Church of God was sent by God into this world in the early morning of Friday, October 11, 1957. Specifically he was sent to the family of late Teacher Gabriel A. Onwioduokit and Madam Theresa Gabriel Onwioduokit of Anai Okpo in Urue Offong/Oruko Local Government Area of Akwa Ibom State.

### **MARRIAGE:**

Professor Fidelis Ating Onwioduokit is married to Mrs. Afiong Fidelis Onwioduokit, a Deputy Director of Internal Audit in the University of Uyo. The marriage which took place on Saturday, November 17, 1984 is blessed with four precious seeds, namely, Miss NseAbasi Fidelis Onwioduokit (Public Health Scientist), Mr. Mbetobong Fidelis Onwioduokit (Civil Engineer); Master Ebenezer Fidelis Onwioduokit (Medical Student) and Miss UbongAbasi Fidelis Onwioduokit (Law Student).

## EDUCATION

Professor Fidelis Onwioduokit attended:

- ♦ St. Jude's Primary School, Udung Uweh in UrueOffong/Oruko Local Government Area and obtained FSLC in 1969.
- ♦ St. Vincent Secondary School Oti- Oron from 1970-1974 where he obtained WASC in Division 2.
- ♦ Methodist Teachers' Training College Oron, from 1974-1975 and obtained Teachers' Grade II Certificate.
- ♦ College of Education, Uyo, Akwa Ibom State, where he obtained NCE (Physics/Chemistry), 1979-1980.
- ♦ University of Benin, 1980-1982 and obtained B.Ed Sc. (Physics)
- ♦ University of Ibadan 1985-1989 and obtained M.Ed (Science) and Ph.D (Physics Education).

It is worthy of note that Professor was the first lecturer to be awarded study leave for Masters and Ph.D degrees in a stretch by the department University of Cross River State. Before then one had to resume work after obtaining the Masters degree before applying again for sponsorship for a Ph. D programme

## WORKING EXPERIENCE

Professor Fidelis Ating Ownioduokit is a complete and seasoned teacher. He taught in the primary school from 1975-1976 and in the secondary school from July to October 1980. On October 08, 1982, he joined the service of the then College of Education, Uyo, Cross River State as Lecturer III in the Department of Physics.

When the Unit of Science Education was created the following year, 1983 as a result of the commencement of the defunct University of Cross River State, he moved to the Unit.

- He rose to the rank of Lecturer II in October in 1989 by reason of his Ph.D obtained that year
- Was promoted to the rank of Lecturer I in October 1992
- Became a Senior Lecturer in October, 1995.
- Was promoted an Associate Professor in 1998
- He became a full Professor in October, 2001
- Member, Faculty of Education, Result Compilation Committee, 1991-1998
- Examination Officer, Department of Science Education, 1991-1998
- Member, Divisional Research Committee, Humanities Division, 1990-1997
- Member, Faculty of Education Hand-out Committee, 1995-1999
- Member, Faculty Consultancy Unit, 1995-1998
- Faculty Representation at the University Research Committee (URC), 1990-1997
- Head of Department, department of Science Education, 1999-2004
- Editor, Journal of Education, 2002-2006
- Member, Central Research Laboratory Management Committee, 1993-1997
- Member, Board of Institute of Education, 1995-2004
- Member, University Senate, 1999 to date
- Member, Business committee of Senate, 2000-2004
- Director, General Studies Directorate, 2004-2006
- Editor, Journal of Quality Education, 2002-2006
- Editor in-chief, Nigerian Journal of Science and Science Education, 2006 date
- Member, University Search Team, 2005
- Member, University Research Committee, 2010
- National Secretary, Physics Panel, Science Teachers Association of Nigeria, 1993-1995

- National Secretary, Association for Promoting Quality Education in Nigeria, 1997-1999
- Youth Leader, Christian Association of Nigeria, Akwa Ibom State, 1994-1998
- President, Nigeria Christian Graduate Fellowship, Uyo, 1994-1998
- On Sabbatical, University of Calabar, 1998- 1999
- Chairman, Governing Council, RCCG Bible College, Uyo, 2001-2005
- External Examiner, University of Calabar, 2004 to date
- External Examiner, University of Port Harcourt, 2006
- External Examiner, University of Nigeria, Nsukka, 2006-2008
- On Sabbatical, University of Port Harcourt, 2007-2008
- Adjunct Lecturer, University of Port Harcourt, 2008 to date
- Senior Pastor, the Redeemed Christian Church of God, 1998 to date.

Professor Onwioduokit has taught many courses. He taught 100, 200 and 300 level Physics courses in the Department of Physics in the defunct University of Cross River State up to 1995 when his responsibilities in the department of Science Education was increased and so could not have much time to serve Physics Department.

In his department and Faculty, he has and is still teaching undergraduate and graduate students in Physics Education, Science Education and Educational Research Statistics.

Professor Onwioduokit has supervised many Masters and Ph. D candidates both in the University of Uyo and the University of Port Harcourt.

#### **RESEARCH AND PUBLICATIONS:**

Professor Fidelis Onwioduokit has Physics Education as his main research interest. He has been very much interested in practical (laboratory) work, effective teaching and learning and evaluation of Science teaching and students' performance. He is an erudite scholar, a researcher and a writer of international repute. He has 48 published articles, one book and two monographs with several other papers presented at seminars and workshops, all to his credit. Professor Onwioduokit has attended over 35 conferences and presented papers in almost all the conferences.

Professor Onwioduokit has served in NUC accreditation team many times and is well known for integrity and uprightness.

#### **MEMBERSHIP OF THE PROFESSIONAL BODIES**

Professor Onwioduokit belongs to the following professional bodies:

- Nigerian Academy of Education
- Science Teachers Association of Nigeria
- National Science Teachers Association of America
- National Association for Science Education Research

Notable among them are Prof. I. T. Eshiet of the Department of Science Education, University of Uyo; Professor T. Omatsaye. Professor A. Mommodu both of University of Benin; and Dr. Obed Ebgbugara, Professors M. B. Ogunniyi, T. A. Balogun and G O. M. Onwu, all of the University of Ibadan. It is worthy of note and appreciation, the impacts my two Vice Chancellors (Universities of Benin and Ibadan) have made in my life. Professor Adamu Baike of the University of Benin used to attend our fellowship, NIFES, and each time he came, he would prefer to be addressed as Bro. Baike. I greatly learned humility from this man. At the University of Ibadan, a religious set rose up to build a worship centre and wanted to cross in another worship centre that had been almost as old as the University, removed. Then Professor Ayo Banyo said and I quote "It is easier for me to be removed as the Vice chancellor of the University of Ibadan than remove the cross".

I deeply appreciate the authority of the defunct University of Cross River State and Professor Eyo Okon that gave me an opportunity to further my studies in 1985. It is on record that I was the first person that was awarded sponsorship to read for Masters and Ph. D degrees at a stretch. The practice use to be that one will return after Masters programme before going back for Ph. D.

I appreciate the encouragement and support of Professor Fola Lasissi, Professor Akpan Hogan Ekpo, Professor Akaneren Essien, Professor (Mrs.) Comfort M. Ekpo, my Dean, Prof (Mrs.) Queendoline Obinaju, Professor Anthony Ezeife, and my colleagues in the Faculty of Education, especially my school mates Professor I. E. Uduk, Dr. Akpan O. Udoh. May the Almighty God bless you all. Amen.

Many men of God have supported me in prayers and in fellowship. I want to mention and acknowledge men of God such as Pastor Enoch A. Adeboye, Rev. Dr. Uma Ukpai, Pastor Jacob Oni, Pastor G. Akingun, Pastor Emmanuel Bassey, Pastor F. A. Titus, among others.

I must not forget the loving hands of my loving and caring wife, Mrs. Afiong F. A. Onwioduokit and our four Godly seeds for their understanding, love and encouragement spiritually and academically. I thank God that you all are mine. I deeply appreciate my two best friends and brothers Dr. G. T. Akpabio and Dr. Nsima Udoko and all my siblings and in-laws for all their contributions.

This is the day that God has made; we must rejoice and be glad in it.

# THE ORDEAL OF SCIENCE TEACHING IN THE CONTEMPORARY SOCIETY: A NEED FOR PARADIGM SHIFT FOR THE NEW GENERATION

## PROTOCOL

### PREAMBLE

When I sent a memo to the Vice Chancellor in October 2012 indicating an interest to present an inaugural lecture, I prayed that I would be the first in the New Year. I thank God that this lecture opens the gate of 2013 for other inaugural lectures to come this year. I wish also to thank the management for the opportunities given me to present this lecture today and for making it the first this New Year.

It is worthy of note that today's lecture is the 36<sup>th</sup> in the series of Inaugural lectures in the University of Uyo, 8<sup>th</sup> from the Faculty of Education and 3<sup>rd</sup> from the Department of Science Education. By academic tradition, an inaugural lecturer is expected to present to world the research works and experiences gathered over the years after ascending to the chair of Professorship, once in a life time.

I was promoted to this chair on October 2001 and I have waited for God's appointed day and time, which is now, to present this lecture. I have decided to pick the topic, **The ordeal of Science Teaching in the Contemporary Society: A need for paradigm shift for the new generation**, having taught science for several years and apparently dissatisfied with the way science is being taught in schools, colleges and the Universities.

## 1.0 INTRODUCTION

My interest in Physical Science started more prominently in secondary school. Then, three subjects were regarded as being very prominent and prestigious. They were Additional Mathematics, Mathematics and Physics, so we used to call them; Maths-Maths-Physics. I had good teachers in these subjects so I was highly encouraged to offer them.

After then, my late Dad exercised a great deal of influence on me urging me to join the Teacher Training College for a one year crash programme. As an obedient child, I obliged and there in the training college I fell in love with teaching as a profession, and from there my journey as a teacher started and now here I am a Science Teacher.

My experience over the years in Science teaching, especially in the contemporary society is that there is wide gap between the practice of science teaching then and now.

I will therefore look at:

- ✓ The practices of science teaching
- ✓ The existing gaps
- ✓ The consequences of the gaps
- ✓ The way forward

Before going far, let's consider some conceptual meanings of the key words in the topic as they relate to this lecture:

## 2.0 Concept of concepts

### 2.1 Ordeal:

This has to do with a prolonged painful or horrific experience. In this lecture, the ordeal means the prolonged painful and horrific experiences of science teachers and learners in the process of science teaching. These experiences have persisted for years unabated.



## 2.2 Science:

This is from a Latin word, scientia, meaning knowledge. It is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and prediction about the universe (Abdullahi, 1982). The emphasis of science is on the universe, natural occurrences and natural events. The essence is to describe, explain and predict natural events and occurrences.

Furthermore, Science is seen as a body of knowledge that has been systematically acquired and made subject to further probing. This body of knowledge is not dogmatic or doctrinal; it is not a finality but changeable, amendable, falsifiable and questionable. In science, the emphasis is both on the process and the products. These two are said to be mutually related and inseparable. This mutual relationship should be recognized and utilized in any meaningful practice of science teaching. Teaching the product alone without the process or vice versa amounts to **incomplete science**.

## 2.3 Teaching

Teaching is different from Education, although a good relationship exists between the two. While Education connotes learning, teaching has to do with the processes leading to learning. It has to do with the pedagogy. It should be noted that teaching goes beyond what happens in the classroom/lecture room or laboratory. At all stages of education, the life of the teacher, his/her attitude, aspirations, knowledge of the subject humility, disposition, among others impact upon the learner directly and indirectly. For instance, if the teacher is always late in coming to class, students will gradually become late comers. The values upheld by the teacher are often silently transferred to the learners.

It should be noted that there exists a difference between **teaching** and **lecturing**. While the teacher is basically involved in the subject matter and the pedagogy, the lecturer is mainly after the subject matter. The goal of lecturing is to transmit knowledge and the research findings in the subject area, often without the knowledge of the learner.

On the other hand, a teacher goes beyond the subject matter to consider the possible way(s) the knowledge could be imparted to the learner to enhance optimum performance. This he does by selecting a teaching strategy that matches learners' background, aspiration, experience, intelligence, age, available resources, and the concept under consideration.

## 2.4 Science Teaching

There are three components of science teaching namely, process of science, product of science and teaching process.

### a. Process of Science:

The processes of science are utilized to arrive at scientific facts, principles, laws, and generalizations. In order to solve scientific problems and arrive at the reliable and dependable solutions, the following processes are required (Onwioduokit, 2002).

- ✓ Observing and identifying problem (OBIP)
- ✓ Describing the observed problem (DOBP)
- ✓ Hypothesizing (HYPO)
- ✓ Experimenting (EXPT)
- ✓ Interpreting experimental results (INTER)
- ✓ Making conclusion and drawing inferences (MACD)
- ✓ Predicting (PRED) and
- ✓ Further experimentation

This is shown in a cyclic form as below:

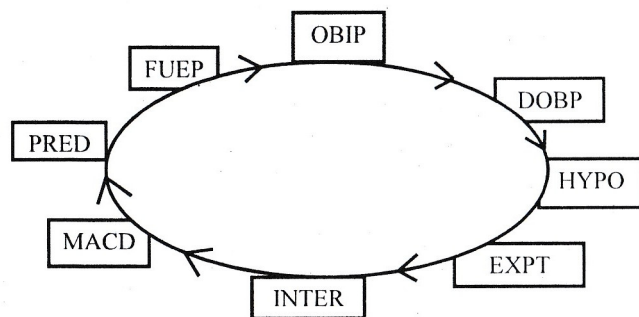


Figure 1: Some processes involved in solving scientific a problem.

While it could be said that the processes start with observation, it should be borne in mind that one can enter the cycle at any point provided that the pre-requisite processes are on course.

#### 2.4.1 Scientific Process Skills

A skill is cleverness at doing something, resulting from either practice or natural ability. Scientific skills or science process skills, therefore, are skills needed to undertake meaningful scientific enquiry. They are mostly developed rather than being natural. The skills are expected to be inculcated in the pupils as they are guided through scientific processes.

There are many of such skills but they can be summarized them into five (5) as follows:

- ✓ Cognitive,
- ✓ Observational,
- ✓ Manipulative,
- ✓ Computational and
- ✓ Communicative.

#### A. Cognitive skill.

The skill contains variables such as:

- (i) logical reasoning;
- (ii) reflective (scientific) thinking;
- (iii) synthesizing;
- (iv) applying knowledge; and
- (v) creative thinking.

#### B. Observational skill.

This has to do with the following abilities:

- (i) using sense organs appropriately;
- (ii) observing changes in phenomenal effects as independent;
- (iii) recording of data (or other phenomena observed);
- (iv) detecting inconsistencies or contradictions; and
- (v) detecting common features or characteristics among objects or events.

#### C. Manipulative skill.

The sub-skills of manipulative skill include:

- (i) Handling of objects;
- (ii) Setting up apparatus;
- (iii) Modeling;
- (iv) Eye-Hand coordination;
- (v) Experimenting (manipulating variables); and
- (vi) Finger dexterity.

#### D. Computational skill.

This has to do with abilities required in:

- (i) Quantifying empirical concepts;
- (ii) Calculation on data obtained;
- (iii) Graph plotting;
- (iv) Making quantitative deductions; and
- (v) Being accurate in measurements.

### E. Communicative skill.

The sub-skills involved here include:

- (i) Reporting;
- (ii) Questioning;
- (iii) Answering questions;
- (iv) Using appropriate language; and
- (v) Drawing conclusion.

It should be noted that the skills, though distinct, are related. Cognitive skill, for instance, is required in the proper exhibition of all other skills. Moreover, these skills should be assessed **on-the spot** using their performance codes.

### 2.4.2 Process skill's performance Codes

#### 1. Cognitive skill

The following are the performance codes:

- (i) Ability to make sense out of what is observed;
- (ii) Knowledge of the science principles involved;
- (iii) Ability to relate one object or event with others;
- (iv) Ability to reason logically;
- (v) Ability to make good guesses;
- (vi) Ability to design experiments;
- (vii) Ability to apply the principles of science in solving problem(s) posed;
- (viii) Ability to deduce from the data or evidence at hand; and
- (ix) Ability to predict accurately.

For any given concept or activity, these codes can be used to assess how well a pupil possesses the cognitive skill. Each correct item could earn 10 marks initially, after which the relative weight is brought into consideration.

#### 2. Observational skill's performance codes

- (i) Correctness of observation, that is, ability to observe correctly;
- (ii) Ability to discover characteristics features of objects or events;
- (iii) Ability to notice changes in characteristics in terms of say, colour, taste, smell shape, etc.
- (iv) Ability to notice the effect of one substance or object on the other (for examples, a vegetable oil makes a white paper translucent when robbed on it). Taking correct readings with measuring instrument;
- (v) Ability to detect inconsistencies or contradictions; and
- (vi) Ability to notice errors involved during experimentation.

#### 3. Manipulative skill's performance codes

- (i) Ability to handle objects/apparatus correctly;
- (ii) Ability to set up apparatus correctly and with correct bearings;
- (iii) Ability to manipulate objects/apparatus correctly;
- (iv) Having good experimental posture;
- (v) Ability to have good eye-hand coordination
- (vi) Ability to construct models; and
- (vii) Ability to draw accurately

#### 4. Computational skill's performance codes

- (i) Ability to relate the variables involved, quantitatively;
- (ii) Ability to get necessary data;
- (iii) Ability to summarize the data in a graphical form, if required;
- (iv) Ability to undertake all calculations required, accurately; and
- (v) Ability to assign correct units of measurement.

## 5. Communicative skill's performances codes

- (i) Ability to ask useful questions;
- (ii) Ability to answer questions;
- (iii) Ability to describe what is observed;
- (iv) Ability to use appropriate tenses in communicating;
- (v) Ability to report on the experiment;
- (vi) Ability to summarize the findings of scientific enquiry;
- (vii) Ability to discuss the findings; and
- (viii) Ability to communicate the conclusion.

### b. Product of Science (Knowledge of subject matter)

This is very crucial in science teaching. No matter how versatile a science teacher is in the skills and knowledge of teaching strategies, if he/she does not have the right knowledge of the science subject then he is not a teacher of science. **To have an excellent method of teaching with a wrong stuff is more dangerous than having a poor teaching method but a sound stuff.**

### c. Teaching process (Teaching Methods/ Strategies)

This is where the difference exists between a science teacher and a science lecturer. A teacher teaches while a lecturer delivers lectures. The emphasis of the teaching is to get the students to understand, comprehend and apply the concepts taught. In doing this, he/she will plan effectively for the lesson, choosing appropriate strategies (considering lots of factors spanning from organismic to environmental), and making the learner the centre of all activities in the course of teaching. On the other hand, the science

lecturer is well vested with the subject matter and is basically interested in delivering the knowledge to the learner often without a careful consideration of the psychology of learning and information processing techniques.

It should be noted however that not all those who claim to be teachers are good teachers. Paper qualification, knowledge of how to teach and registration as a teacher does not mean much if these are not utilized in the classroom. There are science teachers even at the primary schools who are lecturing rather than teaching. This has been the ordeal.

## 3.0 Science Teaching in Nigeria.

### 3.1 Philosophy and Objectives of Science Education.

The fundamental objective of Science Education is to train science teachers who are academically and professionally capable of educating pupils, making them literate in sciences at all levels of educational system. Specifically, the purpose is to produce dedicated and reliable science teachers knowledgeable in all areas of science and skilled in teaching processes and classroom management, with a passionate desire to deliver the best to humanity.

Before independence in 1960, Science Education was still beclouded with "foreign" elements in the curriculum and non-utilization of teaching and learning aids. The laboratories (where available) were ill-equipped, in spite of the popularization Science Teachers' Association of Nigeria started giving to science from its inception in 1957. However, after the independence, science teaching started

to have a form of shape. When the Unity Schools came into existence in 1973, laboratories in those schools were well equipped and the teachers were well trained by the federal government. The progress in the teaching and learning of science continued from then with different missionary schools seeking to excel one another.

The down turn came into the teaching of science with the advent of community secondary schools. Although it was not a bad idea to encourage communities to run schools, most of such communities were only able to provide very limited infrastructural facilities and unable to equip the laboratories.

Another very serious setback the community schools brought was the Day-system of schooling which culminated in a breakdown of discipline in school. The adverse effects of these are still with us today.

### 3.2 Levels of Science teaching in Nigeria

Science is taught at the following levels:

- ✓ Primary level as Primary Science.
- ✓ Upper Basic level as Basic Science (formerly called Integrated Science)
- ✓ Senior Secondary Schools level as Physics , Chemistry and Biology.
- ✓ Science is taught at the Colleges of Education and Polytechnics
- ✓ Science is taught at the university level in four dimensions:
  - Pre-degree level
  - Basic studies level
  - Undergraduate level
  - Graduate level

At every level, there are demands and challenges for proper and effective teaching. I will like to say that of all the levels of science teaching, the Secondary School level (upper Basic Education and Senior Secondary) is most crucial. Although the primary level serves as the foundation, a skillful teacher at the secondary level can correct any wrong or poor foundation existing in the learner. Moreover, at this level a certain minimum grade is required for one to proceed to the tertiary level of science learning.

### 4.0 Global trend in Science Teaching.

Science and scientific research has reached an unprecedented stage in the nations of the world. Technology, which is the different ways scientific ideas and products are applied, has brought great comfort to man in all its ramifications. Science teaching all over the world has gone beyond the traditional classroom experience to a global world experience through the use of computers and e-learning facilities. **It should however be emphasized that no electronic gadget can completely and effectively replace the teacher in the classroom.**

### 4.1 Training of Science Teachers

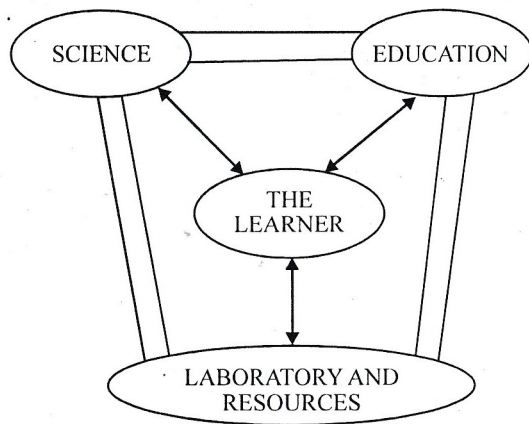
Training is a practical or vocational-oriented process that results in the acquisition of knowledge, skills and competence. Training has specific goals of improving one's capability, capacity and performance. It forms the core of apprenticeship and the basis for entrepreneurship.

Since teaching is a vocation, what is needed in the production of science teachers is more of training than teaching. Teaching will provide the knowledge but training will provide skills and competence. Teaching produces a **qualified teacher** but training produces a **trained teacher**. In Nigeria, all what is happening in all Universities and Colleges of Education is teaching not training. No wonder we have teachers who are not committed and competent. One of the most unfortunate

decisions of the federal government of Nigeria with respect to Teacher Education programme was the scrapping of Teacher's grade II institutions.

Yes, the standard there would not have met with the challenges of today but what stopped us from beefing up the curriculum of the Teacher Training colleges?

### **The ordeal of Science Teaching in the contemporary society: A need for paradigm shift for the new generation.**



For years science has been taught at different levels in an unscientific way. As shown in the figure above, there should be a proper integration of science, education and the laboratory. In this interaction, the learner occupies a central position. That is, whatever is done, whether the consideration of the science concepts to be taught, teaching methods and the use of the laboratory and resources, adequate consideration should be given to the learners. It should be noted that without the learner there will be no need for the teacher.

I will now want to discuss the ordeal at various levels of science teaching.

## **5.0 The ordeal of Science Teaching**

### **5.1 Primary Level**

There has been a prolonged and painful experience in science teaching at this level. Prominent among these are:

#### ✓ **Dearth of Science Teachers**

In Primary schools, there is no subject specialization. Every classroom teacher teaches all subjects including science whether or not he/she has any knowledge of science. The same goes for Mathematics. This is a serious set back because allowing for an improper foundation at that level has adversely affected the learners and science teaching in our society.

#### ✓ **High Pupils: Teacher Ratio**

Another factor affecting science teaching and indeed, teaching generally at this level is the explosion in pupils' population without a corresponding increase in the number of teachers. In the first Akwa Ibom Education summit of 2006, I presented a research paper entitled "Quality Control: Issues and challenges in Akwa Ibom State Education System". In the course of research, I discovered staggering information with respect to pupils: Teacher ratio in Primary schools as at 2005 as shown in Table I.

Table 1: Summary of pupils' enrolment, number of teachers and pupil : teacher ratio in Akwa Ibom State Primary Schools: 2005.

S/N	LGA	NO. OF PRIMARY SCHOOLS	NO. OF PUPILS			NO. OF TEACHERS			STUDENTS/TEACHER RATIO
			M	F	TOTAL	M	F	TOTAL	
1.	Abak	42	33,679	35,205	68,884	315	660	975	71:1
2.	Eastern Obolo	10	11,556	12,342	23,898	34	39	73	327:1
3.	Eket	29	19,730	20,270	40,000	78	464	542	74:1
4.	Esit Eket	15	11,852	12,459	24,311	110	145	255	95:1
5.	Essien Udim	55	19,923	22,870	42,793	297	491	788	54:1
6.	Etim Ekpo	40	21,897	23,829	45,476	235	322	557	82:1
7.	Etinan	41	30,449	31,775	62,224	152	473	625	100:1
8.	Ibeno	12	10,374	12,388	22,762	29	88	117	195:1
9.	Ibesikpo Asutan	50	28,337	27,781	56,118	189	507	695	81:1
10.	Ibiono Ibom	58	33,704	28,680	62,384	312	557	869	72:1
11.	Ika	18	19,413	20,835	40,248	191	173	364	111:1
12.	Ikono	59	41,140	42,453	83,593	244	451	695	120:1
13.	Ikot Abasi	34	30,754	32,234	62,988	780	1026	1806	35:1
14.	Ikot Ekpene	36	38,837	41,626	80,463	135	668	803	100:1
15.	Ini	52	22,233	23,004	45,237	260	235	495	91:1

S/N	LGA	NO. OF PRIMARY SCHOOLS	NO. OF PUPILS			NO. OF TEACHERS			STUDENTS/TEACHER RATIO
			M	F	TOTAL	M	F	TOTAL	
16.	Itu	37	25,355	24,580	49,935	125	618	744	67:1
17.	Mbo	27	20,400	21,177	41,577	206	243	449	93:1
18.	Mkpat Enin	49	34,322	35,160	69,482	165	343	508	137:1
19.	Nsit Atai	25	14,460	14,755	29,213	96	189	285	103:1
20.	Nsit Ibom	31	16,101	16,172	32,273	122	356	478	68:1
21.	Nsit Ubium	38	22,352	22,960	45,312	143	320	463	98:1
22.	Obot Akara	36	25,419	25,994	51,513	192	254	446	116:1
23.	Okobo	29	24,263	24,389	48,707	191	194	381	128:1
24.	Onna	26	18,145	18,986	37,131	88	242	330	113:1
25.	Oron	13	11,671	12,232	23,903	48	328	376	64:1
26.	Oruk Anam	69	42,997	50,166	94,024	346	367	713	132:1
27.	Urue Offong/Oruko	21	22,078	23,239	45,317	178	279	457	99:1
28.	Udung Uko	12	4,947	5,158	10,105	57	97	154	66:1
29.	Uruan	45	19,355	20,111	39,466	157	290	447	88:1
30.	Ukanafun	59	25,693	26,488	52,181	314	469	783	67:1
31.	Uyo	47	17,243	16,893	34,136	178	905	1083	32:1
	Total	1119	718661	746211	1464872	596	1179	17760	
						7	3		

Source: Data obtained from the State Universal Basic Education Board (SUBEB), Uyo

As seen in Table 1, the only Local Government Area that had a normal pupil: teacher ratio then was Ikot Abasi (35:1). Eastern Obolo had the worst with 327:1. If this happened before the declaration of free and compulsory education, you can imagine what is happening today. With such, teaching cannot be effective and pupils leaving the primary school to secondary would have carried over problems in the form of gaps.

It was Martin Luther (1483-1546) who said concerning a teacher and teaching:

For you cannot teach an old dog new trick, and it is hard to reform old sinners, but this is what by preaching we undertake to do, and our labour is often spent in vain; but it is easy to bend and train young trees...

✓ **Lack of Science Laboratories and Resources:**

No meaningful science can be taught without resources and the laboratory (Anderson, 1972; Hirvonen, 2002; Ergin, 2005; & Ottander, 2006). The absent of the laboratory in the Primary school for science teaching has posed prolonged painful and horrific experience to science teachers and learners at this level. Although the natural resources abound within the school environment, because of lack of resourcefulness and interest on the part of some science teachers, they are hardly utilized (Jennings, 2005; & Akporehwe and Onwioduokit, 2010).

**5.2 Secondary Level**

The situation at this level differs slightly from the primary. Teachers with specialization in science subjects are available though not sufficient in number and not trained though qualified, especially in Akwa Ibom State schools where the percentage of graduate teachers is very impressive as shown in Table 2.

Table 2: Summary of Teachers' Qualifications in Akwa Ibom State Secondary Schools by Local Education Councils: 2006

S/N	LGA	STUDENTS ENROLMENT				GR ADUATE	NCE HOLDERS	%GRADUATE
		MALE	FEMALE					
1.	Abak	6207	5273	353		111	76.1	
2.	Eket	3717	5823	239		108	68.9	
3.	Etim Ekpo	3185	3944	148		57	72.2	
4.	Essien Udim	3731	3592	181		49	78.7	
5.	Etinan	5865	6131	278		151	64.8	
6.	Ibesikpo/Asutan	5172	4975	346		101	77.4	
7.	Ikot Ekpene	5369	7921	513		136	79.0	
8.	Ikono	5361	7984	374		102	78.6	
9.	Ikot Abasi	4537	5678	226		84	72.9	
10.	Itu	2634	3295	459		167	73.3	
11.	NSIT Ubium	2657	2939	118		44	72.8	
12.	Okobo	2290	2239	84		23	78.5	
13.	Onna	2040	2032	113		26	81.3	
14.	Oron	4700	4777	151		45	77.0	
15.	Ukanafun	4691	5491	203		85	70.5	
16.	Uruan	3220	3011	251		69	78.4	
17.	Uyo	6197	10,677	935		209	82.6	
	Total	71,573	85,782	4,281		1,485		

Source: Akwa Ibom State Secondary School Board



But the major ordeals here are:

- ✓ Improper grasps of the subject matter on the part of most science teachers (Onwioduokit, 1996; & Clough, 2003).
- ✓ Improper integration of the laboratory resources in science teaching. My work on the role of laboratory facilities on the cognitive development of Physics students in 1998 revealed that most schools lack functional laboratories. Even in the few schools that facilities are available, they are hardly put to use. Most science teachers preferred teaching science without using the needed facilities. It should be mentioned here that the present paradigm of separating theory from practical is faulty. There is hardly any concept in science that does not require a practical demonstration. The study also revealed that science students were only exposed to practical work between two or three weeks to their external examination.
- ✓ Another problem of science teaching in secondary school is that of lack of commitment and discipline on the part of almost all the teachers. This amounts to lack of resourcefulness. A committed and resourceful science teacher should look for improvised materials to teach in the absence of the prototypes. This happens mostly in public schools where there is a high level of laissez-faire attitude.

### 5.3 Tertiary Level

The ordeal of science teaching at this level is not significantly different from the secondary level. Knowing that it is at this level that science teachers are required to be trained for both primary and secondary levels, there should be a great concern. This is because whatever gaps existed in the learner at the primary and secondary levels, cumulatively, should be bridged at the tertiary level of education. If this is not done, our graduates will go back to schools and create greater gaps in the

students. Prominently, the following situation still persists in science teaching at the tertiary level:

- ✓ A gap between the sciences taught to Science Education students and what they are expected to deliver after their training as science teachers. In the present paradigm all courses in science: Physics, Chemistry, Biology and Mathematics) are taught at the Faculty of Science. The department of Science Education teaches the methods and strategies as well as exposed the would-be science teacher to the knowledge of available and improvised resources for science teaching. The primary objective of Science Education is to produce people who are, literate in science. According to National Science Education standard, the scientifically literate person possesses the capability to:
  - ✓ Understand experiment and reasoning as well as basic scientific facts and their meanings;
  - ✓ Ask, find or determine answers to questions derived from curiosity about everyday experiences;
  - ✓ Describe, explain and predict natural phenomena;
  - ✓ Read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions;
  - ✓ Identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed;
  - ✓ Evaluate the quality of scientific information on the basis of its source and the methods used to generate it; and
  - ✓ Pose and evaluate arguments based on evidence and apply conclusions from such argument appropriately.

It should be noted that the present model of teaching science does not make for the production of scientifically literate individuals.

Over 50% of what the students are taught in the Faculty of

Science does not have a direct bearing with the secondary school curriculum that the products are expected to implement. It is true that the teacher should know more than the students but he/she must first know what the students need. Ausubel (1968) in Onwioduokit (1996) has it that learning should start from the most inclusive concept to the least. While this is true in few cases, most students find this order difficult. That is why Ausubel theory is not very popular in science teaching.

- ✓ Improper integration of theory and practicals. The dichotomy between theory and practicals still exists at the tertiary level. Most courses are taught without practical demonstrations. Even in the practical classes, only few students actually handle the apparatus to conduct the experiments, either because the facilities are few or the laboratory space is too small or both. The practice of group practicals should be discontinued especially for Science Education students.
- ✓ Non provision for entrepreneurial skills development. The fact that most graduates of higher institutions in Nigeria cannot secure employment is no news. There are two major reasons the Curriculum and its implementers. The curriculum in Science and Science Education should be drastically modified to provide for entrepreneurial skills acquisition.

However, whether for a new or present curriculum, implementation is crucial. For instance, insufficient provision for manipulative skills development, though provided for in the present curriculum through practicals and laboratory experiments, has brought a serious setback to learners.

## 6.0 The Aftermath of current practices in Science Teaching

- ✓ Consistent poor performance in external examinations
- ✓ Massive unemployment
- ✓ High level of indiscipline among students and teachers
- ✓ Prevalence of Examination Misconducts

Table 3: Summary of performances of Akwa Ibom State students in WASSCE from 2000-2005

Year	Total no. of Candidates (N)	Total no. of candidates with at least 5 credits including Eng./ Maths.	% of candidates qualified for UME
2000	1867	234	12.50
2001	4242	448	10.60
2002	2517	412	16.40
2003	3070	613	20.00
2004	4588	1065	23.20
2005	2900	578	19.90
Total	19184	3350	17.50

Source: West African Examination Council, Uyo

TABLE 4: SUMMARY OF RESULTS FOR THE WASSCE (1999-2009) IN NIGERIA

Year	Subject	ENROLMENT				PERFORMANCE												
		TOTAL SAT	MALE		FEMALE		NO. OF CREDITS 1-6			NO. OF PASSES 7-8			NO. OF FAILURES F9			% CREDIT	% FAILURE	
			MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE				
1999	Physics	210271	134650	75621	43199	21084	38945	22827	48058	29651							30.60	69.40
	Chemistry	223305	138618	84687	45244	24167	32211	19454	56810	38036							31.10	68.90
	Biology	745091	400470	344621	115117	92112	108929	95283	164676	148077							27.81	72.19
	Maths	756669	40889	347780	79257	58839	118828	93684	195951	185072							18.25	81.75
2000	Physics	195226	122489	72737	18203	19883	45756	28401	35585	24453							19.50	80.50
	Chemistry	202900	124049	78851	40284	24000	32507	20798	47980	34053							31.68	68.32
	Biology	641541	342760	298781	68558	54639	100432	88839	164955	155303							19.20	80.80
	Maths	656249	353362	302887	121567	92922	109111	91231	113494	118734							32.68	67.32
2001	Physics	298513	186526	111987	65350	35902	68905	43037	48426	31091							33.92	66.08
	Chemistry	312946	189881	123065	68871	42972	50132	32629	66628	44838							35.74	64.26
	Biology	1031767	554882	476885	128457	107874	159912	140807	253586	218977							22.91	77.09
	Maths	1059974	575287	484687	209032	173620	187876	151148	164547	150922							36.10	63.90
2002	Physics	335388	206460	128928	97940	59234	62355	41517	40140	24487							46.86	53.14
	Chemistry	348291	209255	139036	70425	48624	59106	37888	71701	45566							34.18	65.82
	Biology	1031767	554882	476885	128457	107874	159912	140807	253586	218977							31.18	68.82
	Maths	1059974	575287	484687	209032	173620	187876	151148	164547	150922							34.42	63.90
2003	Physics	305442	184463	120979	85498	57774	54863	36325	35863	21519							46.91	53.09
	Chemistry	313330	186256	127074	90375	64537	43778	29607	41749	25663							49.44	50.56
	Biology	1005549	539415	466134	218697	205937	144413	126643	152555	113667							42.23	57.77
	Maths	1024447	552392	472055	197255	180057	196004	163623	135705	107575							36.83	63.17
2004	Physics	321499	192535	128964	93711	65066	53794	36218	38570	23370							49.39	50.61
	Chemistry	327503	194093	133410	70772	53237	50252	33319	65697	41621							37.96	62.04
	Biology	1005894	540800	465094	156271	142284	172205	153887	195202	153688							29.68	70.32
	Maths	1019524	550300	469224	178238	168172	158481	128703	195424	156088							33.98	66.02

Year	Subject	ENROLMENT				PERFORMANCE												
		TOTAL SAT	MALE		FEMALE		NO. OF CREDITS 1-6			NO. OF PASSES 7-8			NO. OF FAILURES F9			% CREDIT	% FAILURE	
			MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE				
2005	Physics	344411	206931	137480	85205	57738	59878	42158	55513	33637							41.50	58.50
	Chemistry	349936	208700	141236	104531	73743	38991	26508	58917	36578							50.94	49.06
	Biology	1051557	571645	479912	196821	179029	169640	144187	192036	146455							35.74	64.26
	Maths	1054853	574596	480257	212215	190767	147780	119820	202971	160084							38.20	61.80
2006	Physics	375823	225513	150310	128748	89450	52121	34904	39550	22569							58.06	41.94
	Chemistry	380103	226817	153286	99700	70969	51000	35423	71111	43364							44.90	55.10
	Biology	1137180	619569	517611	291346	268507	161918	130399	153226	107974							49.23	50.77
	Maths	1149276	627996	521280	248468	224206	200086	157238	162214	124612							41.13	58.87
2007	Physics	418593	248021	170572	104145	76652	82685	57487	55539	32941							43.19	56.81
	Chemistry	422681	249545	173136	111804	82480	62189	42491	68152	43170							45.96	54.04
	Biology	1238163	673905	564258	210651	202560	174643	155318	234335	167813							33.37	66.63
	Maths	1249028	681542	567486	308337	275687	187379	146465	170372	132402							46.76	53.24
2008	Physics	415108	244565	170543	114841	85504	53217	37899	72548	44228							48.26	51.74
	Chemistry	418423	245742	172681	105759	80190	67163	47534	68587	41830							44.44	55.56
	Biology	1259965	682848	577117	218397	209247	174643	155318	280130	203941							33.94	66.06
	Maths	1268213	688884	579329	381258	345140	171617	130649	124888	93730							57.28	42.72
2009	Physics	465636	273617	192019	125453	97269	83148	58447	52434	27485							47.83	52.17
	Chemistry	468546	274690	193856	114717	90008	66714	47306	75648	43612							43.69	56.31
	Biology	1340206	736276	603930	194676	188436	223359	190655	279577	191735							28.59	71.41
	Maths	1348528	741577	606951	330397	303985	195026	149609	186981	128757							47.04	52.96

Source: West African Examinations Council, Test Development Division, Yaba, Lagos

These poor results show that there is something wrong with science teaching and learning. Many times people blame it on students. That they are dull, unwilling to learn, not attentive, absent from lectures, and all the like. Studies (Onwioduokit, 1996; Ivowi, 1999; & Ogunleye, 2003) have shown that the problems of fallen standard of Science Education (as well as others) go beyond students. Students are the products. It takes a good process to end up with a good product. Moreover, no matter how excellent the processes and the facilities used are, it is the product that justifies the process. For instance if a teaching or lecturing could not produce at least 60% success among the learners, it is not only the students that have failed, the teacher has also failed.

The failure of the teacher is seen in the area of improper preparation for the lesson, inconsistency in delivering lessons, non-integration practical demonstration, non- involvement of students in the teaching/ learning process, lack of passion for teaching, among others. We must not only think that the fault is only with the students. No child who has successfully passed through the primary school is a moron or imbecile. They have ability to learn if properly taught and attended to. Every student has something useful in his/her cognitive structure. What is needed is a skillful teaching capable of bringing about the restructuring of their cognitive frame work.

## **7.0 Some personal work done in Science Teaching**

Let me now outline few of the personal works done in fostering the teaching and learning of science with the view to prescribe a new paradigm for the future generation.

### **7.1 At the Primary level**

What I did at this level centered on the training of primary science teachers through seminars and workshops arranged by both government and private organizations. The core of the

training has been on **Teaching Primary Science in a primary way** (Onwioduokit, 2003,).

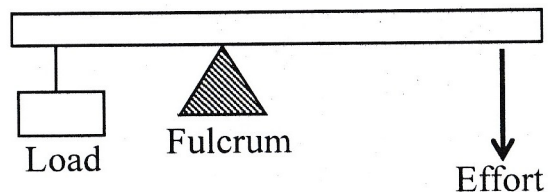
#### **7.1.1 Using the concept of simple machine**

- ✓ Materials: claw hammer, kitchen knife, nut cracker, a pair of scissors, wheel barrow, sugar tongs, cap opener, wooden plank, nails cutter, bottles of Coca-Cola drink, cement block.
- ✓ Action:
  - A. The teacher stands in front of the class with the materials displayed and poses a challenge to the pupils thus:
    - (i) Who can lift me up? "I want someone to lift me up". Using a play-way method, the teacher subjects himself/herself to pupils' attempts. The pupils are not likely to be successful, hopefully.
    - (ii) The teacher now places the plank on the cement block and stands at the end of the shorter arm saying, "let someone lift me up". Standing at the end of the longer arm of the plank, a pupil is likely to lift the teacher. This will likely attract applause.
    - (iii) The pupils are then made to identify the arrangement as a simple machine, and be guided to identify the Load (L), Fulcrum (F) and the Effort (E) in the arrangement as well as the direction each is acting and that this type is called a lever.
  - B. Pupils' Activity.
    - (i) Using a hammer, drive a nail far into the wood provided.
    - (ii) Use your hand to remove the nail from the wood. What do you observe? Try again. Are you successful? Why?
    - (iii) Now use a claw hammer to remove the nail. What have you noticed? Have you noticed the ease with which the

nail is removed using the hammer? The hammer is a simple machine. It helps to do work faster and easier.

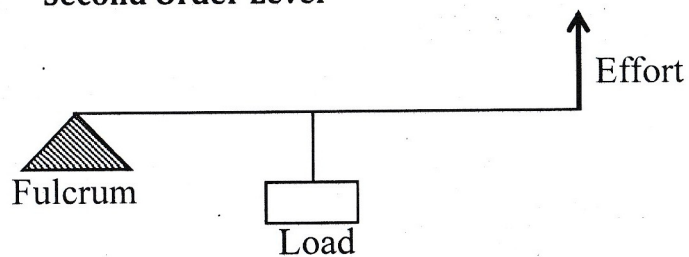
(iv) Then guide the pupils to identify the Load (L), the Fulcrum (F) and the Effort (E).

**C. Symbolic representation.  
First Class Lever**



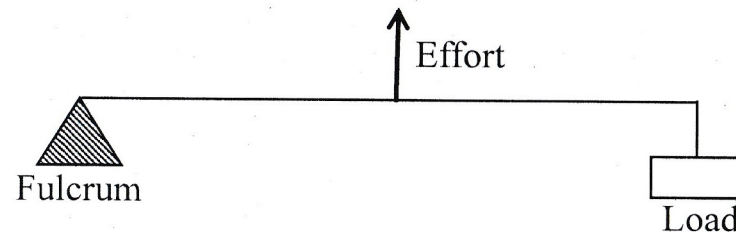
Their examples include: diggers, shovels, a pair of scissors, pliers, pump handles and steelyard.

**Second Order Level**



Examples include: a pair of nutcrackers, manual trucks and oar of a boat.

**Third Order Lever**



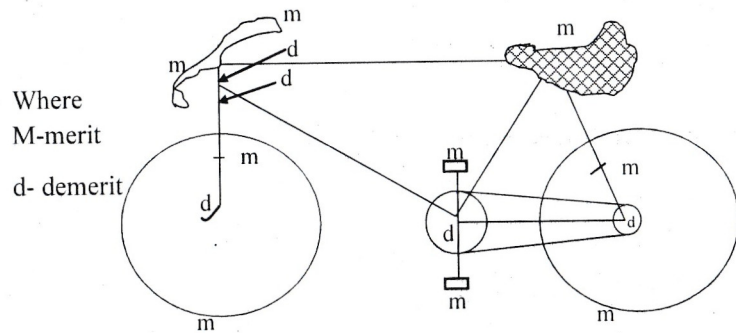
Examples include: sugar tongs, cap openers and table knives.

**7.1.2 Concept 2: Friction**

Here I came up with many pupils-oriented activities that are capable of enhancing their understanding of this concept to include:

- (i) Observing the soles of their shoes.
- (ii) Observing a used car tyres.
- (iii) Trying to walk on a slippery surface with a flat-sole shoe compared to walking on a rough surface.
- (iv) Attempting to cut something with a kitchen knife after washing clothes immediately.
- (v) Pounding okro and pepper, respectively.
- (vi) Rubbing two slices of dry or toasted bread.
- (vii) Rubbing a sand paper against a rough metal surface.
- (viii) Rubbing their palms vigorously, together and immediately touching their cheeks with them.
- (ix) Rubbing the pebble against a cement floor.
- (X) Striking a match
- (xi) Striking the sharp edge of a cutlass against a stone or cement floor and noting the results.

In each of the activities pupils are guided to discuss their experiences, identifying the merits and demerits of friction. I then use d a bicycle to illustrate the merits and the nuisance (demerits) of friction.

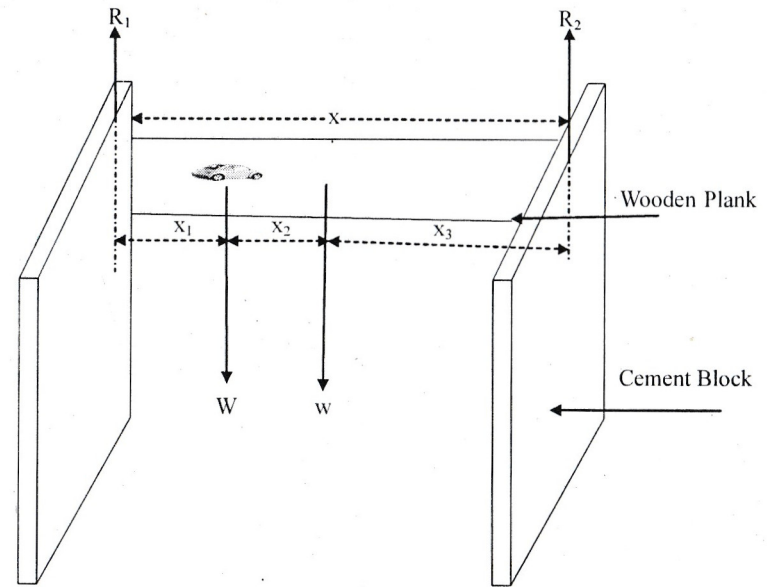


Model of a bicycle showing locations of merits and demerits (nuisance) of friction

## 7.2 At Secondary level

### 7.2.1 Using Models

Since the role of models in the process of teaching and learning science is receiving increasing attention, I also used models in teaching physics at the secondary school level. Among this was a model of a bridge using two cement blocks vertically placed at a distance  $X$  apart. Then a wooden plank on the blocks such that the two edges of the plank rests on each block.



Model of a bridge with a car of weight,  $W$ .

This model was used in teaching quite a number of concepts in mechanics. It aided the teaching and conceptualization of “Action and reaction Forces”, “Equilibrium of Forces”, “Moment of Forces” and the “Principle of Moment”.

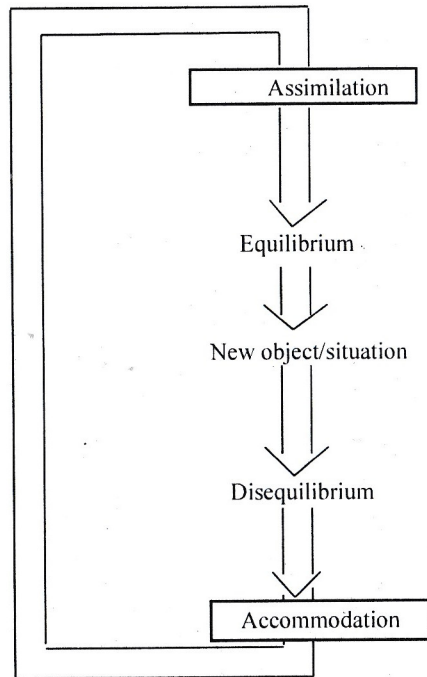
### 7.2.2 Application of Psychological theories of relevance in Science Teaching.

Some fundamental theories that are directly applicable to the teaching and learning of science include:

1. Jean Piaget's (1896-1980)
  - ✓ Interested in the theory of cognitive development of children from the ages of zero to a little above 11 years. This mainly applies to children from preschool through the primary school age.
  - ✓ According to Piaget (1970 ), children learn best through doing and actively exploring their

environment. By implication therefore science should be taught in such a way that children are occupied by useful activities and enabled to explore their natural environment.

- ✓ The concept of Assimilation via Disequilibrium and Accommodation is actually not only useful for children but also for adults in science teaching.



Piaget's model for effective teaching/learning.

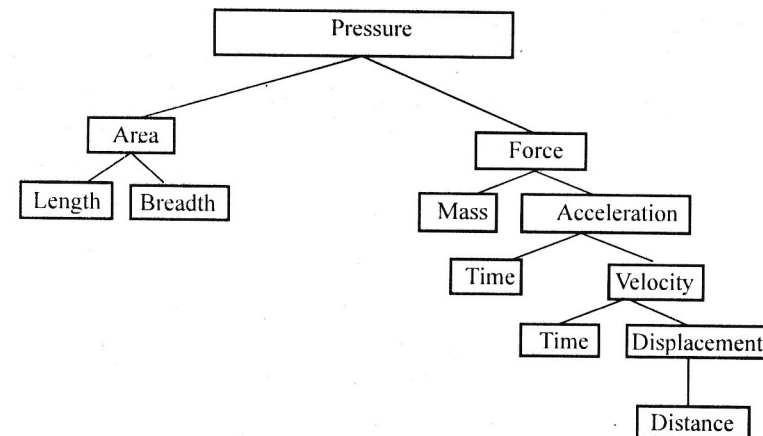
In summary, Piaget favours

- Child-centreness in the teaching process.
- The use of plays in teaching the children.
- Learning by discovery.
- The use of resources in the environment in teaching.

## 2. Robert Gagne (1916-2002)

Paramount in Gagne's learning theory is the concept of task analysis which emanates from his emphasis on prerequisite learning (Onwioduokit, 1996).

- \* The major work of a science teacher in this will be to analyse the task to be taught to prerequisite tasks, arranging them hierarchically from the most inclusive to the least inclusive.
  - \* Then teaching should then be from the least inclusive to the most inclusive.
  - \* Guided classroom and laboratory is favoured by Gagne.
- Using the concept of pressure, the sequence is shown as below (Onwioduokit, 1996).



## 3. Constructivism as a paradigm in science teaching.

- Simply this paradigm learning can only occur meaningfully when there is a restructuring of the learning cognitive structure as the result of seemingly contradictory information or object to be learnt.
- That it is when this "confusion" occurs in the mind that

the learner, in an attempt to resolve, will learn.

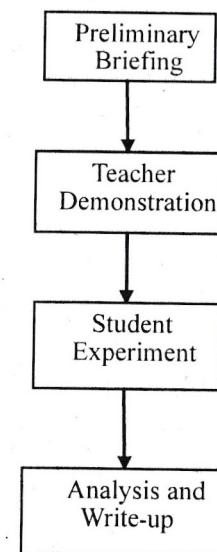
- That, teachers may need to purposefully present certain things that looks and sounds contradictory to the learners before guiding them to resolve the issue.
- For example, the teacher may purposefully reject the first correct answer to a question given by the student.

David Ausubel (1918-2008) belongs to this group with his concept of Subsumption theory where a new material must be subsumed by a subsumer or an advance organizer (in the absence of appropriate subsumer) for meaningful learning to occur. In the process of this subsumption, there is a restructuring of the cognitive framework.

### 7.7.3 Development of laboratory problem solving model

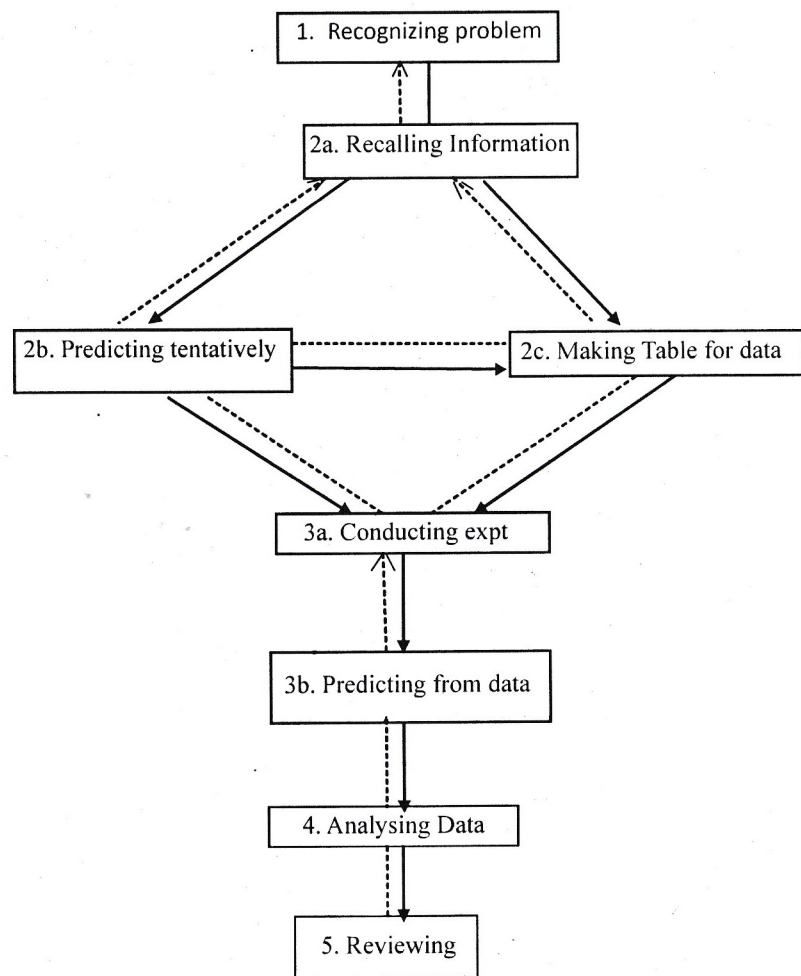
Considering the “cookbook” nature of practicals in secondary school system, I was interested in developing a model for use at the level which could be applied at the tertiary level. It is called Laboratory Problem-Solving Model (LAPSOM).

### Traditional Laboratory pattern for practicals



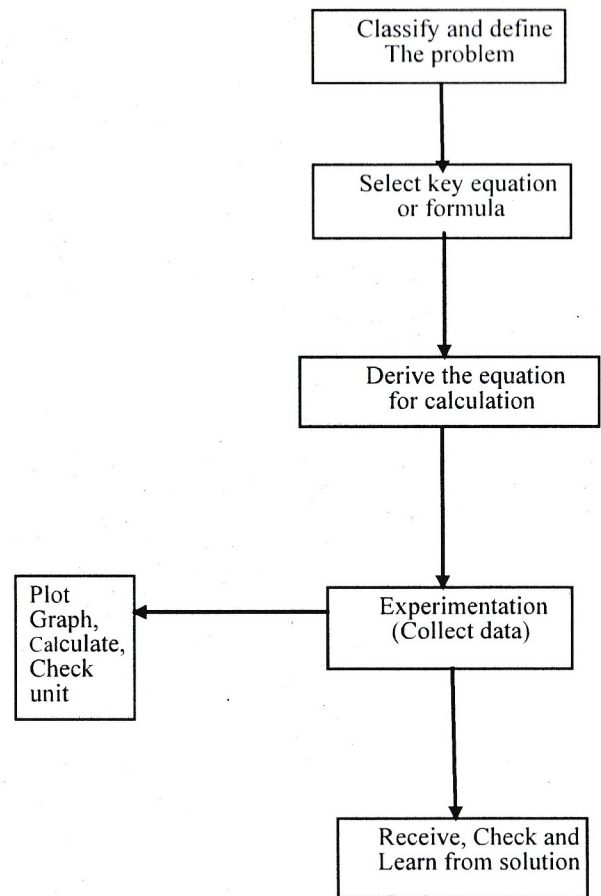


Laboratory problem-solving model (LAPSOM)



LAPSOM(Onwioduokit, 1992)

To test the effectiveness of the model (LAPSOM), I brought in the modified Selvanantnam-Frazer Model (1982)



Modified Selvanantnam-Frazer Model (1982)

The relative effectiveness was measured with respect to the following skills known as laboratory skills (Onwioduokit, 1993,2003):

1. Cognitive skills

2. Manipulative skills
3. Observational skills
4. Computational skills and
5. Communicative skills

Using the following secondary independent variables:

1. Cognitive Style
2. Gender
3. Reasoning Ability
4. Problem-Solving Ability
5. Mathematical Ability and
6. Motor Ability of the students

Table 5. Summary of 4×3×3 Analysis of Covariance on Cognitive skill scores of groups under practical physics conditions and control, attributable to treatment, reasoning ability and cognitive style.

SOURCE OF VARIATION	SS	DF	MS	F	P
<b>COVARIATES:</b>					
Diagnostic	27.8	1	27.80	5.29	.021
Pretest	297.53	1	297.53	56.56	.001
<b>MAIN EFFECTS:</b>					
Problem-Solving Model (PSM)	456.59	3	152.20	28.94	.001
Reasoning Ability (REAB)	151.70	2	75.85	14.42	.001
Cognitive Style (COST)	11.99	2	6.00	1.14	.321 (ns)
<b>2-WAY INTERACTIONS:</b>					
PSM × Reasoning Ability	69.53	6	11.59	2.20	.041
PSM × Cognitive Style	25.11	6	4.19	0.80	.999 (ns)
Reasoning Ability × Cognitive Style	22.06	4	5.52	1.05	.382 (ns)
<b>3-WAY INTERACTION:</b>					
PSM × REAB × COST	10.21	5	2.04	0.39	.999 (ns)
<b>EXPLAINED</b>	13289.91	30	443.00	84.22	.001 (ns)
<b>RESIDUAL</b>	2080.91	396	5.26		
<b>TOTAL</b>	15370.87	426			

ns = Not significant at P < .05

Table 6. Multiple Classification Analysis of 4x3x3 Analysis of Covariance regarding cognitive skill.

VARIABLE + CATEGORY	N	UNADJUSTED			ADJUSTED FOR INDEPENDENT AND COVARIABLES		
		DEV'N	ETA		DEV'N	BETA	
<b>PROBLEM-SOLVING MODEL</b>							
1. Researcher's PSM	110	7.76			7.52		
2. Selvarantnam-Frazers' PSM	104	1.89			1.96		
3. Traditional 'PSM'	106	-4.15			-2.24		
4. Control	107	-5.71	0.89		-7.41		0.92
<b>Reasoning Ability</b>							
1. Low	84	-0.59			-0.76		
2. Average	244	0.67			-1.46		
3. High	99	2.15	0.20		2.97		0.31
<b>COGNITIVE STYLE</b>							
1. Analytic	130	0.83			1.47		
2. Inferential	111	-0.21			0.02		
3. Global	186	-0.46	0.09		2.04		0.18
<b>MULTIPLE R<sup>2</sup></b>							
<b>MULTIPLE R</b>							

Table 7. Summary of 4x3x3 Analysis of Covariance on Observational skill scores of groups under practical physics conditions and control, attributable to treatment, reasoning ability and cognitive style.

SOURCE OF VARIATION	SS	DF	MS	F	P < .05
<b>COVARIATES:</b>					
Diagnostic test	4.67	1	4.67	1.17	.279 ns
Pretest	0.03	1	0.03	0.01	.999 ns
<b>MAIN EFFECTS:</b>					
Problem-Solving Model (PSM)	176.51	3	58.84	14.78	.001
Reasoning Ability (REAB)	58.40	2	29.20	7.34	.001
Cognitive Style (COST)	6.68	2	3.34	0.84	.999 ns
<b>2-WAY INTERACTIONS:</b>					
PSM × Reasoning Ability	33.56	6	5.59	1.41	.210 ns
PSM × Cognitive Style	6.09	6	1.02	0.26	.999 ns
Reasoning Ability × Cognitive Style	23.90	4	5.98	1.50	.200 ns
<b>3-WAY INTERACTION:</b>					
PSM × REAB × COST	11.92	5	2.38	0.60	.999 ns
EXPLAINED	4765.83	30	158.861	39.92	.001
RESIDUAL	1576.06	396	3.98		
TOTAL	6341.89	426			

ns = Not significant at P < .05

Table 10. Multiple Classification Analysis of 4×3×3 Analysis of Covariance regarding communicative skill.

VARIABLE + CATEGORY	N	UNADJUSTED		ADJUSTED FOR INDEPENDENT AND COVARIABLES	
		DEV'N	ETA	DEV'N	BETA
<b>PROBLEM-SOLVING MODEL</b>					
1. Researcher's PSM	110	3.01		3.01	
2. Selvarantnam-Frazers' PSM	104	0.06		-0.23	
3. Traditional 'PSM'	106	-1.41		-1.42	
4. Control	107	-1.76	0.89	-1.55	0.89
<b>Reasoning Ability</b>					
1. Low	84	-0.21		0.23	
2. Average	244	0.10		-0.10	
3. High	99	0.08	0.06	0.05	0.06
<b>COGNITIVE STYLE</b>					
1. Analytic	130	-0.01		0.46	
2. Inferential	111	-0.18		-1.10	
3. Global	186	0.11	0.06	0.34	0.31
<b>MULTIPLE R<sup>2</sup></b>		0.10			
<b>MULTIPLE R</b>		0.32			

Table 11. Summary of 4×3×3 Analysis of Covariance on Manipulative skill scores of groups under practical physics conditions and control, attributable to treatment,

SOURCE OF VARIATION	SS	DF	MS	F	P < .05
<b>COVARIATES:</b>					
Diagnostic test	44.72	1	44.72	11.24	.001
Pretest	126.94	1	126.94	31.89	.001
<b>MAIN EFFECTS:</b>					
Problem-Solving Model (PSM)	69.08	3	23.03	5.79	.001
Reasoning Ability (REAB)	19.36	2	9.68	2.43	.087 ns*
Motor Ability (MOAB)	97.01	2	48.51	12.19	.001
<b>2-WAY INTERACTIONS:</b>					
PSM × Reasoning Ability	14.93	6	2.49	0.63	.210 ns
PSM × Motor Ability	42.43	6	7.07	1.78	.999 ns
Reasoning Ability × Motor Ability	24.85	4	6.21	1.56	.200 ns
<b>3-WAY INTERACTION:</b>					
PSM × REAB × MOAB	42.37	12	3.53	0.89	.999 ns
<b>EXPLAINED</b>	4403.29	37	119.00	29.90	.001
<b>RESIDUAL</b>	1548.25	389	3.98		
<b>TOTAL</b>	5951.54	426			

ns = Not significant at P < .05

Table 12. Multiple Classification Analysis of 4×3×3 Analysis of Covariance regarding observational skill.

VARIABLE + CATEGORY	GRAND MEAN = 7.98		UNADJUSTED		ADJUSTED FOR INDEPENDENT AND COVARIABLES	
	N		DEV'N	ETA	DEV'N	BETA
<b>PROBLEM-SOLVING MODELS</b>						
1. Researcher's PSM	110		3.97		2.34	
2. Selvarantnam-Frazers' PSM	104		1.33		2.13	
3. Traditional 'PSM'	106		-1.97		-1.75	
4. Control	107		-3.43	0.78	-2.73	0.61
<b>Reasoning Ability</b>						
1. Low	84		0.17		-1.05	
2. Average	244		0.12		0.80	
3. High	99		0.15	0.04	1.08	0.25
<b>MOTOR ABILITY</b>						
1. Low	83		-0.51		-2.54	
2. Average	252		-0.57		-0.48	
3. High	92		2.01		3.60	
<b>MULTIPLE R<sup>2</sup></b>			0.19			
<b>MULTIPLE R</b>			0.43			0.55

Table 13. Summary of 4×3×3 Analysis of Covariance on Computational skill scores of groups under practical physics conditions and control, attributable to treatment, reasoning ability and mathematical ability.

SOURCE OF VARIATION	SS	DF	MS	F	P < .05
<b>COVARIATES:</b>					
Diagnostic test	4.64	1	4.64	1.99	.155 ns*
Pretest	0.00	1	0.00	0.00	.999 ns
<b>MAIN EFFECTS</b>					
Problem-Solving Model	135.71	3	45.24	19.24	.001
Reasoning Ability	28.20	2	14.10	6.05	.003
Mathematical Ability	27.98	2	13.99	6.00	.003
<b>2-WAY INTERACTIONS:</b>					
PSM × Reasoning Ability	18.03	6	3.00	1.29	.259 ns
PSM × Mathematical Ability	28.43	6	4.74	2.03	.059 ns
Reasoning Ability × Math. Ability	23.90	4	5.98	2.57	.037
<b>3-WAY INTERACTION:</b>					
PSM × REAB × MAAB	19.27	11	1.75	0.75	.999 ns
<b>EXPLAINED</b>	4658.38	36	129.40	55.54	.001
<b>RESIDUAL</b>	907.31	390	2.33		
<b>TOTAL</b>	5565.69				

ns = Not significant at P < .05

Table 14. Multiple Classification Analysis of 4×3×3 Analysis of Covariance regarding computational skill.

VARIABLE + CATEGORY	N	UNADJUSTED		ADJUSTED FOR INDEPENDENT AND COVARIABLES	
		DEV'N	ETA	DEV'N	BETA
<b>GRAND MEAN = 3.99</b>					
<b>PROBLEM-SOLVING MODEL</b>					
1. Researcher's PSM	110	5.01		3.49	
2. Selvarantnam-Frazers' PSM	104	0.48		0.99	
3. Traditional PSM	106	-2.26		-1.85	
4. Control	107	-3.38	0.90	-2.72	0.68
<b>Reasoning Ability</b>					
1. Low	84	-0.18		-1.95	
2. Average	244	-0.16		0.24	
3. High	99	0.54	0.08	1.07	0.28
<b>MATHEMATICAL ABILITY</b>					
1. Low	85	-0.17		-2.01	
2. Average	290	0.02		0.63	
3. High	52	0.14		-0.24	
<b>MULTIPLE R<sup>2</sup></b>					
<b>MULTIPLE R<sup>2</sup></b>		0.21	0.03		0.29
		0.46			

### 7.3 At the Tertiary level

My contributions to science teaching at the tertiary level has been in the areas of research and the teaching the would-be science teaching on how to teach concepts branded difficult, particularly, in Physics Education (Onwioduokit, 1996; Onwioduokit and Mkpanang, 2001).

- Improvisation of materials in the teaching of physics (Onwioduokit, 1998; Onwioduokit, Akinbola and Udo, 2008; Onwioduokit, 1997, 1998; Onwioduokit and Efut, 2000, 2010).
- Determining the predictors of students' performances in Science learning (Onwioduokit, 1999; Onwioduokit and Utibe, 2003, 2004; Onwioduokit and Mkpanang, 2005).
- Assessment of the effects of teaching and learning science (Onwioduokit, 1992, 1993, 1995, 1998, 1998a, 2002, 2007, 20011).

#### 7.3.1 The use of local materials in teaching Physics.

- Determination of tensile strength and stiffness of local ropes (piassava and tie-tie) when in a dry and dampened states. This was published in Alberta Science Education Journal in 1998.

#### Theory

To obtain the tensile strength and stiffness (Young's modulus) of each material, the following expressions were used:

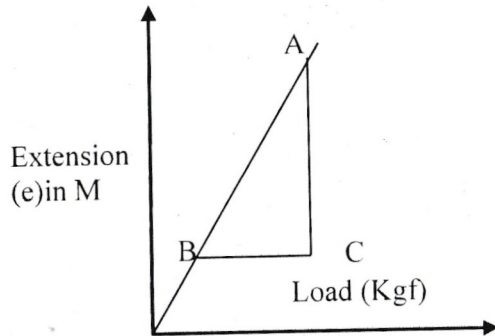
1. Tensile strength =  $\frac{\text{Maximum force applied before the material breaks}}{\text{Original cross sectional area}}$
2. Stiffness =  $\frac{\text{Tensile stress}}{\text{Tensile strain}}$

Where (a) Tensile stress =  $\frac{\text{Force applied}}{\text{Cross sectional area of the material}}$

Where  $r$  = radius of the cross section of the material

Where (b) Tensile strain =  $\frac{\text{Extension obtained (e)}}{\text{Original Length (L}_0\text{)}}$

The value of Young's modulus can practically be obtained by plotting a graph of mean extension against the load applied:



From the sketch above, the slope =  $\frac{AC}{BC}$

$$\text{Young's modulus (E)} = \frac{F}{\pi r^2} \div \frac{e}{L_0} \dots\dots\dots(1)$$

where F = Force applied

e = Extension

L<sub>0</sub> = Original length of material

r = radius of the cross section of the material

$$\text{from Equation 1, } E = \frac{F}{e} \cdot \frac{L_0}{\pi r^2} \dots\dots\dots(2)$$

Where  $\frac{F}{e} = \frac{1}{\text{slope}}$

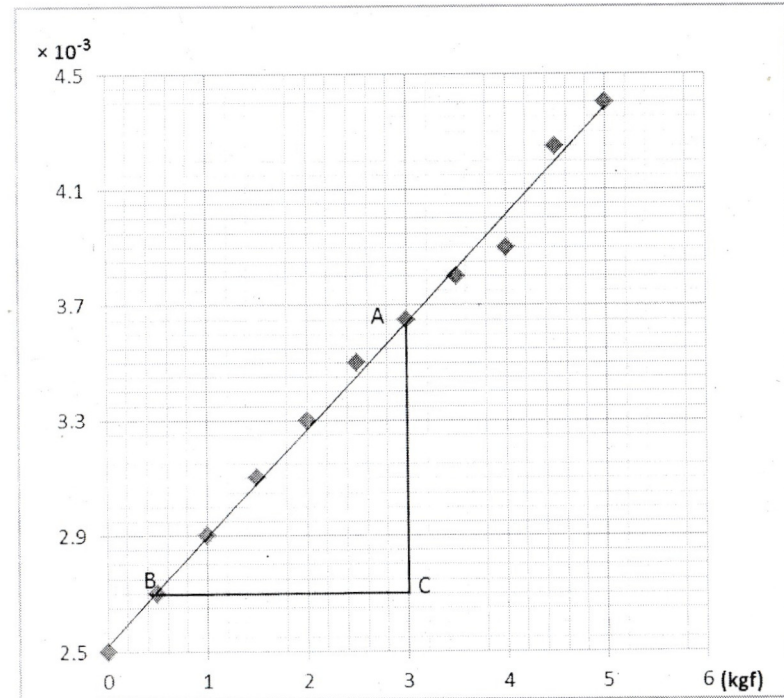
$$\text{Hence, } E = \frac{1}{\text{Slope}} \cdot \frac{L_0}{\pi r^2} \dots\dots\dots(3)$$

## RESULTS

The results obtained from the experiments are given as follows.

**Graph 1**

A plot of extension (e) against force applied (F) using a dampened piassava (DAP-1) of length (L<sub>0</sub>) 0.805m and mean diameter (r) 7.42 × 10<sup>-3</sup>m. Breaking stress = 5.00Kgf



$$\frac{BC}{AC} = 2.58 \times 10^4 \text{NM}^{-1}$$

Graph 1 yields the slope  $3.87 \times 10^{-5} \text{MN}^{-1}$ . The reciprocal of the slope is therefore  $2.58 \times 10^4 \text{NM}^{-1}$ . Based on this, the following calculations are made:

1. Tensile strength ( $\text{TS}_1$ ) of dampened piassava (DAP-1)

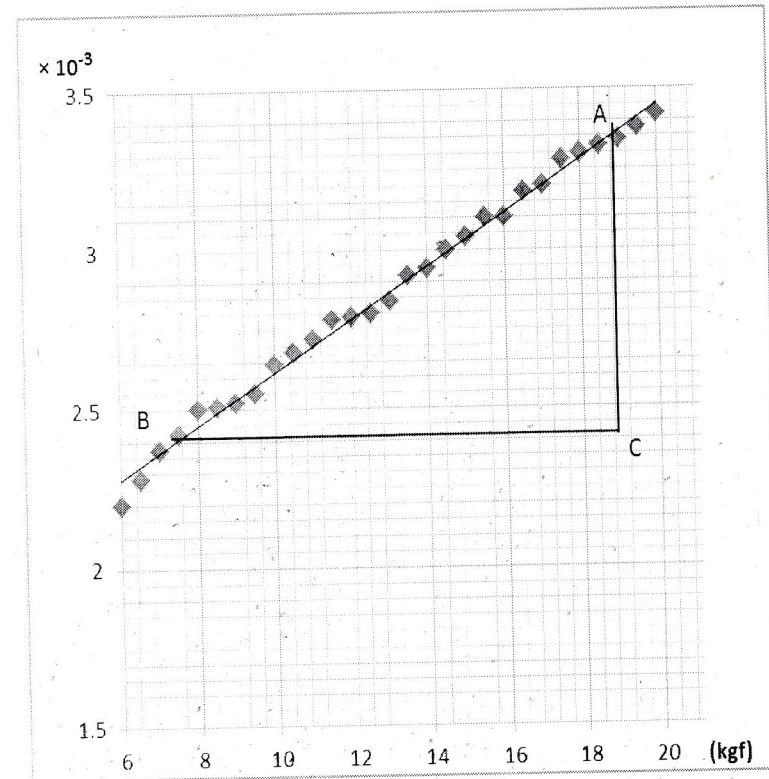
$$\text{TS}_1 = \frac{Mg}{\pi r_1^2} = \frac{4.5 \times 9.81}{3.142 \times (3.71 \times 10^{-3})^2} = \frac{44.15}{43.25 \times 10^{-6}}$$

2. Young's modulus

$$(E_1) = \frac{1}{\text{Slope}} \cdot \frac{L_1}{\pi r_1^2} = 2.58 \times 10^4 \times \frac{0.805}{43.25 \times 10^{-6}} = 4.80 \times 10^8 \text{NM}^{-2}$$

### Graph 2

A plot of extension ( $e$ ) against force applied ( $F$ ) using a dampened piassava (DAP-2) of length ( $L_2$ ) 0.92m and mean diameter ( $r_2$ ),  $5.3 \times 10^{-3} \text{m}$ . Breaking stress =  $20.00 \text{kgf}$



$$\frac{BC}{AC} = 1.21 \times 10^5 \text{NM}^{-1}$$



From Graph 2, the slope is  $8.29 \times 10^4 \text{NM}^{-1}$ , giving a reciprocal of  $1.21 \times 10^5 \text{NM}^{-1}$ . Consequently, the following results are obtained:

1. Tensile strength of dampened piassava (Dap-2),  $TS_2 = 8.66 \times 10^6 \text{NM}^{-2}$

2. Young's modulus ( $E_2$ ),  $E_2 = 5.04 \times 10^9 \text{NM}^{-2}$

From these values of tensile strengths and young moduli, the mean values can be calculated for a dampened piassava thus:

1. Tensile strength of dampened piassava:

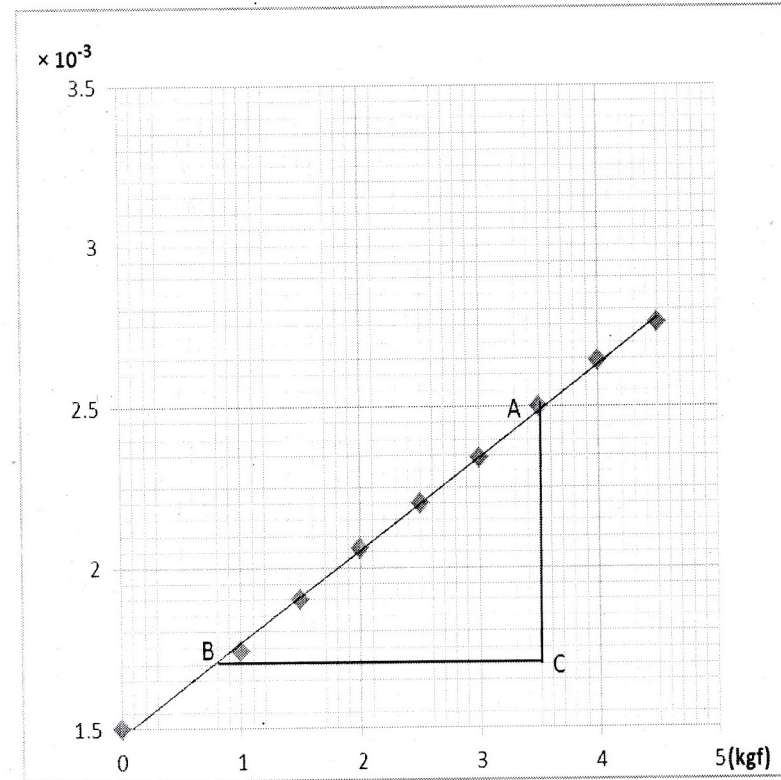
$$\frac{TS_1 + TS_2}{2} = \frac{(1.02 \times 10^6 + 8.66 \times 10^6)}{2} = 4.84 \times 10^6 \text{NM}^{-2}$$

2. Young's modulus of dampened piassava:

$$\frac{(E_1 + E_2)}{2} = \frac{(4.80 \times 10^8 + 5.04 \times 10^9)}{2} = 2.77 \times 10^9 \text{NM}^{-2}$$

**Graph 3**

A plot of extension (e) against force applied (F) using a d piassava dry (DRP-1) of length 0.97m and mean diameter  $7.7 \times 10^{-3} \text{m}$ . Breaking stress = 5.00kgf



$$\frac{BC}{AC} = 3.44 \times 10^4 \text{NM}^{-1}$$

As shown in the Graph 3 , the slope is  $2.91 \times 10^{-5} \text{MN}^{-1}$ , thus giving its reciprocal as  $3.44 \times 10^4 \text{NM}^{-1}$ . Consequently,

1. Tensile strength ( $\text{TS}_3$ ) of dry piassava

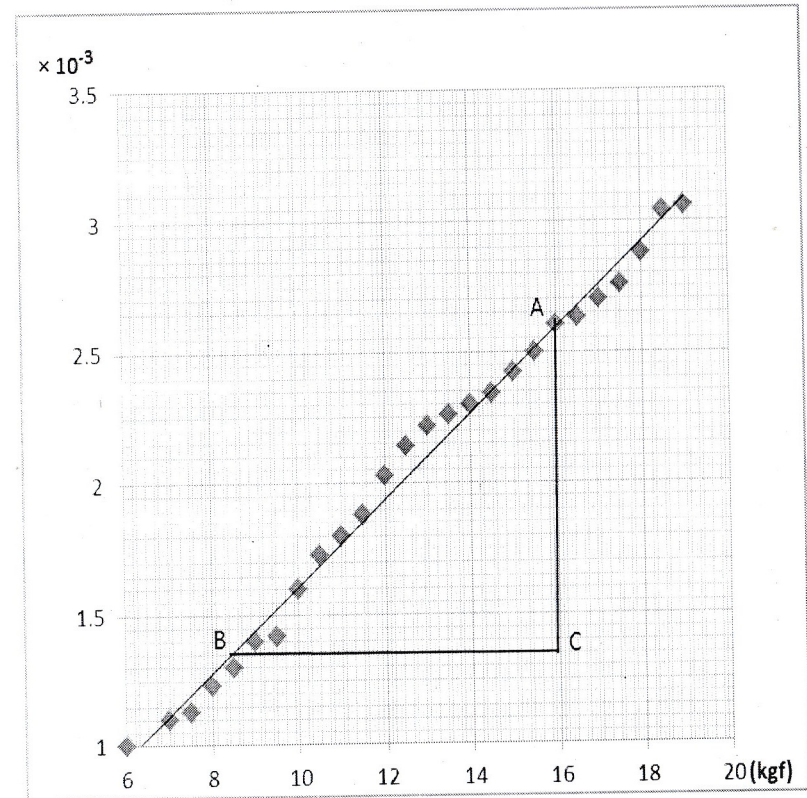
$$\text{TS}_3 = 1.05 \times 10^6 \text{NM}^{-1}$$

2. Young's modulus ( $E_3$ ) of dry piassava

$$E_3 = 7.17 \times 10^8 \text{NM}^{-2}$$

**Graph 4**

A plot of extension (e) against force applied (F) using a dry piassava (DRP-2) of length 1.38m and mean diameter  $5.78 \times 10^{-3}$  m. Breaking stress = 19.50kgf



$$\frac{BC}{AC} = 6.13 \times 10^4 \text{NM}^{-1}$$

From Graph 4, the slope =  $1.63 \times 10^{-5} \text{MN}^{-1}$ , giving the reciprocal as  $6.13 \times 10^4 \text{NM}^{-1}$ .

1. Tensile strength ( $\text{TS}_4$ ) of dry piassava =  $7.10 \times 10^6 \text{NM}^{-2}$
2. Young's modulus ( $E_4$ ) of dry piassava =  $3.22 \times 10^9 \text{Nm}^{-2}$

Considering calculations based on graphs 3 and 4, the mean values for dry piassava are:

1. Tensile strength  

$$\frac{(\text{TS}_3 + \text{TS}_4)}{2} = 4.08 \times 10^6 \text{NM}^{-2}$$

2. Young's modulus  

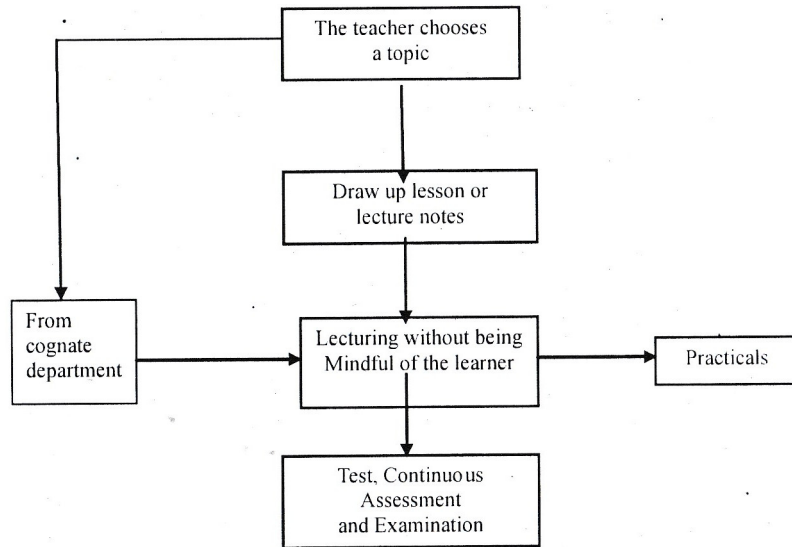
$$(E_3 + E_4) = 1.97 \times 10^9 \text{NM}^{-2}$$

Similarly, graphs for extension versus force applied can be made for dry tie-tie (hard), dry tie-tie (soft), dampened tie-tie (hard) and dampened tie-tie (soft). The results are summarized in Table 1.

Material	State	Tensile strength ( $\text{NM}^{-2}$ )	young's modulus ( $\text{NM}^{-2}$ )
Piassava	dampened	$4.84 \times 10^6$	$2.77 \times 10^9$
Piassava	dry	$4.08 \times 10^6$	$1.97 \times 10^9$
Tie-tie (hard type)	dry	$3.00 \times 10^7$	$9.25 \times 10^9$
Tie-tie (soft type)	dry	$5.39 \times 10^7$	$2.08 \times 10^{10}$
Tie-tie (hard type)	dampened	$5.25 \times 10^7$	$3.24 \times 10^{10}$
Tie-tie (soft type)	dampened	$1.16 \times 10^8$	$6.26 \times 10^{10}$

### 8.0 The need for a paradigm shift

From what has been said so far, the prevailing paradigm governing science teaching especially here in our continent is:



The present paradigm has brought about:

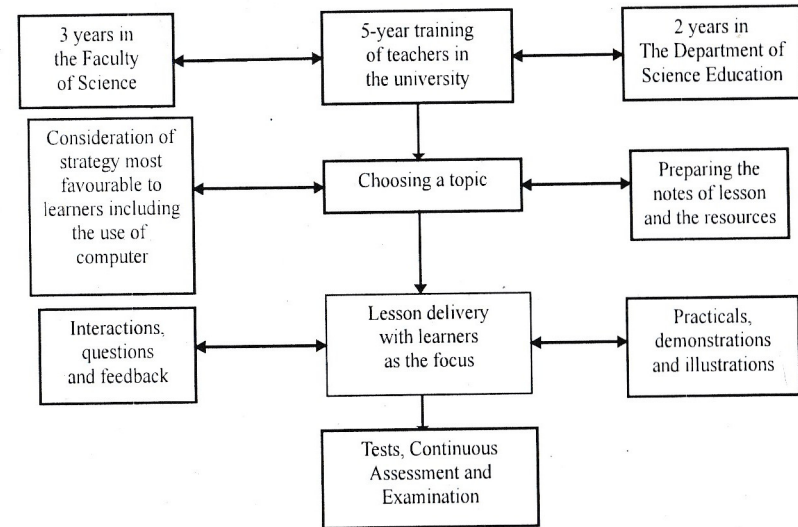
- Poor understanding, comprehension and application of science concepts by learners.
- Poor performances in both internal and external examination.
- Non development of entrepreneurial skills in learners.
- Massive unemployment, among others.

#### The question is where do we go from here?

If we must address the problems of science teaching with the attendant unfavorable consequences, science teaching

revolution is needed. This must start from the training of science teachers (those that are both scientists as well as teachers). After scrapping the Teacher Training Colleges what is being embarked upon now is teacher qualification and not teacher training.

### 9.0 The New Paradigm



#### Main Emphasis of The new paradigm

- ✓ In- built processes for the training of science teachers
- ✓ Integration of theory with practical
- ✓ learners as being central in the teaching process
- ✓ 5-year undergraduate training for science teachers:
  - First 3 years at the Faculty of Science
  - The last two years in the Department of Science Education to cover hands-on training on all science concepts the students are expected to teacher after graduation as well

one full year of closely monitored and supervised teaching practice

The new paradigm is expected to work with:

- Proper attitude of teachers
- Close supervision of the Heads of Departments with respect to regularity and promptness to work and the quality of lesson delivery.
- The school or university authority regulating the use of cell phones among students during lecture periods 8.00am 5.00pm
- 75% attendance policy should be strictly enforced.

### **10.0 CONCLUSION**

Science Education is the basis for scientific and technological development of any country. The quality of science teachers and teaching therefore is very crucial to national development. The science teacher needs to possess both adequate knowledge of science and teaching skills, coupled with good attitude to work.

There are quite a number of challenges. The problems have lingered for years and it is time they should be tackled if we must make it technologically and economical, for actualization of Vision 20-2020. It is my candid opinion that the poor performances of students and their involvement in examination misconducts as well as the high level of unemployment can be overcome with learner-centered teaching and the proper use of laboratory and the resources available or improvised.

There is therefore a need for a shift in science teaching paradigm.

And the time is now!!!

Vice Chancellor and the Chairperson of this gathering, the Deputy Vice Chancellors, University Librarian, My Dean, Dean of the Faculty of Education, distinguished professors and other academic staff present, Honourable Justices of the High court, seasoned men and women of God here present, Great Nigerian Students, Gentlemen of the press, Ladies and gentlemen, I have been lecturing on the topic "The Ordeal Of Science Teaching In The Contemporary Society: A Need For Paradigm Shift For The New Generation".

I am glad to inform you that I have finished.

Thank you for spending your time with me.

**God bless you all.**

- Onwioduokit, F. A. (1992a). The development and use of laboratory problem-solving model (LAPSOM) in school physics. **Journal of Research in Education and Humanities**, Vol 1(1), 27-36
- Onwioduokit, F. A. (1993). The use of models in physics teaching. In **Eshiet, I. T. (Ed) Methodology of Science Teaching: Historical and Conceptual Approach**, Abak: Belpot Nig. Co., pp115-127
- Onwioduokit, F. A. (1993a). The effects of three problem-solving models in the acquisition of laboratory such as senior secondary physics students, **Journal of Education**, Vol 2(1), 88-97
- Onwioduokit, F. A. (1995). Teaching physics concepts in primary science modules. **Journal of Research in educational and Humanities**, Vol 3(1), 10-19
- Onwioduokit, F. A. (1996). Difficult concepts in physics as experienced by senior secondary students in Akwa Ibom State. **Research: Journal of research Information in Education**, Vol 3(1), 65-75
- Onwioduokit, F. A. (1996a). The relative effects of Ausubelian and Gagne sequences of physics instructions on students' performance. **Journal of Science and Science Education**, vol 3(1), 65-75
- Onwioduokit, F. A. (1997). Causal effects of some critical variables on students' acquisition of practical skills in physics. **Journal of Science and Science Education**, Vol 4(1), 417
- Onwioduokit, F. A. (1997a). Improvisation of material in the teaching of physics: A case for instigation of the physical properties of local materials, **STAN 40<sup>th</sup> Anniversary Conference proceedings**, 2070-2078
- Onwioduokit, F. A. (1998). Tensile strength of local materials used as ropes in Nigeria. **Alberta Science Education Journal**, Vol 30(2), 28-34

- Onwioduokit, F. A. (1998a). Using reasoning ability and cognitive style as critical variables in the development of cognitive skills in school physics students. **Journal of Quality Education**, Vol 5, 15-26.
- Onwioduokit, F. A. (1998b). The role of infrastructural facilities in the cognitive development of physics students in Nigeria. **Journal of Functional Education**, vol. 1(1), 112-120
- Onwioduokit, F. A. (1999). The Laboratory and affective domain of physics studies, **International Journal of Educational Development**, Vol 1, 50-56.
- Onwioduokit, F. A. (1999a). **Approaches to the teaching of primary science**, presented at the seminar organized by M & E consultants for Onna L.G.A of Akwa Ibom state.
- Onwioduokit, F. A. (1999b). Knowledge of mathematics as the predictor of Students' performance in Physics. **Journal of Science and Science Education**, vol. 6(1), 9-15
- Onwioduokit, F. A. & Efut, O. I. (2000). Enriching Physice Education in Nigeria to cope with the Challenges of the present Millenium. In Akale, M. A. G. (ed) **Enriching Science Technology and Mathematics Education**. Ibadan, Heinemann educational Books (Nig) Plc.
- Onwioduokit, F. A. (2000a). Supervision and Evaluation of Universal Basic Education (UBE) Programme. **Journal of Nigerian Education Research Reporter's Association**, vol. 5 (1), 74-80.
- Onwioduokit, F. A., & Mkpanang, T. T. (2001). The level of understanding of radioactivity concepts among senior secondary school students in Ikot Ekpene LGA. **Nigerian Journal of Science and Science Education**, Vol 7(20) 1-14.

- Onwioduokit, F. A. (2001a). Science and Technology in Early childhood Education, **Journal of Education and Training in Technology**, 3(2), 31-50.
- Onwioduokit, F. A. (2001b). Science Education, and Nation Building, Curriculum implications, **Nigerian Journal of Curriculum Instruction**, vol. 10(1), 65-68.
- Onwioduokit, F. A. (2002). An-on the spot assessment in Integrated Science, **Journal of Education**, 2(1), 1-11.
- Onwioduokit, F. A. (2003a). Teaching primary science in the primary way. In Ekpo, C. M. (ed) **Strategies for effective Teaching and Learning of science, Technology and Mathematics Education**, Uyo: Ivy press Ltd, 116-124.
- Onwioduokit, F. A. (2003b). National standards for Science Education Research. In Baiyelo, T. D., and Busari, T. (ed). **Standards for Science, Technology and Mathematics research. Lagos: NASER Academy Press** 82-89.
- Onwioduokit, F. A. (2006). Quality Control: Issues and challenges in Akwa Ibom State Education system. **Akwa Ibom State Government press**.
- Onwioduokit, F. A., Akinbobola, A. O. & Udoh, M. A. (2008). Sporting equipment and students' academic performance in the concept of projectile in Nig. Secondary school physics. **African Research Review**, Vol 2(1), 1-18.
- Ottanda, J. & Grelsson, P. (2006). The role of laboratory in secondary school science programmes. In **M. B. Rowe (Ed) What research says to the science teacher**, Vol 1. Washington, D. C.: National Science Teacher Association.
- Selvarantnam, M. & Frazer, K. M. J. (1982). **Problem-solving in chemistry**, London: Heinemann Books.

## INDEX

- A  
Abdullahi 2  
Aftermath 18  
Ability 6
- B  
Bicycle 28  
Bridge 29  
Biology 19
- C  
Cognitive skill 5  
Computational skill 5  
Communicative skill 6  
Curriculum 20
- D  
Dearth of science teachers 13
- E  
Experimenting 3  
Education 2  
Environmental 8  
Effort 25
- F  
Friction 27  
Fulcrum 26
- G  
Graph 48  
Gaps 16
- H  
Hypothesis
- I  
Incomplete science 2
- L  
Lecturing 3  
Lever 25  
Laboratory 32  
Load 25
- M  
Manipulative 5
- O  
Ordeal 1  
Observational skill 5  
Organismic 8
- P  
Primary 13  
Process of science 3  
Piaget's model 30  
Pressure 31  
Product of science 8  
Paradigm 12  
prediction 2  
Piassava 47  
Poor results 24  
Pounding 27  
Psychological theories 29

Q  
Qualified 11  
Quality control 13

R  
Ratio 32

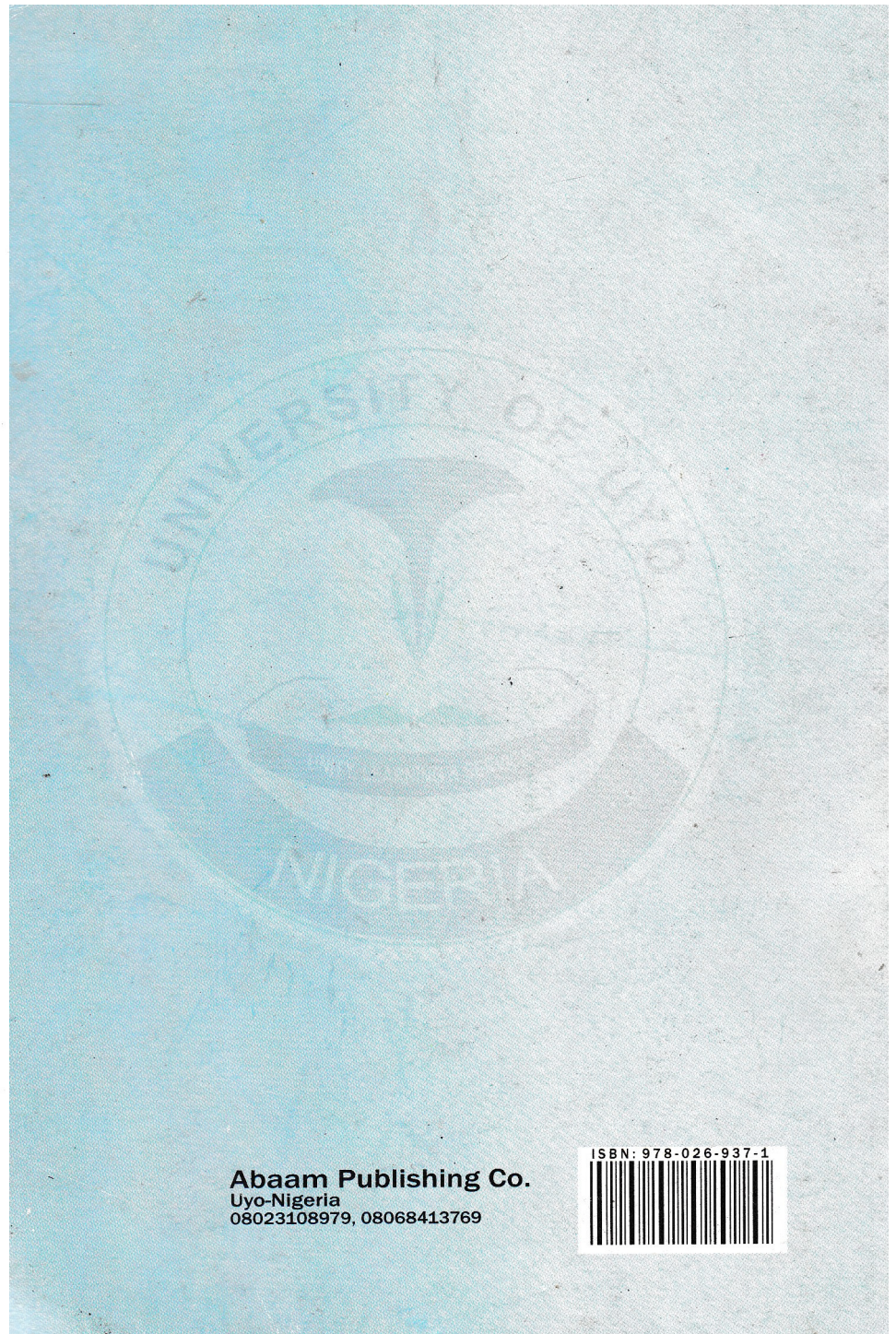
S  
Symbolic 26

T  
Training 11

U  
Universe 2

W  
Wheel barrow 25

Y  
Young's modulus 47



**Abaam Publishing Co.**  
Uyo-Nigeria  
08023108979, 08068413769

