Designed & Printed by University of Lagos Press

CAPACITY BUILDING IN THE SCIENCES: IMPERATIVES FOR TEACHER EDUCATION IN NIGERIA

BY

PROFESSOR DURO AJEYALEMI

UNIVERSITY OF LAGOS PRESS - 2002

INAUGURAL LECTURE SERIES

CAPACITY BUILDING IN THE SCIENCES: IMPERATIVES FOR TEACHER EDUCATION IN NIGERIA

An Inaugural Lecture Delivered at the University of Lagos on Wednesday, 6th November, 2002.

By

PROFESSOR DURO AJEYALEMI
B.Sc. Educ. (Lagos), M.Sc., Ph.D. (East Anglia), C. Chem., M.R.S.C., MSTAN
Professor of Curriculum Studies (Science)

University of Lagos, 2002

First Published 2002

By

University of Lagos Press
Unilag P.O. Box 132,
University of Lagos,
Akoka, Yaba – Lagos
Nigeria

ISSN 1119 - 4456

CAPACITY BUILDING IN THE SCIENCES: IMPERATIVES FOR TEACHER EDUCATION IN NIGERIA

Introduction

It is a truism that we now live in the modern age of science and technology. To participate in that world and derive benefits from it, every nation requires the relevant manpower. According to Nigeria's National Manpower Board (2000), "manpower is the most important ingredient of the development process". For optimum national development, every nation requires various categories of manpower, including artists, social scientists, lawyers, journalists, accountants, scientists, technologists, engineers, medical doctors, agriculturists, teachers, researchers, etc. *Teachers*, who are the products of *teacher education*, are responsible for producing these different categories of manpower through the process of *teaching*. The teacher is the main catalyst for educational productivity in any nation. Hence, the importance of the teacher in national development is well recognised by Government. It is emphasised in the National Policy on Education (1977, reprinted 1998) that "education in Nigeria is an instrument '*par excellence*' for effecting national development" (p. 5) and that "no education system can rise above the quality of its teachers" (p. 33).

The quality of each category of manpower produced would, of course, depend upon the inputs into and the quality of teaching and learning at each level of education, from primary through secondary to tertiary level. In other words, the quality of the manpower produced from the educational system would essentially be determined, among other inputs, by the quality of the teacher and indirectly by the quality of that teacher's education programmes. It can then be said that the final objective of teacher education, in any discipline and for any level of education, is *capacity building* in that discipline for national development, be it social, economic, political, educational, scientific or technological development. First, let us clarify certain terms.

Capacity Building

Capacity building means establishing resources needed to fulfil a mission or achieve a goal. The term *'capacity building'* is often used interchangeably with a more recent term *'capacity development'* by researchers and practitioners. While the former focuses solely on building new capacities, the latter emphasises the notion of an 'on-going' process, which takes account of existing capacities. According to CIDA (1996) capacity building is

> *a process by which individuals, groups, institutions, organisations and societies enhance their abilities to identify and meet development challenges in a sustainable manner.*

This process may take place in the formal education sector and/or through specialised training to meet specific occupational or professional needs.

In the context of this lecture, *capacity building* is the process, particularly in the formal education sector, of enhancing the abilities and capabilities of human resources *in the sciences* for identifying and meeting national development challenges in a sustainable manner. The main actor in this enhancement process is the *teacher*. This means that teachers are responsible for capacity building for any nation in the formal education sector. Even, in specialised training, the *trainer* is still a *teacher*.

In the formal education sector, capacity building may be said to begin from the primary school level, for the lawyer or technologist of tomorrow begins his/her formal education at that level. This is not to say that what happens at the pre-school level is unimportant. In fact, it has been argued elsewhere that science and technology education should be emphasised right from early childhood (Ajeyalemi, 2001). However, formalisation is recognised by Government from the primary level. Therefore, the education of the teacher, even for that primary school level, is of crucial importance to capacity building and hence, national development.

What is Teaching?

Teaching is a complex task. It embraces many activities, processes and various kinds of behaviour, which may take place in various contexts and which may result in both intended and unintended outcomes. The major objective however, is for *somebody* to **learn** *something*. The task of teaching carries with it a heavy responsibility as the teacher is expected to at least know and behave better than the taught. This is recognised by the Holy Bible, which in the Book of St. James 3:1 says

> *Not many of you should presume to be teachers, my brothers, because you know that we who teach will be judged more strictly*

As we have professional teachers in the school system teaching some students to learn a subject matter, there are amateur teachers all around us teaching different things. What of a father or mother teaching his/her baby how to walk or talk, a pastor preaching to a congregation, a political speaker influencing an audience at a rally or a master-tailor teaching an apprentice how to thread the needle? As Highet (1954) observed, "*we are all pupils and we are all teachers*". Therefore, teaching may not be fully described by a simple definition.

Many people view teaching as an art and that it may be futile, if not dangerous, applying the aims and methods of science to its study (Highet, 1954). This explains the paucity of knowledge on teaching before the 1960s; rather, the preponderance of knowledge was on learning, which is easily measurable. Others argue that it is possible to subject it to theoretical analysis and scientific inquiry (Gage, 1964; Gallagher, 1970). In this lecture, we accept that teaching is an art, especially when it is realised that it involves more of interactions between human beings that display different emotions and values depending on the circumstances. However, as it is generally acknowledged now, teaching can be and has been subjected to scientific scrutiny in order to understand its intricacies and develop both a theory and empirical knowledge about it. Such theory and knowledge have been found useful in teacher training, assessment and supervision.

As observed above, teaching may be described as effective or ineffective depending on its outcome. But, just as selling may not necessarily result in buying, teaching may not necessarily result in learning. If it results in learning, it is said to be effective and if otherwise, *vice versa*. This is not to say that no learning occurs without teaching! What is certain is that the learning of an organised curriculum material will be possible only if someone, *the teacher*, presents it to the learner. The quality of presentation will then determine how effective the teaching was. That is, teaching can be described as '*good*' or '*bad*'! Good and effective teaching will more often result in learning and *vice versa if* otherwise.

Teacher Education

As teachers are responsible for capacity building in any other profession, the *teachers of teachers* are equally responsible for capacity building in teaching itself. Capacity building in teaching takes place pre-service and in-service. The training of pre-service professionally qualified teachers takes place in formal teacher education institutions, while short or long-term, up-dating courses are available for teachers in service. Of recent, many teachers (pre- and in-service) are being trained through open and distance learning methods using interactive multimedia resources.

In Nigeria, formal teacher education is only available for the primary and secondary school teachers but not for the tertiary teachers. For the primary level, this used to occur in the then Grade II Teachers' Colleges, which produce a generalist teacher for the teaching of all subjects of the primary school curriculum. The Grade II Certificate is equivalent to the G.C.E. O' Level certificate. The National Policy on Education (1977, revised 1981 and reprinted, 1998) has, however, made it mandatory for the National Teachers' Institute (NTI), through distance education, to up-grade all serving primary school teachers with the Grade II Certificate to the National Certificate in Education (N.C.E.) level. The N.C.E. should now be the minimum qualification for teaching at the primary school. In

addition, as we shall see later in the Lecture, the NTI now runs a crash programme for the production of Grade II teachers to meet the demands of the Universal Basic Education (UBE). Also, we now have some Colleges of Primary Education, which produce teachers with the N.C.E.

The education of secondary school teachers takes place either in Colleges of Education, which produce N.C.E. graduates for the Junior Secondary School or in Faculties/Institutes of Education in Nigerian Universities, which produce graduates who may teach in the Junior or Senior Secondary School. The major goal of teacher education in any system is to produce 'good' and effective teachers for the implementation of the curriculum at each level of education. This is because, in common parlance, no matter how good a curriculum may be in its design and development, it will fail if not implemented as expected by the teacher. Teacher educators must therefore be interested in what differentiates a 'good' from a 'bad' teacher.

Qualities of a Good Teacher

Teaching is inseparable from learning; good teaching will obviously result in learning. Certain key characteristics must distinguish 'good' from 'bad' teachers. These include:

i. **mastery of the subject matter as well as the philosophy and goals of teaching that subject at that level.** A competent teacher must be at the frontiers of knowledge in his subject, at least, far above the level of his student and he must have adequate perception of the teaching objectives of the subject.

ii. **mastery of general and subject-specific teaching strategies.** A good teacher is a specialist in methodology. He should be competent in, among other things, planning instruction, providing leadership, managing the students and the learning environment, the art of questioning and leading discussions, motivating students, using a variety of instructional resources and media, evaluating instruction and conducting co-curricular and extra-curricular activities. If he is a science teacher, he must master those strategies that are peculiar to the teaching of science, e.g., inquiry methods in and out of the laboratory.

iii. **knowledge of the learner, learning theories, principles and methods.** A good teacher must know his students individually and collectively in terms of ability, interests and character for him to determine the proper tone of the class. He must recognise and cater for individual differences among the students and he must be conversant with the different learning theories, principles and methods.

iv. **good personality as a leader and positive attitudes to the subject matter and the students.** It is not enough for the teacher to know his subject, students and methods, he must also be intelligent, kind and humorous, determined to achieve his objectives and presentable to command respect. He should be able to make learning fun.

An effective teacher education programme must foster these characteristics in the trainees. Any teacher possessing all or most of these characteristics would be able to teach effectively and thereby produce quality manpower needed by the economy.

Capacity Building in the Sciences

The launching of the first orbiting satellite, the Sputnik I, by the Russians in October 1957 jolted the Western countries into questioning the quality of their own human capital in the Sciences. It was concluded that quality in capacity building in the Sciences would be improved by re-examining school science education. This led to deliberate and unprecedented efforts from the Governments and other agencies at reforming the science curricula for the elementary and high school levels. Of course, a major component of these great reforms was teacher education and re-orientation, both pre- and in-service. A major achievement of the innovative curriculum reforms of

the 1950s, 1960s and 1970s was the strengthening of human capital in the sciences so much so that the West, particularly the U.S.A., has now emerged the leaders over the East bloc in scientific and technological development.

From the 1980s however, the emphasis of the science curriculum on the structure of the disciplines is shifting to a science-technology-society (STS) emphasis, which '*brings out the interrelatedness among scientific explanation, technological planning and problem-solving, and decision-making about practical matters of importance to society*' (Roberts, 2002; p. 35). The latter emphasis is to promote general scientific literacy, while the former was appropriate only to the few students interested in pursuing science careers.

In Nigeria, one of the major constraints militating against rapid national growth and development has been identified as the inadequate supply of skilled and well-trained people (National Manpower Board, 2000). Hence, manpower policies and programmes of Government had sought to meet the needs in these areas through increases in the number of training institutions, enrolment and academic programmes as well as graduate out-turn at all levels of education. The enrolment and graduate out-turn figures for different categories of scientific and technological manpower from Nigerian universities and polytechnics up to 2002 are shown on Tables 1 and 2. These Tables predict increasing enrolment and graduate out-turns from 1998 to 2002 and beyond.

Table 1

SCIENCE & TECHNOLOGY STUDENT ENROLMENT IN AND GRADUATE OUT-TURN FROM NIGERIAN UNIVERSITIES, 1998/1999 – 2001/2002

Faculty of Study	ENROLMENT					
	1998/99 (Actual)		1999/2000 (Estimated)	2000/2001 (Projected)	2001/2002 (Projected)	
	No	%	No	No	No	%
Sciences (Pure & Applied)	50,546	15.8	52,799	54,806	57,246	16.0
Medicine & Related Courses	23,034	7.2	24,241	25,507	26,476	7.4
Pharmacy	5,119	1.6	5,645	6,204	6,440	1.8
Engineering/Technology	29,115	9.1	30,551	31,715	33,632	9.4
Environmental Studies	11,837	3.7	12,286	13,098	13,596	3.8
Agriculture	21,114	6.6	22,249	23,094	24,330	6.8
Veterinary Medicine	2,899	0.9	2,657	2,758	2,865	0.8
Education (Science)	26,555	8.36	27,230	28,265	29,339	8.2
Sub Total	**170,194**	**53.2**	**177,658**	**185,447**	**193,921**	**54.2**
All Arts & Management Studies	**149,720**	**46.8**	**154,412**	**159,243**	**163,867**	**45.8**

GRADUATE OUT –TURN

Faculty of Study	1998/99 (Actual) No	%	1999/2000 (Estimated) No	2000/2001 (Projected) No	2001/2002 (Projected) No	%
Sciences (Pure & Applied)	7,966	12.9	8,469	9,003	9,571	13.2
Medicine & Related Courses	3,952	6.4	4,234	4,536	4,858	6.7
Pharmacy	926	1.5	1,042	1,168	1,305	1.8
Engineering/Technology	4,755	7.7	5,081	5,361	5,728	7.9
Environmental Studies	2,099	3.4	2,215	2,406	2,538	3.5
Agriculture	3,581	5.8	3,844	4,124	4,423	6.1
Veterinary Medicine	371	0.6	391	412	435	0.6
Education (Science)	8,830	14.3	9,251	9,759	10,224	14.1
Sub Total	**32,480**	**52.6**	**34,527**	**36,769**	**39,082**	**53.9**
All Arts & Management Studies	**29,269**	**47.4**	**30,618**	**31,959**	**33,426**	**46.1**

Source: *National Rolling Plan, 2000-2002*, National Manpower Board, Abuja

Table 2

SCIENCE & TECHNOLOGY STUDENT ENROLMENT IN AND GRADUATE OUT-TURN FROM NIGERIAN POLYTECHNICS, 1998/1999 – 2001/2002

Faculty of Study	ENROLMENT					
	1998/99 (Actual)		1999/2000 (Estimated)	2000/2001 (Projected)	2001/2002 (Projected)	
	No	%	No	No	No	%
Agriculture & Related Courses	9,230	4.2	9,897	10,499	11,189	4.5
Engineering/Technology	39,559	18.0	41,449	43,459	45,252	18.2
Environmental Design	23,076	10.5	24,274	25,532	26,853	10.8
Computer Science/ Technology	18,021	8.2	19,007	20,283	21,632	8.7
Food Science/Technology	7,032	3.2	7,328	7,874	8,702	3.5
Education (Science)	4,176	1.9	4,295	4,295	4,476	1.8
Other Science Programmes	13,626	6.2	14,198	14,794	15,415	6.7
Sub Total	**114,720**	**52.2**	**120,454**	**126,706**	**133,519**	**53.7**
All Arts & Management Studies	**105,050**	**47.8**	**108,546**	**111,912**	**115,120**	**46.3**

GRADUATE OUT –TURN

Agriculture & Related Courses	1,923	3.3	2,110	2,247	2,247	3.5
Engineering/Technology	13,170	22.6	14,026	15,004	15,004	22.8
Environmental Design	6,527	11.2	6,951	7,469	7,469	11.4
Computer Science/ Technology	4,196	7.2	4,469	4,825	4,825	7.4
Food Science/Technology	1,748	3.0	1,924	2,049	2,049	3.1
Education (Science)	1,282	2.2	1,366	1,454	1,454	2.2
Other Science Programmes	4,021	6.9	4,282	4,561	4,561	6.9
Sub Total	**32,867**	**56.4**	**35,128**	**37,609**	**37,609**	**57.3**
All Arts & Management Studies	**25,408**	**43.6**	**26,935**	**28,488**	**28,488**	**42.7**

Source: *National Rolling Plan, 2000-2002*, National Manpower Board, Abuja

In spite of these efforts, however, the National Rolling Plan 2000-2002 observes that there continues to

> *exist in the economy, high unemployment rates side by side high vacancy rates in certain crucial areas of need, particularly, **those requiring high scientific and technological skills*** (p. 9).

Perhaps, such vacancies may have resulted from the alarming wastage rate between enrolment and graduate out-turns in the universities and polytechnics observed on Tables 1 and 2. From 1998 to 2002, the wastage rate in each science or technology course is in the ratio of about 6:1 every year in the universities, except for Education (Science) where it is about 3:1, while it is slightly better in the polytechnics where the ratio is about 4:1 yearly.

Also, it had been observed that the sciences were taught in Nigerian universities as pure academic science with little or no attempt at relating theory to practice or the content to its social and technological applications, hence, to the world of work (van den Berghe, 1973; Beetlestone, 1975; Ajeyalemi, 1979). Graduates from such a system would find it difficult securing employment, especially in industry, which should employ a majority of science and technology graduates.

In addition, the Rolling Plan recognises some other contemporary problems contributing to the obvious decay in education, especially at the tertiary level (dwindling resources, strikes, demonstrations, brain drain, cult activities, etc.). The effects of these problems are felt more in science and technology disciplines, which are more capital-intensive and require academic/supporting staff with special skills. The Plan laments the poor quality of education provided by these educational institutions and consequently the poor quality of the human capital produced for the economy (p. 10).

A consequence of this is the large-scale graduate unemployment and/or under-employment in the system. The situation is so bad that many of the large employers of labour in

industry have now resorted to special re-training programmes for graduates (especially science and technology) from the higher institutions before employment. An example is the Shell Petroleum Development Company's Graduate Employment Scheme, where fresh graduates are only employed after successfully completing a one-year training programme in the Company's Training School.

The observed lapses in education at the tertiary level notwithstanding, a major factor contributing to the problem of poor quality human capital in Nigeria has been the poor quality of educational provisions at the primary and secondary levels of education. This is especially so for the science and technology disciplines, which are capital-intensive but which have suffered serious neglect in the educational system for more than two decades now (Ajeyalemi & Baiyelo, 1990; Ajeyalemi, 1987). Not too long ago, Jegede and Okebukola (1995) had confirmed that secondary science teachers themselves listed difficulty in obtaining equipment and materials for effective teaching as the greatest stressor in the performance of their duties. If the foundation had not been properly laid at these lower levels, it would be foolhardy expecting miracles at the highest level. Let us examine the status of science teaching and learning in the Nigerian school system.

Science Teaching in Nigerian Primary Schools

Even though the rudiments of science were introduced into the school curriculum in Nigeria as far back as 1859, there were no nationally co-ordinated efforts on primary science until 1982. Then, the Nigeria Educational Research Council (NERC, now NERDC) initiated the National Primary Science and Mathematics Project (NPSMP) in realisation of the objectives of the 6-3-3-4 system of education. The science component was based on an Integrated Science Curriculum developed by the Federal Ministry of Education. The curriculum is inquiry-oriented and emphasises the acquisition of the process skills of science by the primary school child as was recommended for contemporary science education then.

As a Consultant to the NERC then, I was a member of the team that participated in the re-orientation of some serving teachers in the pilot schools on the use of the curriculum. However, the planned follow-up training of other teachers in the pilot and other schools nation-wide did not take place (Ajeyalemi, 1990). This was due, in part, to re-organisation and subsequent re-focussing in the NERC as well as lethargy on the part of both Federal and State Governments. Consequently, the implementation of the curriculum failed mainly because of the absence of qualified and committed teachers at that level. Primary school teachers at that time were 'generalist' Grade II certificated teachers, most of whom never studied any science because General Science in the Teachers Colleges was not a compulsory subject (Ajeyalemi, 1987). The situation has still not changed much; science is yet to be a compulsory subject in primary teacher education.

The current situation may, in fact, be worse, judging by the quality of Grade II teachers churned out by the National Teachers Institute (NTI) under its current Pivotal Teachers' Training Programme (PTTP), a crash programme under the Universal Basic Education (UBE) Project. In the PTTP, anybody, including artisans and local craftsmen, who has a minimum of three Passes in any three subjects in the Senior Secondary School Certificate Examinations (SSCE) is recruited as a teacher-trainee and rushed through a two-year (mostly weekend and distance learning) programme to qualify as a primary school teacher. That kind of teacher would be deficient in the science subject matter as well as in methodology. What kind of science is such a teacher expected to teach? With this type of primary science foundation, there is little hope for the nurturing of scientists in the post-primary institutions. Are we not paying a lip service to national development in this age of science and technology?

If our primary teachers were found wanting on the use of inquiry methods as recommended by the curriculum, they would certainly be found wanting with the current emphasis in contemporary science education, which is on the *constructivist* perspective to learning (Gunstone, 2002; Shapiro, 2002, Driver, 2002 & Klein, 2001). According to this perspective, learning is an active process involving the construction of meaning by the student as a

result of interaction between his/her current conceptions and on-going experience in an enabling learning environment created by the teacher and the student. The teacher, who must recognise and value the learner's personal approaches to learning, brings into instruction his own prior conceptions about the subject matter as well as his views of teaching and learning, which certainly influence classroom practice. Teaching is then more of a facilitation of the knowledge construction process than the dispensing of knowledge to a passive learner as is common in a lecture. Learning has taken place if there is conceptual change. Such change is achieved by the teacher getting the students involved actively in problem-solving, exploration, conjecture, invention, working in groups and learning to communicate scientifically. Our primary teachers are definitely incompetent in these strategies. If the teacher is incompetent in the prescribed subject matter as well as in relevant methodology, it is double jeopardy!

Science Teaching in the Secondary Schools

General Science was taught in the lower forms of the secondary school up to 1973 and before the implementation of the 6-3-3-4 system of education. With the introduction of the Nigeria Integrated Science Project (NISP) by the Science Teachers' Association of Nigeria (STAN) in 1972 into the secondary school, Integrated Science was taught in Years I & II, and is now taught in the 3-year Junior Secondary School (JSS). As it was in the contemporary science curricula, inquiry methods of teaching were recommended by the curriculum.

However, major problems have been observed about the curriculum and its implementation. First, is the criticism that the developers of the curriculum did not properly understand the concept of integration; aspects of the separate sciences were merely grafted together but not integrated in the real sense. In addition, the curriculum was not field-tested, no orientation of teachers took place and basic infrastructure and facilities were not installed before the curriculum was foisted on the school system. Thirdly, there were no teachers specifically trained for Integrated Science; most of the teachers teaching the subject were and are Biology teachers, who would naturally use the lecture method and most often, avoid teaching the physical sciences aspects of the curriculum due to their incompetence in the latter. Much of the content to provide adequate foundation for SSS science subjects is therefore left unattended.

At the 3-year Senior Secondary School (SSS), the separate pure sciences, – Biology, Chemistry and Physics, – in addition to Mathematics, Agricultural Science and Health Science, are taught. In a survey of some educational administrators and heads of science departments respectively, on the status of secondary school science teaching, Grant (1967) and Thollairathil (1973) had concluded that Nigerian science teachers favoured the lecture method and emphasised fact-finding and fact-acquiring. Similarly, in a discourse analysis of 10 Forms I and II science lessons, Durojaiye (1979) had found teacher-pupil ratio of talk to be 2:1, while the use of minor clauses by pupils predominated. Perhaps, this pattern of teaching might be due to difficulties experienced by the teacher as a second-language speaker of the English Language communicating science with its own technical and non-technical language (Cassells and Johnstone, 1977).

In subsequent studies of the teaching and learning of Biology and Chemistry, observed *in situ* in the upper classes of Nigerian secondary schools, Ugwu (1980) and Ajeyalemi (1981), respectively, concluded that the teaching of science in Nigerian schools was teacher dominated, didactic, textbook-bound and examination-oriented. In both studies, the Science Teaching Observation Schedule (STOS; Eggleston, Galton & Jones, 1975) was used to observe 53 Form IV Biology lessons and 69 Chemistry lessons respectively over a period of time, with a view to determining the language use and intellectual transactions occurring in the classrooms.

Furthermore, in a cluster analysis of the STOS data as well as a discourse analysis of a sample of the recorded lessons (Sinclair & Coulthard, 1975), *two typologies of science teaching, which differ slightly in their degree of didacticness*, were identified. Style A was extremely teacher-dominated, didactic and theoretical, while Style B

was a little problem-solving oriented, carried out some demonstration activities but still favoured more the lecture-discussion model of teaching (Ajeyalemi & Maskill, 1982; Ajeyalemi, 1987a). See Extracts of Style A and Style B's sample lessons in Figs. I & II.

FIG. 1: SAMPLE OF STYLE A's LESSONS – EXTREMELY DIDACTIC STYLE

TEACHER: 2 FORM IV

TOPIC: **Industrial Applications of Electrolysis**

Discourse Act.	
T. marker:	Now,
T. inform:	the industrial application would include (i) the electro-refining of copper (WRITES), industrial or simply uses of electrolysis, (i) the electro-refining of copper; we can also make use of electrolysis for electroplating, electroplating (WRITES) and we can make use of it to extract some metals and of course, obtain some non-metals. Now for the extraction of, extraction of metals and of course we can say this will include, this includes the preparation of (WRITES) some gases, like um, chlorine, you could make hydrogen or even fluorine.
T. marker:	Now.
T. metastatement:	We will start by um, you know, by discussing the electro-refining of copper.
T. comment:	now, this you know, process is very similar to um, on, you know, problem you were given during the exam., in which you were given a c ell, a voltameter and then you were asked to say which of the electrodes would, um, you know, decrease in mass.
T. marker	Now,
T. inform:	if the impure, um, mass, you know contains copper, it means the copper itself is impure.
T. check:	isn't it?
P. reply:	Yes (CHORUS)

T. marker — now,

T. inform — if we immerse such substance into an electrolyte and you use pure copper as the other electrode (WRITES), now the impure copper would be the anode.

T. starter: — and since it is the anode,

T. elicit: — to which of the electrodes, you know, shall we connect that impure, you know, copper to?

P. reply: — Ø (silence)

T. clue — is it to, you know, negative end of the battery or to the positive end?

P. reply: — positive end (CHORUS).

T. evaluate: — because we are making it the anode, therefore we should, you know, connect this to the positive end.

T. inform: — and the pure, you know, copper onto which the pure one of this impure would, you know, get deposited to, would be taken as the cathode, so this is the cathode, while this is the anode (WRITES) and then our electrolyte here would be, our electrolyte would be copper sulphate solution, copper sulphate solution.

T. marker: — now,

T. metastatement: — it is, what we need to do now is to explain how we can extract, you know, copper from this impure, you know, copper.

T. inform: — this is the impure copper, now the pure form of the copper here gets out of it and then deposits itself onto this pure copper, now this is, you know, pure copper which is serving as the cathode.

T. marker: — now,

T. metastatement: — what you need to do at this stage is to explain what happens at the electrodes.

T. marker: — now,

T. inform: — what happens, what would happen at the, anode, um at the anode, at the anode, now the copper would dissolve into the solution and it would become ions with, you know, liberation of two electrons and then the copper ions would then move, you know, towards the cathode, the copper ions would gain electrons

to become copper, so that the copper which is dissolved out of this impure copper would be transferred to this pure, you know, copper, which is serving as the cathode.

T. check: — is that clear to you?

P. reply: — Yes (CHORUS)

T. marker: — now,

T. conclusion: — that's one way of making use of the knowledge of electrolysis, um, electro-refining of copper.

T. marker: — now,

T. inform: — we could also make use of electrop0lating of (WRITES) electroplating, now this electroplating, now this electroplating of course is the electrical, you know, precipitation of one metal on another to secure improved appearance, it's the electrical precipitation of one metal on to the other to improve appearance; this is if a company is selling, um, spoons, you know, um, for instance, the erm, um, you know, producing forks, and you know, and um, you know, cutlery in, in general and originally they discover that the, the colour, the surface of that spoon or the cutlery is not attractive enough and therefore, you know, they are not making enough sales from their products just because of the appearance of the cutleries and then, you know, they decided to change the colour from red , you know, copper would give this red appearance, or brownish and then they decided that they would change the, you know, surface colour from, from the reddish-brown to silver, you know, to the, um, silvery appearance; now what they would simply do is to electroplate, you know, generally it's easier to electroplate any substance, you know, which is made from copper, now to explain that you would need a bath, may be

T. marker: — now,

T. metastatement: — I would start by explaining how we can make, how we can, you know, copper-plate any substance, how we can, you know, copper-plate any substance. Co----, co--- how we can copper-plate any substance.

T. comment: — that is, you want a substance to be covered up with, you know, copper, thin layer of copper.

T. marker: — now,

T. inform:	we would simply use copper, you know, plating bath, the copper-plating bath is any, you know, copper solution and the copper solution which we can use conveniently is copper sulphate, now we would make the, um, the pure anode, impure copper as the anode. Now if this is our anode, what we want to copper-plate would hang into the solution, we would make, you know, whatever we want to copper-plate; assuming these are the materials (USES A PIECE OF CHALK AND DUSTER TO ILLUSTRATE), you know, we want to copper plate now (WRITES).
T. marker:	Now,
T. inform:	this is serving as the anode, this is the anode and this is the cathode. (PUPILS GRUNT).
T. check:	I don't know whether, you have, you know, tried to understand what I am trying to explain.

FIG. 2: SAMPLE OF STYLE B's LESSONS – SLIGHTLY PROBLEM-SOLVING STYLE

TEACHER: 6 FORM: IV

TOPIC: **Determination of the Solubility of Copper (11) Sulphate**

Discourse Act	
T. marker	Now,
T. metastatement:	we prepared, yes, we prepared the saturated solution; the first step is to prepare the saturated solution.
T. starter:	we prepared it and then we filtered it, we got a clear solution.
T. elicit:	what's the next step?
P. reply:	weigh a clean, dry evaporating dish.
T. evaluate:	ya, weigh a clean, dry evaporating dish.
T. starter:	this is the evaporating dish.
T. elicit:	what do we remember when we are weighing?
P. reply:	it should be clean, empty and dry.
T. clue:	it is clean and empty and dry, what about the balance?
P. reply	we take the first reading of the balance.
T. evaluate:	yes, you have to take the first reading of the balance.
T. elicit:	Can you read it?
P. reply:	110, 130.
T. clue:	it's not 130.
P. reply:	110, it's 110.
T. accept:	she says 110.
T. inform:	you have to tilt slightly because we are now going to take a bigger evaporating dish, so it will be heavy.
T. elicit:	what's the weight now?

P. reply: 200

P. reply: no 190

P. reply: 200 (CHORUS)

T. loop: it's 200 exactly?

P. reply: it's not (CHORUS)

T. clue: it's more than 200.

P. reply: 210

P. reply: It's not; 205

T. clue: it's between 200 and 210

P. reply: 205 (CHORUS)

T. accept: So let's take 205.

T. marker: Now,

T. inform: what do we do? We have to take saturated solution into the beaker and we find the weight (PAUSE) teacher weighs solution).

P. inform: 225

T. evaluate: it is the line between second and the third one, the pointer between second and the third line.

T. elicit: it's 2.....?

P. reply: 25 (CHORUS)

T. evaluate: it's 225, the value is 225.

T. elicit: What do we do next?

P. reply: filter it

T. nominate: NV

P. reply: weigh it, that's where we stopped.

T. clue: what do we do next, we have weighed the evaporating dish.

P. reply: we filter the mixture.

T. evaluate: we have filtered.

T. clue: We weighed the evaporating dish with the saturated solution inside it, we weighed it, the solution is inside it, what do we do next?

P. reply: evaporated it (CHORUS)

T. evaluate: we have to evaporate to get the solute back.

T. elicit: first, we have to heat strongly or slowly?

P. reply: strongly

T. evaluate: you have to heat strongly at first and then slowly (PAUSE T. prepares to heat).

T. direct: Open the gas tap.

P. react: NV

To inform: it should be heated strongly and then when the solute begins to appear, we have to heat slowly.

T. nominate: Guanta,

T. direct: write down the weight on the board, those we have measured.

P. react: NV

P. elicit: we didn't measure this, the first reading of the balance.

T. reply: we weighed it first

P. clue: the weight of the balance, I mean

T. reply: the first reading was 130.

P. inform: no, 110

T. accept: 110

T. starter: then we weighed the evaporating dish.

T. elicit: the reading was?

P. reply: 205 (CHORUS)

T. accept:	205
T. elicit:	the difference between the two will be?
P. reply:	95
T. evaluate:	ya, that will be the mass of the evaporating dish.
T. metastatement:	we will come to that one later.
T. direct:	put down the unit.
P. react:	NV
T. evaluate:	it's not weight of the balance, initial reading;
To comment:	this is weighed, it is the reading, that's not the mass.

None of the lessons encouraged active participation of students in laboratory activities. In earlier studies, using the STOS, three different styles of teaching were found In British science classrooms (Eggleston, Galton &Jones, 1976) and two in Canadian science classrooms (Hacker, Hawkes & Hefferman, 1979). The Nigerian Styles A and B contrasted sharply with the experimentally-biased, heuristic and pupil-centred Style III teaching pattern found predominantly in British classrooms, but compared favourably with the British Style II and the Canadian Style A. However, the Nigerian Style B shared some characteristics with the British Style I and Canadian Style B in its problem-solving orientation and larger pupil participation.

In the middle 1980s, new science curricula, derived mainly from the science curriculum reform efforts of the Western countries in the 1960s and 1970s, were introduced into the junior and senior secondary schools to meet the requirements of the 6-3-3-4 system. A common thread in the different science curricula is the emphasis on teaching science as 'what science is' and 'how a scientist works' and consequently the recommended use of the guided-discovery teaching approach. Also, the contents were up-dated to serve as adequate foundation for advanced studies in science. But as usual,

a very limited effort at re-orienting the serving teachers (who had been found to be consistent in the lecture-recitation pattern of instruction) was made by the Federal Ministry of Education (FME) before the installation of the curricula in the school system. Very few teachers got exposed to how to teach the new curricula in the summer Orientation Workshops (1986-89) organised by the FME after the curricula had been installed. That is, most of the teachers were and are still incompetent in the use of the recommended guided-discovery method as well as in teaching some of the content introduced into the curricula.

In summary and as observed above, the major problem of implementation at the JSS level is the inadequacy of qualified teachers of Integrated Science; most of those teaching the subject are not competent to teach it. This further reinforces the weak foundation brought from the primary level. The problems continue at the SSS level. A majority of the teachers are incompetent and unqualified to teach any of these curricula as expected (Adeyegbe, 1993). Many of them are, in fact, not professionally qualified in their subjects. These, coupled with over-crowded classrooms and the unavailability of necessary laboratory and other instructional facilities, including technical support personnel in many public schools, have made the achievement of the desired objectives impossible. Teachers at the SSS level still use the lecture method predominantly instead of the recommended guided-discovery and students still learn science mainly by rote and not by 'doing'. During examinations, the student regurgitates the memorised content to pass. Perhaps, teachers' poor performance may also be attributed in part to the poor reward system for their labour and the low esteem in which society holds them. All these combine to lay a weak foundation for capacity building in the sciences in the post-secondary institutions.

Our Efforts at Improving Science Teachers' Performance

At this juncture, it will be pertinent to discuss some of our own efforts at helping the science teacher overcome the persistence of the lecture-recitation pattern of instruction as well as improve on students' performance in science. In an experimental study, Ajeyalemi and Lawal (1987) found that teaching English for science and through science, in an activity-oriented learning environment enhanced students' achievement in both Integrated Science and English Language. The study was designed to examine the possibility of ameliorating the difficult problem of teachers' communicating science to students in second-language situations as in Nigeria. Also, it has been shown that students' achievement in science will be enhanced if the lecture method were to be used but the teacher structures the learning content such that concepts, discriminations and principles were taught before the complex ones (Gagne, 1962; Ajeyalemi, 1987b).

Alonge (1986) had reported that large class sizes did not adversely affect students' performance in Chemistry while Okebukola (1985) had found that promoting teachers' use of co-operative interaction strategies would strengthen students' performance in science classes. Ajeyalemi and Busari (1986) had also found that in spite of the adequate provision of necessary instructional facilities, many Chemistry teachers still persisted on the use of the lecture method. It was then decided to investigate some other factors, which may be intervening to make teachers behave as they do in the classroom. Thus, Ajeyalemi and Busari (1989) were able to show that the teacher's cognitive style is a major determinant of his/her teaching behaviour. Teacher education may therefore need to identify the cognitive styles of prospective teachers with a view to planning programmes for widening the perceptual modes of trainees, so that they could cope with students of differing cognitive styles.

Some Ph.D. theses I supervised in this University have also contributed in this regard. Busari (1991) investigated the effects of varying four instructional strategies in different combinations on students' cognition in Chemistry. It was found that if teachers would combine concept mapping and problem-solving strategies with guided-discovery, students would perform significantly better than if exposed to concept mapping/problem solving/lecture combination or to any of these methods (the guided-discovery, lecture method, concept mapping and problem solving) singly. That concept mapping is a better strategy in science classes than the lecture

method confirms earlier findings by Okebukola (1990) on the efficacy of the strategy to promote students' performance in biology and meaningful learning of Genetics and Ecology, respectively. As for Nwosu (1995), having diagnosed the indices of teachers' ineffectiveness in school Chemistry, some strategies were designed and used for remediating the ineffectiveness. This indicates that if conscious efforts were made in teacher education to involve teachers in other strategies continuously, it is possible to influence them away from the lecture method.

In order to provide a concrete context for one of our Core Courses for student-teachers, 'Curriculum Theory and Development', the Department of Curriculum Studies of this University introduced another course 'Curriculum in Subject Areas', i.e., Curriculum in Physics/Chemistry/Biology for the sciences. That course involves, among others, a comparative analysis of curricula in the different subjects and their development world - wide. Very few, if any, of the curricula considered in the course were African in origin. As a Visiting Lecturer to the University of Zimbabwe (1988/89), I decided to bridge this gap in knowledge about science curricula in African countries by embarking on a Book of Readings project involving seeking contributions from experts in different African countries. Contributions from only seven sub-Saharan African countries were however, received. The efforts culminated in the publication of the book "***Science and Technology Education in Africa: Focus on seven sub-Saharan countries***" (Ajeyalemi, 1990a). The Carnegie Corporation of New York sponsored the publication and world – wide dissemination of the book, for which I am eternally grateful.

As a Fulbright Professor at the Science Education Center, The University of Iowa, Iowa City, U.S.A. in 1990, an effort was made to study exemplary science teachers in American classrooms in an attempt to enrich our Science Education offerings for Nigerian student-teachers. This was made possible through serving as a Resource Person in various Workshops of the NSF-sponsored *Iowa Chautauqua Project on the Teaching of Science in a Science/Technology/Society (STS) Context.* The teaching strategies employed *by exemplary teachers* in the STS classrooms help to promote creativity, acquisition and use of knowledge and process skills of science, positive attitudes, problem-solving and decision-making. These skills have since been infused into our methodology courses and many students' projects have been steered towards preparing STS teaching packages based on our curricula in the last couple of years. However, the rigidity of our centralised curriculum system makes the adoption and utilisation of such innovations difficult.

What is clear from all these efforts is that the teacher is the main actor in the successful implementation of the science curriculum and that current teacher preparation programmes (pre- and in-service) are not meeting the desired objectives. Revisions in the current teacher education programmes, especially for meeting the objectives in the new millennium are therefore imperative.

Government and Other Agencies' Efforts at Promoting Science Education

In spite of the fact that all has not been well with science education in Nigeria, it will be uncharitable not to mention some positive efforts of the Governments, particularly the Federal Government, at promoting science education for capacity building. The 60:40 Science to Arts admission ratio policy for universities is worthy of mention. Other Government policies regarding education and science are as set out in the National Policy on Education (1977, revised 1981 and reprinted, 1998) and the National Policy on Science and Technology (1988). Some of the strategies suggested for improving science and technology education in the Policy on Science and Technology include:

- manpower development and re-orientation of the educational system to emphasise science at all levels;
- popularisation of science to orient the entire society towards science and technology; and

motivation and reward structure to attract and retain a substantial percentage of the society in the mainstream of science and technology

In an attempt to realise some of these objectives, the Federal Ministry of Science and Technology in 1988 collaborated with its Education counterpart to launch in schools the Junior Engineers, Technicians and Scientists (JETS) Clubs and to stage Youth Science Fairs and Competitions. This is commendable, but then the Ministry has since pre-occupied itself with the supervision of its parastatals including about 50 Research Institutes while neglecting its responsibilities for promotion of science and technology education in the nation. Perhaps, the Ministry of Science and Technology can contribute more to science education by sponsoring an organisation as the National Science Foundation (NSF) in the U.S.A., which funds research and development in science and technology education.

Also, the Federal Ministry of Education has set up in each State, Unity Secondary Schools that are well equipped and staffed for science and technology to serve as models for other proprietors of schools. Improvisation and the local production of science equipment and materials are also promoted through the Federal Science Equipment Centre. Similarly, some States' Ministries of Education have set up specially equipped Science Schools, while some others pay a special science allowance to teachers to motivate them.

Particular mention must be made of the contributions of the Science Teachers' Association of Nigeria (STAN) to the promotion of science and technology education in Nigeria. The STAN was responsible for spearheading science curriculum reform in Nigeria through its Curriculum Development Committees in the early 1970s. The Association's Nigeria Integrated Science Project (NISP) has already been mentioned. It must be stated that the current SSS curricula in the sciences were derived from the earlier syllabuses developed by the STAN. These syllabuses were taken over by the Comparative Education Study and Adaptation Centre (CESAC) for full development into the Nigeria Secondary Schools Science Project (NSSSP), the precursor of the new SSS curricula.

The STAN, the largest Subject Association in Nigeria, has continued to influence science education policy in Nigeria through its activities. In addition to its Annual Conferences, which bring on the front burner, issues affecting science and technology education, STAN produces curriculum materials (student text and workbooks, teacher's guides, supplementary readers, etc.) and organises annual Science Fairs and Quizzes (now sponsored by Mobil Producing Unlimited). Also, the Association provides continuous education for science teachers through the organisation of annual Workshops by the different Subject Committees. Many of such Workshops are devoted to helping teachers learn how to teach many of the difficult topics in the different subjects and feedback has shown that they have been valuable. However, participation by most teachers in the Workshops has been hampered by their inability to secure sponsorship from their employers.

What is not in doubt is that teachers need continuous capacity building, such as provided by the STAN, which would promote their effectiveness and commitment to the job. Most of the other efforts by Government and other agencies are bound to fail, if the teacher factor is ignored. However, from the way education generally, and teachers in particular, are being treated by the various tiers of Government, it may seem that Government is merely paying lip service to education and to the promotion of science and technology education, in particular.

Tertiary Science Education

It is not a surprise, therefore, that very few candidates elect to study, as 1st and/or 2nd Choice(s), the Pure Sciences and Education Science in Nigerian universities (see Table 3 for example). Table 3 shows the pattern of choice of courses by UME candidates at the University of Lagos in the last three academic sessions. While 3,030, 2594, 2,240, 1,753, 1,582 and 2,340 candidates respectively opted for Medicine & Surgery, Accounting, Economics, Business Administration, Law and courses in Engineering as 1st Choices, the

total number that chose Pure Science Courses and Education Science were only 874 and 38, respectively. It should be noted that of the 874 for all Pure Sciences, 713 chose Computer Science and the remaining eight courses shared the balance of 161. Also, for Education Science, 17 of the 38 candidates were not for the 'pure sciences' but for Geography, Physical Education and Health Education.

TABLE 3

PATTERNS OF CHOICE OF SOME COURSES AT THE UNIVERSITY OF LAGOS, 2000 – 2003.

FACULTIES/DEPARTMENT	2000/2001		2001/2002		2002/2003	
	1ST Choice	2ND Choice	1ST Choice	2ND Choice	1ST Choice	2ND Choice N/A
ADMINISTRATION						
ACCOUNTANCY	776	220	2,594	1,906	3,921	
BANKING /FINANCE	233	264	948	1,963	1,622	
BUS. ADMIN. & MGT.	440	264	1753	2,611	3,229	
INDUSTRIAL REL./PERS MGT.	138	161	437	849	1,039	
	1,587	**909**	**5,732**	**7,329**	**9,803**	
EDUCATION (SCIENCE)						
BIOLOGY	-	-	2	4	2	
MATHEMATICS	-	5	2	8	9	
PHYSICS	-	5	2	7	4	
CHEMISTRY	2	2	-	2	5	
GEOGRAPHY (SINGLE/COMB.)	-	-	-	2	2	
PHYSICAL & HEALTH EDUCATION	1	-	3	8	3	
HEALTH EDUC.	-	-	4	7	8	
	3	12	13	38	33	

FACULTIES/DEPARTMENT	2000/2001		2001/2002		2002/2003	
	1ST Choice	2ND Choice	1ST Choice	2ND Choice	1ST Choice	2ND Choice
ENG. /TECHNOLY/ENV. DESIGN						
CHEMICAL ENG.	325	132	900	783	879	
CIVIL ENG.	37	44	142	305	183	
ELECTRICAL ENG.	222	88	658	589	697	
MECHANICAL ENG.	192	88	539	663	662	
	776	**342**	**2,239**	**2,340**	**2,421**	
LAW (CIVIL)	**623**	**220**	**1,582**	**1,220**	**1,977**	
SURGERY (DENTAL)	14	88	42	289	132	
MEDICINE/SURGERY	122	220	30	1,652	3,178	
MEDICINE	**136**	**308**	**3,072**	**1,941**	**3,310**	
PHARMACY	**159**	**264**	**281**	**1,725**	**597**	
PURE SCIENCES						
BIOCHEMISTRY	17	44	47	318	105	
BIOLOGY	1	9	6	10	16	
BOTANY	-	-	3	8	5	
CHEMISTRY	6	44	14	96	61	
COMPUTER SCIENCE	179	88	713	775	954	
MATHEMATICS	-	39	25	102	76	
MICROBIOLOGY	17	44	62	262	109	
PHYSICS	10	34	-	53	36	
ZOOLOGY	-	6	4	9	5	
	330	**308**	**874**	**1,633**	**1,369**	

FACULTIES/DEPARTMENT	2000/2001		2001/2002		2002/2003	
	1ST Choice	2ND Choice	1ST Choice	2ND Choice	1ST Choice	2ND Choice
SOCIAL SCIENCES						
ECONOMICS	666	220	2,240	1,837	3,261	
MASS COMMUNICATION	251	220	861	1,812	1,206	
	1,104	**748**	**4,038**	**5,245**	**4,467**	

N/A: Not Available

It is an open secret that the relatively large enrolment figures for the Pure Sciences in Tables 1 and 2 are mainly made up of seeming **'rejects'** from other more lucrative courses (Medical Sciences, Pharmacy, Engineering and Environmental Sciences). That is, the most able products of the 'limited' secondary science would normally elect to read the Science-based courses, which lead to the professions. Enrolment in these professions is controlled and training is longer, more rigorous and monitored by the professional bodies, thus, ensuring higher quality.

For the Pure Sciences, the relatively large increases in enrolment have not been matched with improvements in teaching infrastructure, equipment and facilities. Thus, the lecture rooms and laboratories are over-crowded and the necessary practical activities, including student projects, are often not carried out. For example, the classrooms and laboratories in the Faculty of Science of this University designed for less than 200 students in the early 1980s are still the ones available for the current 1-2000 students enrolled. In addition, the incessant strikes by the academic staff as a result of disenchantment with the quality of their working environment and their welfare scheme do not induce the required commitment and innovation from them. Teaching is, of course, by the familiar "lecture method". That is, it is more of theory than practice and students still memorise to pass examinations. This, coupled with the very poor quality of student intakes into science courses, makes the graduates to be of very poor quality and hence, unsuitable for employment as observed by the National Rolling Plan 2000-2002.

Science Teacher Education

For Science Teacher Education in the tertiary institutions (Colleges of Education, the universities and some polytechnics), the situation is even more pathetic. It is most often **"the bottom of the barrel"**, who in most cases have scored 200 and above in the UME, but who could not secure admission into any other course, including some *'further rejects'* from the Pure Sciences, that eventually get admitted into the programmes (the four-year programmes of the Faculties/Institutes of Education or the three- or four-year courses of the Colleges of Education). That is, most of the candidates **reluctantly choose** to train as science teachers. As a matter of fact, most consider the offer of admission as a stepping-stone into other courses. At the slightest opportunity after the 100 or 200 level, such reluctant teacher-trainees opt for transfer into other courses in other Faculties, thus depleting the stock of teacher-trainees. In addition, while most of the intakes into Teacher Education courses up to the mid-1980s were mature and more committed to training as teachers, many intakes are now much younger, confused about a career in teaching and more of neophytes in the kind of personality expected of a teacher.

Within the Science Teacher Education programme itself, the majority of the candidates opt for Biology Education because they consider it a soft option. Some others settle for Mathematics Education because they did not pass more than one other science subject at Credit level in the O' Level examinations, while very few with the three Science subjects at the O' Level offer Chemistry Education and still fewer Physics Education. Of course, as in the computer science maxim, it is *"garbage in, garbage out"*!!! How much quality teaching can we expect from such *reluctant* trainees on graduation?

Structure and Quality of Science Teacher Education

The quality of the Teacher Education programme itself leaves much to be desired these days. In the 1960s, a graduate science teacher only became professionally qualified when he/she had obtained a PostGraduate Diploma or Certificate in Education (PGD/CE) after a degree in a science subject. This ensured competence in the subject matter prior to training as a teacher. With the shortage of science teachers in the system, however, the Federal Government introduced a Crash Programme for the training of science teachers in the early 1970s leading to the beginning of the B.Sc. Educ. (Hons.) degree programme, in addition to continuing with the PGDE. In order to encourage enrolment into the Science Education programme, a monthly stipend was paid to the intakes. This Lecturer was a beneficiary of that programme!

In 1973, I enrolled for Chemistry Education as a Direct Entry candidate for the B.Sc. Educ. (Hons.) degree in this University. From then till the mid-1980s when the Unit Course system was introduced into the universities, a Year I science student-teacher took two science subjects, a Principal and a Subsidiary subject. In the Principal subject, the student-teacher was exposed to the same content and laboratory activities (including Final Year Projects) as a Pure Science student, in addition to the Education courses. By the Second Term of the Final Year, he/she dropped a few specialist courses in the Principal subject to allow for more Education courses as well as another Project in Education. **Some of us in Science Education, including my humble self, were in fact entreated, to no avail, to cross over into the Pure Sciences because of our superior performance over the Pure Science students.** The Subsidiary subject was also studied fully up to Year II of a three-year programme, such that the graduate from the system was able to teach the Subsidiary subject even up to the School Certificate level. Most of the graduates from the programmes were therefore competent in the subject matter they were to teach.

In terms of professional development, student-teachers were involved in classroom observation, micro - teaching and Teaching Practice in the schools lasting a minimum of 12 weeks in addition to the relevant Education courses. The Teaching Practice, which was well planned and supervised, occurred during the holidays; of course, there was a stable Calendar for the universities! There was generally a better monitoring of standards and a sense of commitment on the part of student-teachers.

This scenario has since changed. With the introduction of the Unit Course system and in conformity with the National Universities Commission's (NUC) Minimum Standards, a science student-teacher now majors in a Principal Science subject and takes a few units in another Science subject only up to the 200 level. Most often, the science courses are taken from the Faculty of Science, which often discriminates against Education students. Even in the Principal subject, the student-teacher, at best, takes all courses up to the 300 level and a maximum of 12/14 Units at the 400 level. For example, in most Faculties of Education, a Biology Education student in a four-year degree programme may not take more than about 60 Units of the Principal (Biology), 21Units of Faculty of Science courses from Mathematics, Physics and Chemistry at the 100 level, and 14 extra Units of Chemistry (up to the 200 level). His/her Pure Science counterpart in Botany or Zoology, on the other hand, takes about 81Units of the Principal subject. With the very poor quality of the intakes and the incessant strikes embarked upon by the various Unions in the system, not much of that 'limited' content is covered; thus, very few of the trainees graduate and mostly with poor grades. With the best of training in methodology, such a graduate cannot be as competent in the teaching of even the Principal subject at the secondary level, let alone confident to teach the Subsidiary subject to any class appreciably. You can only teach what you know!

While the student-teacher is still exposed to the theoretical courses in Education, the practical professional development has deteriorated. Very little school observation takes place, micro-teaching is hardly done and the once revered Teaching Practice now effectively lasts between six to eight weeks in a four-year programme. Training in the preparation and use of even the traditional instructional materials and equipment has suffered due to obsolescence of the equipment and inadequate funding, let alone training in the use of contemporary Information, Communication and Technology (ICT) materials. The quality of preparation for, supervision and monitoring of the practical activities has also deteriorated.

This is due, in part, to the fact that the Faculty of Science may not be inclined to co-operate with the Faculty of Education, especially in the scheduling of the Teaching Practice. Perhaps due to the rigidity in the organisation of academic programmes and the instability in the University Calendar, the Faculty of Science would normally continue to schedule its lectures for all students irrespective of the pre-occupation of Education students with Teaching Practice. Other contributing factors include the unavailability of science instructional materials in schools and in the Faculties of Education, the poor quality and low productivity of some of the lecturers due to

poor attitude to work, the general low morale of lecturers and the unstable University and school Calendars. Also, very little interaction and co-operation occur these days between the academic staff in the Faculties of Education, the co-operating teachers in the schools and generally the school system.

In summary, the result is that the universities churn out every year 'quarter-, or at best, half-baked' graduate teachers into the system, many of whom are unemployed because of their poor quality and/or the prevailing economic situation of the nation. Those who get employed cannot teach effectively and the vicious cycle continues. The implications for capacity building in the sciences are obvious. "No education system can rise above the quality of its teachers" (National Policy on Education, 1998; p.33).

Conclusions and Imperatives for Teacher Education in Nigeria

Mr Vice Chancellor, Sir, from the foregoing, it is clear that, even with limited resources, a well-trained and good science teacher can still make things happen in the science classroom. At least with a good personality, competence in the subject and the relevant methodology of science teaching, including capability to improvise some equipment and materials, he/she can make his teaching effective. Extrapolating from the situation at the University of Lagos for secondary teacher education, the NTI programmes for primary and UBE teachers and the near total absence of in-service education provisions, we can conclude that all is not well with Teacher Education in the Sciences in Nigeria. In fact, for about two decades now, the Teacher Education curriculum in Nigeria has remained the same. In this new millennium and with globalisation, there is therefore a need to rethink Teacher Education and Science Teacher Education in particular.

Mr Vice Chancellor, Sir, the following recommendations aimed at improving quality in pre- and in-service teacher education, are what I call some of the "***Imperatives for Teacher Education in Nigeria***":

1. **Making Science a Compulsory Subject in UBE Teacher Preparation.** The primary teachers, who are being trained

by the NTI as 'generalist' teachers should be empowered to teach science to their pupils by making Integrated Science compulsory for all students throughout the course. It may be argued that not all trainees may be endowed to learn science. In the alternative then and since NCE has been recognised by the National Policy on Education, teachers who specialise in different subject groups at the N.C.E. Primary level (e.g., Maths and Science, English and Social Studies, etc.) but could still teach some other subjects should be introduced into the primary schools.

This has implications for the improvement of the quality of teacher education curriculum at this level and the quality of the teacher-trainers engaged by NTI and the Colleges of Education. Most of the trainers would normally come from the secondary teacher education stock. Currently, many universities do not offer Integrated Science Education as a degree programme. It is therefore imperative that all universities be mandated and funded to run a degree in Integrated Science Education, emphasising its teaching at the primary and JSS levels. The University of Lagos Senate recently approved such a programme for my Department and the first set of students will be admitted for the 2002/2003 Session.

2. **Introduction of a 'Teacher Certification' system into Pre-Service Education.** In order to improve on the competence of the secondary school teachers in both subject-matter and methodology, it is imperative to increase their exposure to content in Science and professional courses in Education. This is impossible with the present structure of the B.Sc. Educ. (Hons.) degree programme. It is therefore proposed that the structure be modified such that student-teachers take all Science courses in two (2) allied subjects (e.g., Physics/Chemistry, Chemistry/Biology, Maths/Physics or Chemistry, either of Chemistry or Physics or Biology /Integrated Science) as the Pure Science students up to the

300 level as well as Education courses. The Education courses will not include Teaching Practice but emphasise school observation and action research between the co-operating teacher and the student-teacher. At the 400 Level, courses in only one Science subject and Education will be taken. This will ensure both *horizontal flexibility* (competence in two subjects for teaching them at the same level) and *vertical flexibility* (competence to teach at both the junior and senior secondary).

The student-teacher will then graduate with a degree but will not be "certified" to teach until supervised practical teaching in a school lasting a period of one academic year. That is, the teacher would only be licensed to teach after the certification process and with certification, the training programme will now last five (5) years as for other professions. The Ministry of Education of a particular State where the University is located and the University Faculty of Education will jointly supervise the certification process. This means that each State will have a *Teacher Certification Board*, which will work in collaboration with the National Teachers' Registration Council for the certified teachers' registration. Of course, the Certification system will be for all teachers, science or non-science and will encourage the much-sought professionalisation of teaching. To ensure continuing relevance and competence, every registered teacher must submit himself/herself to re-certification every five years. This will make it imperative for employers of teachers to make the teachers avail themselves of every opportunity for continuing education.

3. **Promotion of ICT-Based Teacher Education.** As we are in the era of information and globalisation, teacher education programmes for any level of education must be empowered to provide Information, Communication and Technology (ICT) – based training for the student-teachers. That is, if the importance of teacher education in the production of relevant

manpower for national development were recognised, it should be a priority for every teacher education institution to be linked to the information highway. This will make it possible for their trainees to be exposed to how to teach through and with such ICT materials. Already, the NTI is investing in such technology to promote its distance education programme, but it is doubtful if that organisation considered the objective of ICT-based teacher training in its planning.

The University of Lagos should blaze the trail here by providing the Faculty of Education with a Computer laboratory and other ICT materials needed for the training of the teachers for the new millennium This will also enhance the implementation of the B.Sc. Educ. (Hons.) Computer Science programme planned by the Department of Curriculum Studies, but still awaiting the Administration's approval. A Computer Science Education programme will contribute immensely to the production of qualified teachers for implementing the nation's Computer Education Programme for Schools

4. **Improving the Quality of Pedagogical Courses.** For the science teacher to 'know more' and be above the level of his students, teacher education must make the trainee go through the relevant curricula for his/her students. Especially in science teaching, the student-teacher must be made to carry out and master all the practical activities, including projects prescribed for his/her students in the curriculum. Faculties of Education must therefore be provided with well-equipped science laboratories for this purpose. **In this regard, I like to publicly acknowledge the efforts of the immediate past and present Administration of this University at restoring the science laboratories in our Faculty; the past Administration constructed the laboratory and office block and the present is about to complete its furnishing and equipping**. We pray that the efforts be sustained.

A thorough review of all the theoretical courses in Education (many are out-dated) is needed to reflect the challenges of the new era of information and globalisation. Pedagogical courses must include involvement of the student-teacher in extensive classroom observation and action research, in collaboration with the co-operating teacher, aimed at solving practical instructional problems. This will encourage partnerships (which are now lacking) between the Faculties of Education and the school system.

The improvement of communication skills of the trainee, including writing, is another major point for consideration in the improvement of pedagogical skills. Most teachers are not competent in ordinary day language use, let alone the language of instruction. Thus, they are unable to communicate the subject matter effectively, especially in science with its unique technical and non-technical registers and are particularly inefficient in training the students in higher-order skills. Apart from the general Use of English course for all students, a special Communications Skills Course for Teachers, designed and taught by lecturers in English Education, should be offered for all student-teachers.

5. **Encouragement of Admissions into Science Teacher Education.** As the future of any nation depends on the quality of its education system, "only the best and the willing should be recruited into teaching" as recommended by Ejiogu (1998). However, we have shown here that choice of Science Education as a career by prospective candidates in the universities and Colleges of Education is at its lowest ebb. In fact, Science Teacher Education is now for the "bottom of the barrel" among candidates seeking admission. This is not unconnected with the teachers' poor service conditions and their low status in the society. A conscious effort by the nation at encouraging more candidates to seek

admission into Science Education is therefore imperative if Science Education is to be sustained in the primary and secondary schools and if the nation would develop scientifically and technologically. The implementation of the proposed Teachers' Salary Scale with other special inducements for science teachers may be an incentive.

Perhaps, a re-introduction by Government of the Crash Programme of the early 1970s, involving the payment of special allowances to registered science student-teachers may be the panacea in order to attract competent/suitable and not the 'reluctant' candidates. This may encourage UME and Direct Entry candidates to want to choose teaching. Also, if the employers (Governments and the private sector) insist on recruiting and keeping in employment only professionally qualified teachers, many of the unqualified teachers will seek up-grading courses.

6. **Encouragement of In-Service Education for Science Teachers.** The importance of continuing education for all personnel cannot be over-emphasised. It becomes more important for science teachers especially if it is realised that they need to be up-to-date in their knowledge and skills because science knowledge is tentative, dynamic and prone to obsolescence while new techniques, equipment and skills are introduced regularly. The initiative taken by the STAN should be supported by the Governments through sponsorship of large numbers of their teachers to the Workshops. In addition, an annual allocation should be made directly to STAN by the Federal Government to encourage more and regular in-service workshops for the science teachers.

7. **Empowerment of College of Education Lecturers.** Most of the Lecturers in the Colleges of Education nation-wide would not have had more than the Masters degree, particularly the M.Ed., in their respective subjects. Many of

the graduates of the Masters programme are those responsible for teaching the content in the Colleges as well as teaching the subject matter in the school system. We have shown earlier in this Lecture that majority of the College Lecturers and school teachers may not be competent in their Teaching Subjects from their Bachelors' degree programmes. Thus, the student-teachers in the Colleges are not likely to be competent in their teaching subjects; and the vicious cycle would likely continue when they go to teach the content at the JSS and/or SSS.

In order to enhance such Lecturers' or school teachers' competence in the subject-matter, as the Ag. Head of Department from 1992-1994, I initiated and the University Senate approved, that it is mandatory for all M.Ed. students (science and non-science) to offer and pass at least six Units of content at the Masters level in their Teaching Subjects before graduation. This is recommended to all the universities offering the M.Ed. programme in Curriculum Studies or Teacher Education to improve students performance in the JSS and SSS. It may in fact be necessary to increase the number of Units of content at this level with time.

8. **Establishment of a Capacity Building Initiative for Science in Nigeria (CABISIN).** Even with all the problems with science education from the primary to the tertiary level in Nigeria, some students can and still do well in the sciences. These, if identified and nurtured well, can provide the critical mass for science and technology development in Nigeria. An initiative for the identification and nurturing of such citizens right from the early secondary school classes is advocated here as a joint effort between the Ministries of Education and of Science & Technology. Such an activity happens continually even in developed countries. If such students are identified, say from the JSS3 Examinations in Integrated Science, Introductory Technology, Mathematics and English

Language, a Science and Technology Learning Enrichment Programme (STLEP) can be planned for them at every vacation. This will, of course, be institutionalised, funded by the Governments and supported by industry. The National Science Foundation and industry fund such programmes in American universities.

Staff in appropriate Faculties of Education will enrich the science learning of students in the Programme through various activities. These will include remedial teaching of some identified difficult topics in science subjects; exposure of the students to the frontiers of knowledge and research in the sciences and technology in universities, research institutes and in industry; applications of ICT materials and techniques in learning of science and technology; field-trips, visits and excursions to places of scientific and technological interest; science projects and follow-up activities during term -time. The students' progress will be monitored vertically and longitudinally up to installation in employment after graduation from a degree programme.

9. **Prioritisation by the Nigerian Academy of Sciences, Science Association of Nigeria and Nigerian Academy of Education.** Promotion of Science Education at the primary and secondary school levels should be the priorities of the Nigerian Academy of Sciences (NAS) and the Science Association of Nigeria (SAN) if they want to promote capacity building in the sciences in Nigeria. Such is a major priority of the American Association for the Advancement of Science (AAAS); see its Project 2061, for example. About three weeks ago, the NAS advertised that its Quarterly Forum meant for all stakeholders in Ibadan, would be on 'Capacity Building in Science and Technology for Sustainable Development'. I could not attend this Forum because of other official engagements.

However, since the Academy has always concerned itself only with encouraging promotion of capacity building at the tertiary institutions and industry without bothering itself with what is happening at the lower levels of education, it is doubtful if science educators were invited. It is in fact doubtful if membership of the Academy is encouraged for Professors and other practitioners of Science Education! The Academy needs to be alive to its responsibilities to Nigeria by supporting the efforts of STAN and initiating its own programmes in this regard. The same goes for the Science Association of Nigeria, which should normally encourage school science teachers to be members, the activities of STAN as well as the JETS activities in schools to assist in preparing budding scientists.

The Nigerian Academy of Education, on its own part, seems to be alive to its responsibilities in the promotion of science education in Nigeria; in fact, one of its Annual Congresses, had been devoted to the promotion of science and technology education in Nigeria.

Mr Vice Chancellor, Sir, let me conclude this Inaugural Lecture by re-emphasising that Teacher Education in Nigeria needs re-thinking for it to effectively contribute to capacity building for Nigeria in the sciences and technology. Such rethinking should take into consideration all the imperatives listed in this Lecture.

Acknowledgments

First, to the Almighty God and the Lord Jesus Christ be the glory, the honour, power and praise! He made me to achieve this height. He has sustained my family and me thus far and has remained faithful to us. May He continue to support us, Amen.

I have to acknowledge the immense contributions of my late parents to what I have become today. My late father, **Joseph Obisesan Ajeyalemi** departed this world in October 1983. He loved us his children and valued education so much, even though he did not have an opportunity of much schooling himself; he could read (especially the Holy Bible) and write in Yoruba! He would part with his last penny when it came to feeding his family, buying school

needs and paying the school fees of his children, including the female. He always believed we would make it in life through education. Today, thanks to God and to him, all the surviving children, except one, who opted out of school on her own volition, are well educated. May his generous soul continue to rest in perfect peace, Amen. Some of my half-brothers and sisters are here present: Mrs Comfort O. Fagunleka, a retired teacher and her husband; Pastor Isaac Ajeyalemi of the Four Square Gospel Church, a Mass Communication expert, Mr Nathaniel Olusegun Ajeyalemi, an experienced Computer Scientist, Mr Richard A. Ajeyalemi, a Principal Rural Employment Promotion Officer at the National Directorate of Employment and Mrs. Adekemi Idowu.

I am particularly indebted to my late mother, **Felicia Adeoti Ajayi Ajeyalemi**, who was ready to sacrifice even her life to care and protect me, *her only surviving child* out of 11. She had three of us, sons, until 1955 when my younger brother, **Babatunde**, passed on as a result of a minor domestic accident. While still nursing that loss, in 1957 my only older brother, **David Folorunsho Ajeyalemi** died mysteriously a day before he was to assume duties in the Nigerian Ports Authority as a clerk and was buried here in Lagos. She bore all the agonies with equanimity and faith in the Lord Jesus that she would not die childless. She loved all of us in the family and took special care of all her stepchildren and grandchildren from the time they were babies. By the grace of God, she did not die childless; her three grandchildren and I survived her when she departed this world on February 13, 1998 at the age of 93 and was gloriously buried on May 2, 1998. Mama, we miss you. Please continue to rest in the bosom of the Lord Jesus.

Next, I must commend the efforts of my late Uncle, **Chief Rufus Olajide Ajayi** for his contributions to my upliftment in life. He brought me to Lagos after graduating from the secondary school, secured a job for me at the Nigerian Ports Authority on the second day of arrival in Lagos, taught me to be prudent, courageous and forthright and encouraged me to further my education up to the Ph.D. level. In addition, Chief Ajayi believed in and tolerated me as a human being, facilitated my getting married to my darling wife, and

was always there to guide and chastise me, when necessary. Indeed, he was my second Father! How I wish he were here today to witness this day of my manhood; he only died exactly nine months ago, on February 6, 2002! May his wonderful soul rest in perfect peace. However, his "twin" brother, **Dr Festus Adebisi Ajayi, *O.O.N., S.A.N.***, the first Nigerian First Class graduate in Law from the University of London and erstwhile Attorney General/Commissioner for Justice of the Western State, is here with us today. He facilitated my admission into the Adeyemi College of Education, Ondo for the N.C.E. programme in 1970 and he has remained a source of strength and wisdom.

I cannot but recognise the early contributions of many people to my attaining this height in academics. I will start with the late **Mr. & Mrs. M.A. Adeyemi**, my Headmaster at St. Peter's School, Ibokun and his wife. On our first day at school, Mrs Adeyemi, as a kindergarten teacher, received me together with my two childhood friends, now **Dr. Jaiye Oyedotun**, the *Managing Director of Marina International Merchant Bank Ltd.* and **Ambassador Christopher Adegboyega Ariyo**, the *Deputy High Commissioner at the Nigerian High Commission in the Republic of Egypt*. Next is my late Principal at the Kiriji Memorial College, Igbajo, late **Baba E.A. Lagunju**, who preached and taught me the dignity of labour as well as my English teacher, His Excellency Chief Adebayo Adefarati, the Executive Governor of Ondo State.

Mr Vice Chancellor, Sir, I acknowledge the co-operation and support of the University Administration, under your able leadership, towards the successful hosting of this Inaugural Lecture. More importantly, I thank you for sharing your intellect with me always, even when we were in far away Zimbabwe in 1989. You will continue to succeed in your onerous tasks in Jesus' Name, Amen.

I thank all the past Vice Chancellors of this University, who contributed to my academic/administrative career from the time of Professor J.F. Ade Ajayi. Particularly, I must single out the indefatigable and visionary **Professor Jelili Adebisi Omotola**, who challenged me most by appointing me to the most difficult job on campus as the first Director and later Dean of Student Affairs of this

University. Thank God, I survived the job for four years and four months!!! I thank him for his support and the opportunity to learn new things about the University, which I never expected I would be able to.

I remember my Lecturers at Adeyemi College, the University of Lagos and the University of East Anglia, Norwich, U.K. I acknowledge the indefatigable and erudite international scholar, Professor M.O.A. Durojaiye, the pioneer Dean of the Faculty of Education here, who attracted me to this University as a Graduate Assistant and made the University to sponsor me to the University of East Anglia for the M.Sc. and Ph.D. degrees. As a demonstration of his love and confidence in me, he came all the way from Lagos to be the Chairman at my wedding in Norwich, U.K.

So also I am grateful to Professor Taiwo Odunusi, my Lecturer at Adeyemi and at the University of Lagos, and late Professor E.A. Adegoke, alias "Rigour" and Professor M.S. Olayinka, who were my Project Supervisors in Chemistry and Education respectively at the degree level. My Lecturers in the Faculty of Education - Professors A.O. Osiyale, E. Fagbamiye and E.O. Obe and Drs. E. O. Fagbohungbe and E.A. Babalola as well as my Lecturers in the Department of Chemistry, Professors A. Akisanya, T.O. Emokpae, O. Somorin, M.O. Ogunlesi, and O. Banjoko, Drs F.A. Ayanbadejo, T.O. Sonola and S. A. Adeniji are all duly acknowledged.

Those who inspired me at the School of Chemical Sciences, University of East Anglia include Professors Malcolm Frazer and R.A.Y. Jones (my M.Sc. Supervisors), Drs Roger Maskill (my Ph.D Thesis Supervisor) and Malcolm Seddon, Professor Peter J. Fensham and late Emeritus Professor Frank Halliwell. I salute all of you.

Of course, I must recognise the contributions of my colleagues and wonderful friends, Professor Olufunke Lawal, Professor Aloy Ejiogu (appointed Professor the same day with me), Professor O.J. Aisiku (Visiting Professor from the U.S.A.) and Dr Ayo Baiyelo, my intellectual 'sparring' partners in this University; we share our anxious moments together. I thank them especially for their encouragement and support for the preparation of this Inaugural Lecture. I need to

specially commend Professor (Mrs) Lawal and Dr Baiyelo, who helped to read this manuscript. In addition, Professor Lawal, as our family friend, conducted the naming ceremony of my first child, Olubanke in Norwich; she is today the Godmother.

The support of some other colleagues such as Dr Uche Udeani (PG Co-ordinator) and the Heads of Units - Dr Adekoya, Dr Ohiri-Aniche and Mrs Gbemi Ashiru, who make my job as Head of Department lighter, is duly acknowledged. In like manner, I acknowledge the cooperation of colleagues at the University of Zimbabwe, Drs L. Nyagura and Richard Hodzi; and at The University of Iowa, Professors Robert E. Yager, John E. Penick and Edward L. Pizzini. Let me also seize this opportunity to thank the current Dean of Education, Professor Bade Adegoke for his support towards moving the Department of Curriculum Studies forward. In addition, I pay tribute to the memory of làte Dr Ilori Alonge, my colleague and friend at the Universities of Lagos and East Anglia and Professor Ade Adegite, a great senior colleague in Chemistry and friend.

To my numerous friends in and out of the University and for which space would not permit me to mention all individually, I thank you for your love and co-operation. However, I would specifically mention some relatives and friends, who always help(ed) to provide opportunities for me to advance academically and socially, Prince Lola Omojowolo, Elder Imisiola Aremu Shobowale, Late Lolade Fadeyibi, Mr Kola Okunlola, Chairman/CEO of Barewa Pharmaceuticals Ltd., Late Phil. Kumolu, former Managing Director of NAL Merchant Bank and Professor Peter Okebukola, Executive Secretary, National Universities Commission.

I cannot but acknowledge my numerous students, past and present, for sharing many ideas with me. Present here among these, are Dr O.O. Busari, an Associate Professor in my Department, Dr Eric Nwosu and Ayo Odumosu (my reliable friend), both Chief Lecturers at the Federal College of Education (Technical), Akoka.

Finally, Mr Vice Chancellor, Sir, my nuclear family deserves a great mention for providing a conducive home environment for me to pursue my intellectual pursuits and for their unconditional love and affection. I have the honour to present my very responsible, dutiful, pragmatic and always contented wife, Mrs Frances Kofoworola Ajeyalemi (nee Amusu), my only daughter, Olubanke, a Final Year Economics student, my sons, Oladipupo, a 400 Level Estate Management student, and last but not the least, Babajide, a Diploma student of Law, all of University of Lagos.

Mr Vice Chancellor, Sir, distinguished Guests, Gentlemen of the Media, Ladies and Gentlemen, I thank you for your attention. God bless you all.

References

Adeyegbe, S.O. (1993). "The Senior Secondary School Science Curricula and Candidates Performance: An Appraisal of the First Cycle of Operation". *Journal of the Science Teachers Association of Nigeria*, 28, (1&2), 3-12.

Ajeyalemi, D. (2001). "Science and Technology Education in Early Childhood Education." *Lead Paper presented at the 1st Annual Conference of the Institute of Education,* Obafemi Awolowo University, Ile-Ife, 6-8 November.

Ajeyalemi, D. (1990) ."In-Service Teacher Education for Nigeria's National Primary Science and Mathematics Project (NPSMP)". *Science Education International,* 1, 3, 22-23.

Ajeyalemi, D. (ed. , 1990a). *Science and Technology Education in Africa: Focus on seven sub-Saharan countries.* Lagos: University of Lagos Press.

Ajeyalemi, D. and Baiyelo, T.D. (1990). Nigeria. In Ajeyalemi, D. (ed.) *Science and Technology Education in Africa: Focus on seven sub-Saharan countries.* Lagos: University of Lagos Press.

Ajeyalemi, D. and Busari, O.O. (1989). "The Influence of teachers' Cognitive Styles on their Teaching Strategies". *Zimbabwe Journal of Educational Research,*1, 2, 206-222.

Ajeyalemi, D. and Lawal, O.O. (1987). "The Effect of Teaching English Language in the Scientific Context on Students' Achievement in Science and English Language. *Journal of Research in Curriculum* Special No. 2, 1-8.

Ajeyalemi, D. (1987). "Science Education in the Last two Decades: Are We Really Serious"? In Ejiogu, A.M. and Ajeyalemi, D. (eds.) *Emergent Issues in Nigerian Education* Volume 1, 147-159.

Ajeyalemi, D. (1987a). "The Effect of Knowledge Structure on Achievement in "Oxidation-Reduction Reactions" at O' Level Chemistry. *Educational Perspectives* 2, 1, 17-29.

Ajeyalemi, D. (1987b). "Education and Employment: A Crisis Point". In Ejiogu, A.M. and Ajeyalemi, D. (eds.) *Emergent Issues in Nigerian Education* Volume 1, 60-75.

Ajeyalemi, D. (1987c). "Cognitive Styles of Science Teaching from a Discourse Analysis of Lessons". *Journal of Research in Curriculum*, 5, 2, 95-110.

Ajeyalemi, D. and Busari, O.O. (1986). "Factors associated with Under-achievement in O' Level Chemistry – An Investigation into Classroom Processes, Teacher and Pupil Opinions". *Proceedings of the 27th Annual STAN Conference*, Owerri, August, 250-256.

Ajeyalemi, D.A. and Maskill, R. (1982). "Discourse Analysis of Chemistry Lessons: Patterns of Cognitive Transactions in Nigerian Chemistry Classrooms". In *Chemical Education Research – Implications for Teaching*. London: Royal Society of Chemistry, 137-145.

Ajeyalemi, D.A. and Maskill, R. (1982). "A Survey of Studies of Science Classroom Activities with particular reference to their Usefulness for Developing Countries". *European Journal of Science Education* 4, 3, 253-263.

Ajeyalemi, D. A. (1981). "Patterns of Cognitive Interactions in Chemistry Classrooms: a Descriptive Analysis of Lessons of some Lagos Metropolis Nigeria Secondary School Teachers". *Unpublished Ph.D. Thesis, University* of East Anglia, Norwich, U.K.

Ajeyalemi, D.A. (1979). "An Investigation into the Forms of University-Industry Interactions in Chemistry in Nigeria". *Unpublished M.Sc. Dissertation*, University of East Anglia, Norwich, U.K.

Alonge, E.I. (1986). "Teaching Chemistry to Large Classes: an Exploratory Study". *Journal of Research in Curriculum*, 4,2, 29-38.

Beetlestone, J.G. (1975). "Science in a Social Context". *An Inaugural Lecture*. University of Ibadan, November 27.

Berghe, Van den (1973). *Power and Privilege at an African University*. London: Routledge and Paul Kegan.

Busari, O.O. (1991). "The Effects of Enriching Two Main Instructional Strategies with Concept Mapping and Problem Solving on Senior Secondary School Students' Cognition in Chemistry". *Unpublished Ph.D. Thesis*, University of Lagos.

Cassels, J.R.T. and Johnstone, A.H. (1977). "Language in Chemistry. *Research for the Classroom and Beyond*. London: Education Division, The Royal Society of Chemistry.

CIDA (1996). *Capacity development: the concept and its implementation in the CIDA context*. Hull: Policy Branch, CIDA.

Driver, R. (2002). "Theory into Practice II: A Constructivist Approach to Curriculum Development". In Fensham, P. (ed.) *Development and Dilemmas in Science Education*. London: RoutledgeFalmer, 189-217.

Durojaiye, S.M. (1979). "Discourse Acts and Clause Process Options: an Investigation into the Spoken English used by Teachers in some Secondary School Classrooms in Urban Areas of Nigeria". *Unpublished Ph.D. Thesis*. University of London, Institute of Education.

Eggleston, J.F., Galton, M. and Jones, M.E. (1976). *Processes and Products of Science Teaching.* London: MacMillan/Schools Council.

Eggleston, J.F., Galton, M. and Jones, M.E. (1975). *A Science Teaching Observation Schedule.* London: MacMillan/Schools Council.

Gage, N.L. (1964). Theories of Teaching. In Hilgard, E.R. (ed.) *Theories of Learning and Instruction.* N.S.S.E. Yearbook No. 63, Part 1. Chicago: University of Chicago Press.

Gagne, R.M. (1962). "The Acquisition of Knowledge". *Psychological Review,* 69, 355-365.

Gallagher, J.J. (1970). "Three Studies of the Classroom". In Gallagher, J.J., Nuthall, G.A. and Rosenshine, B. (eds.) *Classroom Observation.* American Educational Research Association Monograph Series on Curriculum Evaluation, No. 6. Chicago: Rand McNally.

Grant, J.N. (1967). "The Appropriateness of the Science Curriculum in Nigerian Secondary Schools for the Country's Scientific Manpower Needs" *Unpublished Ph.D. Thesis.* University of Connecticut.

Gunstone, R.F: (2002). "Learners in Science Education". In Fensham, P. (ed.) *Development and Dilemmas in Science Education.* London: RoutledgeFalmer, 73-95.

Hacker, R.G., Hawkes, R.L. and Heffernan, M.K. (1979). "A cross-Cultural Study of Science Classroom Interactions". *British Journal of Educational Psychology,* 49, 51-59.

Highet, G. (1954). *The Art of Teaching.* London: Methuen & Co. Ltd.

Jegede, O.J. and Okebukola, P.A.O. (1995). "Personal and Demographic Predictors of Science Teachers' Levels of

Occupational Stress". *Journal of the Science Teachers Association of Nigeria,* 30, 1&2, 3-14.

Klein, M. (2001). "Constructivist Practice, Pre-Service Teacher Education and Change: the Limitations of appealing to Hearts and Minds". *Teachers and Teaching: Theory and Practice.* 7, 3, 257-270.

Nigeria (2000) "Manpower Development and Utilization. In *National Rolling Plan 2000-2002.* Abuja: National Manpower Board".

Nigeria (1997) "Manpower Development and Utilization. In *National Rolling Plan 1997-1999.* Abuja: National Manpower Board".

Nigeria (1977, revised 1981 & reprinted 1998). *National Policy on Education.* Lagos: Federal Ministry of Education.

Okebukola, P.A.O. (1995). "Effects of Cooperative and Competitive Interaction Techniques in Strengthening Students' Performance in Science Classes". *Science Education,* 69, 501-509.

Okebukola, P.A.O. (1990). "Attaining Meaningful Learning of Concepts in Genetics and Ecology: An Examination of the Potency of the Concept Mapping technique". *Journal of Research in Science Teaching,* 27, 5, 493-504.

Roberts, D.A. (2002). "What Counts as Science Education". In Fensham, P. (ed.) *Development and Dilemmas in Science Education.* London: RoutledgeFalmer, 27-54.

Shapiro, B.L. (2002)."What Children bring to Light: Towards Understanding What the Primary School Science Learner is Trying to Do". In Fensham, P. (ed.) *Development and Dilemmas in Science Education.* London: RoutledgeFalmer, 96-120.

Sinclair, J.M. and Coulthard, R.M. (1975). *Towards an Analysis of Discourse: The English used by Teachers and Pupils.* London: O.U.P.

Thollairathil, G. (1973). "An Analysis and Evaluation of Nigerian Secondary School Science Teaching". *Journal of the Science Teachers Association of Nigeria,* 11, 4, 60-69.

Ugwu, I.E. (1980). "An Investigation into the Teaching Styles of Secondary School Biology Teachers in Anambara State of Nigeria". *Unpublished Ph.D. Thesis.* University College, Cardiff, U.K..

Designed & Printed by University of Lagos Press