UNIVERSITY OF ILORIN

THE ONE HUNDRED AND FORTY-SEVENTH (147th) INAUGURAL LECTURE

"THEORY INTO PRACTICE: BEYOND SURFACE CURRICULUM IN SCIENCE EDUCATION"

By

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Preamble

I consider it a great privilege and honour to stand before you on this day, Thursday, 22nd May, 2014 to deliver the 147th Inaugural Lecture of this great University and the 4th from the discipline of Science Education. Today's lecture would not have become a reality, except for the grace and the mercies of God who has made it possible. It is unto this great God I ascribe all the glory, honour, praise and adoration. For it is God who when He says yes; no other being can say no.

As a little and young growing boy, I had always wanted to be of help to people around me, and so, I thought if I could become a Pastor, Teacher, Pharmacist or even a Medical Doctor; I would really be able to fulfil my dreams. As at the time I finished my secondary education, this desire had grown stronger in me and luckily for me, I had excellent grades in mathematics and the sciences which made it possible for me to be offered admissions in two universities. After a series of divine intervention, I decided to train as a science teacher and an educator. This I believed would make my desire become a reality. Today, I stand before this great audience with great joy in my heart; and with an outpouring thanksgiving unto the Almighty God that I took that decision and I have never regretted it. Even though, I did not train as a medical personnel, I have since been blessed with a family of medical scholars.

I started my academic career as a Graduate Assistant at the Ahmadu Bello University, Zaria and later transferred to this great University of Ilorin in February, 1979. Initially, I hesitated to accept the offer of appointment because I felt the salary was less in grade level compared to my status and take home pay in ABU, Zaria. As I journey back to Zaria, I was offered a ride by my former Physics lecturer, Professor T. O. Aro, who had transferred from ABU, Zaria to University of Ilorin. As we interacted, I told him I was hesitant about the offer and he asked why. When I told him of the monetary difference, he asked, "**.is money everything?"** I said no, sir! There and then, I decided to accept the appointment and I have since been happy and thankful with no regret. Incidentally, the University of Ilorin later rectified my status to the position of Lecturer II with comparable salary earnings and I was paid my arrears!

I have passed through every academic cadre from Graduate Assistant to the position of a full-fledged Professor some 15 years ago. Though a challenging experience, but a successful voyage! The voyage took me to the University of Wisconsin-Madison (USA), where I obtained my Doctorate degree in Science Education in the area of Chemistry. As a doctoral student, I made a foray into the field of curriculum, combining it with my mandatory chemistry courses. This later helped me to develop expertise in curriculum studies.

Mr. Vice-Chancellor Sir, from the title of this Inaugural Lecture, "**Theory into Practice: Beyond Surface Curriculum in Science Education,"** it can easily be deduced that my interest and concern is about a phenomenon of saying and claiming one thing; but actually doing something else. In the Holy Bible, God admonished His people to beware of, and turn away from such **"...who have a form of godliness, but deny the power thereof"** (II Timothy 3:5).

It is this situation that has stimulated my research endeavours into examining what happens to our school curriculum on the surface and what actually goes on beyond the surface; factors militating against students' performances in the science and how to assist them learn meaningfully and thus, improve on their performance. Much of what is presented theoretically as official prescriptions are in practice dented with discrepancies that raise concern on why the intent is not always implemented. I have attempted to address this phenomenon issue under the following sections: theory into practice (the symbiosis); disciplines of science and science education; official curriculum and classroom practice; current status of science education; students' performance and learning difficulties in the sciences; enhancing scientific literacy through science education; my other contributions; conclusions and; recommendations.

Theory into Practice *(The Symbiosis)*

Theories and practices in education are two important concepts that summarise the education process. A third component which makes for a complete description of education is educational outcome. The relationship between these three concepts (educational theory, educational practices and educational outcome) can be illustrated using the analogy of a tree with the roots representing the theories, the trunk/stem representing the practices, and the fruits representing the outcome (Fig. 1).

Educational theories form the basis of any educational design, which are embedded in the curriculum. Theories (roots) are transformed into practices (stem) which themselves give credence to the theories to ensure the attainment of outcomes which are the goals and objectives of the system. The quality of the outcomes is expressed in the extent to which a programme has achieved its goals.

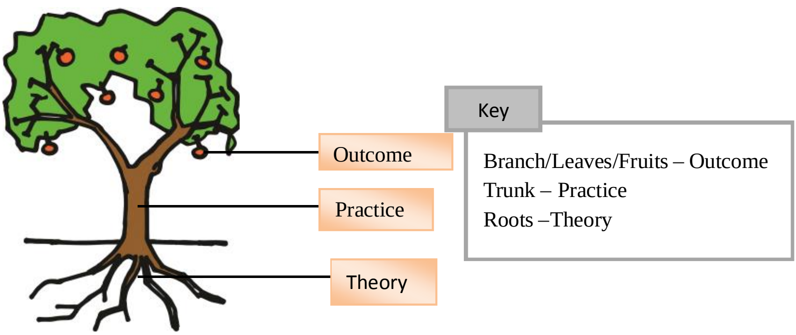

Figure 1: Educational Tree

Behaviourist and constructivist theories of education come from educational psychology while functionalist theory of education comes from sociology of education.

Our education systems are formulated based on some forms of theories reflecting culture, tradition and needs of the society they serve. Knowledge of these theories is critical both in curriculum development and implementation and classroom teachers must have thorough understanding of them not only to understand the basis of their work but also to assist them in carrying out their duties as appropriate. Unfortunately, this is not often generally so. Many teachers are either ignorant of this need or chose to ignore their provisions as captured in the theoretically formulated policies of education handed over to them for classroom implementation.

The nature of the relationship between theory and practice has for several decades been oscillatory, depending on the philosophical thesis being advanced. For instance, the German philosopher Immanuel Kant postulated that: 'theory without practice is empty, sterile and practice without theory is blind'.

It can also be said that theory without practice is like a flying bird that never lands whereas, practice without theory is a bird that never flies. Thus in theory, there is no difference between theory and practice, in practice however, there really is!

In the educational scene, the relationship between theory and practice is symbiotic and one must exist along with the other even though it may be difficult for both to live with (and without) each other. Theoretical basis of practice must be established and practice must seek to validate theory. Hence, both theory and practice have a close and inseparable union.

Theory and practice must cooperatively coexist for any fruitful outcome to be achieved. Our educational theories which drive our school curricula, must be appropriately put into practical realities, otherwise we risk a system dominated with good ideas but which is characterized with little, poor or even non-measurable practical realities.

In science teaching and learning, theoretical formulations of objectives and curriculum emphases are expected to be actualized in practice. The science curriculum that teachers implement and which students are assisted to learn provides specific intended and expected learning outcomes. Unfortunately, findings from a series of studies about science teaching/learning show that what actually happens in the classroom situation is beyond the surface. The findings consistently showed that official curriculum ideals were often compromised in practice at the school and classroom levels (Olorundare, 1985a; 1987b; 1990; 2011a, b; 2013a; Olorundare & Upahi, 2013).

Mr. Vice-Chancellor Sir, there is now an increasing evidence from research to show that the effectiveness of the curriculum is significantly influenced by subtle influences not originally captured by the principles and policies outlining that curriculum. Influences such as: teacher's warmth, intellectual competence, socio-economic happenings, learners' personal and innate difficulties, are usually not subject to the schools, teachers or even students' control. Behind the classroom door, is an environment that is special and unique to the individual teacher and the students themselves which are not explainable by the principles of the surface curriculum. Beyond this curriculum is the classroom reality.

Analysis of a science teacher's perceptions, priorities, students' activities and data from observation of actual teaching and learning interactions show that with respect to much that go on in actual implementation of the Officially Prescribed Curriculum (OPC) neither the teacher nor the student can control; much less the 'theory builder' curriculum theorist and developer who has long forgotten how his curriculum content would be actualized. In the words of Francis Bacon, 'theoretical knowledge has to prove itself, its worth by fruits and works'. This is the reason why the questions we now ask should go beyond the traditional ones of: what did the student score? Who has scored the highest? Findings from our studies as well as from other colleagues have shown that equally important, we need to ask questions such as: what did he get wrong? Why did the student not get it right? (Olorundare, 1985a, 1990, 1999; Adebayo, 2008). This latter question exposes some interesting information about how students actually learn and why they find learning science difficult. I will shortly address this issue with highlights of findings from my investigations.

Disciplines of Science and Science Education

Mr. Vice-Chancellor Sir, I am going to attempt to discuss the basic characteristic features of my discipline, science education. In doing this, I have tried to examine answers to simple but pertinent questions such as: What is science? What is education? What is science education? How do they relate with technology?

Science is first and foremost a multidisciplinary human activity which involves a planned systematic investigation and understanding of the world, nature and the universe. This activity culminates into testable falsifiable and verifiable body of knowledge. It is a dynamic enterprise that primarily is a *quest* for *knowledge*, though not the knowledge itself (Olorundare, 1987a; 1987b; 1988b; 2000a, 2000b, 2000c). The body of knowledge generated by science is used in an applicative mode to benefit man and society. It is this latter situation that encompasses the activities of Science Educators. *Education* is also a human activity. Its activities involve providing members of the society with relevant knowledge skills and competencies as well as behaviour and lifestyle that are socially acceptable. The activities of scientists impact on the society and vice-versa. The primary purpose of education is the acquisition of appropriate knowledge, skills and values relevant to live a 'good life' and also make positive contributions to the society. While education is generally too diverse to be susceptible to direct investigation, science education could however be seen as furnishing a more manageable field for investigation.

Science itself is a self-criticising, correcting and improving activity which deals with facts relating to natural phenomena of the universe and how these are interpreted. However, the teaching of science involves teaching individuals how to practise such self-correcting and improving activities. In science education, teachers and the taught are engaged in these scientific activities and as a consequence, activities of science educators are also involved in the activities of scientists.

By the very nature of science and activities of scientists, it can be stated that science has potential for both the positive and the negative; besides, its knowledge has been (and is still being) used to benefit or harm man. Knowledge from science has also been used for emancipatory as well as oppressive purposes. In the view of Albert Einstein, the goal of science is 'both to extend the range of our experience and reduce it to order'. Thus, the knowledge sought for and generated by science is put in order for human use.

If we now conceive science as the quest for knowledge, then Science Education would be a discipline, the area of human activity in which individuals students/pupils, teachers and the general public are educated (or helped) to quest for that knowledge. This knowledge is in the physical, earth and biological worlds. Science education is responsible for discovering, developing and evaluating methods and strategies to be used in teaching science. When the individual searches for knowledge, both the search process and the knowledge generated by the search constitute the hallmark of Science Education. The major focus of the science educator is to determine status of students' understanding and what facilitates their learning of science. How students think and learn reveal the various obstacles they face in science learning. It is through our attempt to ascertain these that we develop and utilize strategies that draw from many branches of science, engineering, computer science, cognitive science, cognitive psychology and even anthropology. Most of the research efforts in science education is to characterize and stipulate what actually constitutes learning in science, what hinders or promotes this learning and, how learning in science takes place.

We may then ask, is the focus of Science Education about Education in Science or Education about science? Education in science involves very specific preparation and training as a career in science. It is driven by activities of scientists and others strictly within the bounds of science. The practitioners are a minority of the educated who seek to acquire new epistemological understanding of nature and the universe.

Science Education can be viewed from two perspectives: Education in science and Education about science. Education in science is a process whereby a 'minority' of the education community is schooled in and provided with scientific knowledge, skills, competencies, ethics/behaviour and attitudes that demonstrate scientifically literate individuals. On the other hand, Education about science involves majority of the citizenry and indeed all stakeholders. These are provided with science knowledge, skills, competencies and scientifically literate characteristics. Education in science prepares the individual *specifically* within the *confines* of science while Education about science prepares the individual to acquire requisite experience in understanding activities involved in and related to scientific knowledge and competencies. Education about science is a primary activity of Science Education.

Many citizens often perceive and discuss science as being synonymous with technology. As close as these two terms are, they are not the same when we carefully examine the nature of knowledge they individually address. While science is the quest for knowledge generally in the physical, earth and biological disciplines, technology is a problem-solving discipline that focuses primarily on the improvement of the quality of human life, resources and constraints of human needs and natural resources. It requires scientific knowledge as well as knowledge from other disciplines of human endeavour which are cooperatively used. This is an instance of divergent thinking. Scholars in technology operate as problem solvers and consequently, they put emphasis on the functional, technical and scientific aspects of the problem solving operations. It can be seen therefore that the knowledge that science develops as well as that utilized by technology have some interactive effect and influence on the society. The discipline of Science Education traverses this interaction. It is submitted in this lecture that, even though technological activities and devices seen around are products of the principles of science, technology cannot and should not be regarded merely as an extension of science: it has its own specific autonomy as our colleagues here in the field of technology would affirm.

The discipline of Science Education focuses attention on three main enterprises undertaken by man: the learner, the milieu under which the learner operates, and the activity focus or object of learning, in this case science. It is by and large an interdisciplinary discipline comprising of science as the major and lead reference discipline and, other disciplines juxtaposed: history and philosophy of science, pedagogy, psychology, mathematics, technology, linguistics, religion and sociology. Fig.2 is a representation of this interrelationship of reference disciplines in Science Education.

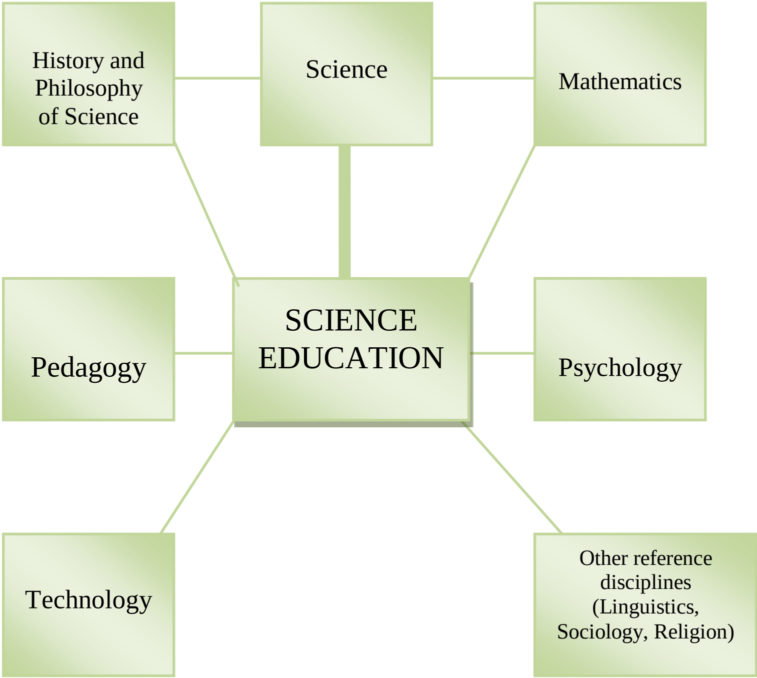

Figure 2: Science Education and its Reference Disciplines

By the very nature of the training and activities of the Science Educator, a sound background knowledge in at least one of the sciences is of utmost necessity with substantial knowledge base and competencies in other disciplines as shown in this figure. It is not enough to know science well, it is also expedient for the science teacher to teach it well.

Mr. Vice-Chancellor Sir, my subject area of speciality as a science educator is Chemistry. My research endeavours have been streamlined to focus on the improvement of students' learning and teachers' teaching of science at the lower level and chemistry at the higher levels of schooling. It is this desire for improving science teaching/learning that made me to undergo very specific further Graduate work in curriculum studies and thus qualify as a Curriculum Expert, in addition. I have been fortunate to be tutored by some of the best curriculum scholars in the USA at the prestigious University of Madison-Wisconsin.

Official Curriculum and Classroom Practice: Filtration of the Interplays

The curriculum field has been played with a definitional problem resulting into many varied definitions ascribed to the word 'curriculum'. In 1860, Herbert Spencer's famous question "what knowledge is of most worth?" dominated the attention of most educators of the day as they wrestled with what was to constitute the school curriculum. The various definitions ascribed to the curriculum since then point out the changing role of the school in the society, conceptions of the learner and the nature of knowledge. For instance, Rule (1973) identified 119 different definitions of curriculum as used by students, scholars, curriculum scholars, educators and philosophers of education.

A harmonised definition of curriculum in this lecture and in my view, would be taken to mean '....structured, series of intended learning outcomes'. Curriculum is a plan for learning and such plan encompasses the framework for what to learn and how it is to be learned. It also includes the strategies and materials designed to support and give direction to the teaching/learning transaction. The Oxford Dictionary defines the Curriculum as 'a course of study' deriving from a latin word '*currere*,' which means to run or run a race-course. This presupposes curriculum as involving 'hurdles' to overcome. The American Webster's Dictionary presents it simply as 'a specific course of study at a school: many of us today have these notions of the dictionary definition of curriculum.

Mr. Vice-Chancellor Sir, within the context of this lecture, intentions would not be training armed robbers, rapists, kidnappers or bigots. What the average individual usually refers to as curriculum is actually the syllabus. The latter in the real sense is actually a sub-set of the curriculum.

Curriculum and syllabus have been erroneously used as being synonymous. They do not mean the same thing! Syllabus is a macro element of curriculum and can be seen basically as a prescribed content of what should be studied in the school in terms of subjects listed for a particular course. Curriculum is more than listed subjects, it includes other elements including syllabus (Olorundare, 1990; 1997).

The official curriculum has all the details of the theoretical policy formulations of the nation. In view of the fact that we have an examination oriented education system, it is generally the major examination bodies such as: West African Examinations Council (WAEC); National Examinations Council (NECO) that present to schools what should be focused on in the form of syllabus subject matter content and the required skills that must be developed and utilized. It is expected that once the schools satisfy the requirements of these examination bodies they have indirectly implemented the curriculum. It is submitted here that what actually goes on in our schools is the implementation of the syllabus which has been previously drawn from the curriculum officially developed. Fig. 3 shows the process a gradual *filtration* of the Official Prescribed Curriculum (OPC) to actual classroom level.

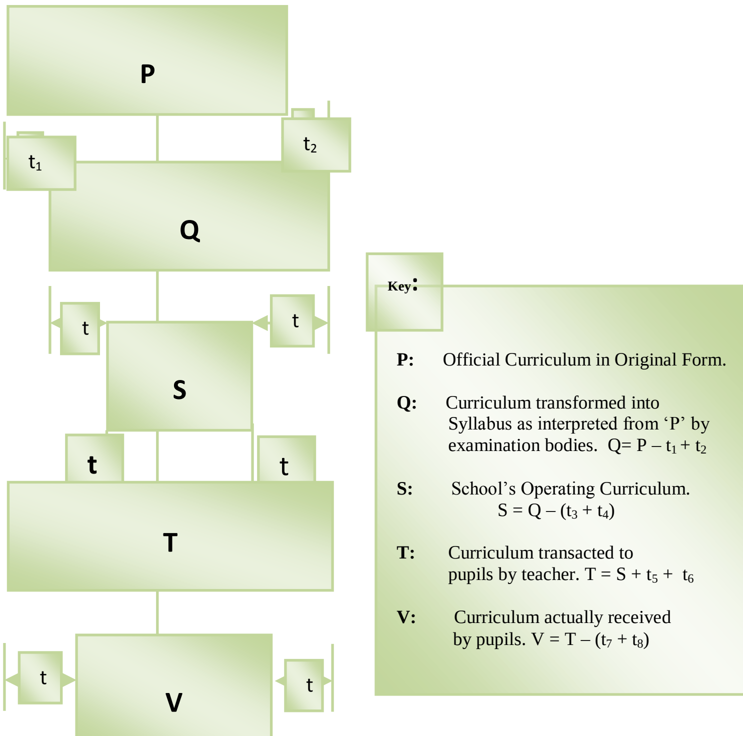

Figure 3: Filtration of the Officially Prescribed Curriculum, OPC

In figure 3, the Officially Prescribed Science Curriculum (OPSC) is represented by a rectangular box P. This is then transformed into a syllabus, Q by the examination bodies through additions or deletions to P. From Q, schools usually construct their own 'operating curriculum' in the form of a scheme of work, S. Between stages P, Q and S, several deletions and/or ,modifications of the OPC have taken place, varying from school to school and even from one set of teachers to another. In the course of implementing S, a teacher's operating curriculum is further restructured to the transacted curriculum, T. The latter constitutes what teachers actually do in the classroom situations after considering their own perceptions of pupils' needs, resources available at their dispsosal and the situations in which they find themselves. In T, teachers are often involved in a great deal of conscious decision making so that, what pupils eventually learn (V) from the original curriculum P, thus arises from T. It is V that represents a reduced and often times 'distorted' from of P.

A further examination of figure 3 shows that there are obvious gaps between the original official curriculum and what eventually becomes the *'transacted curriculum'* in the classroom. Findings from our studies in the area of implementation of official science curriculum show that several factors are responsible for these discrepancies (Olorundare, 1985a; 1985b; 1990; 2011a; 2011e). Unfortunately, these are not usually taken into consideration by the policy formulators and curriculum developers. On the surface, the science curriculum is well-structured and contains what is needed for achieving its outcomes. Beyond the surface or theoretical curriculum however is the actual chronology of what teachers and students do.

Clinical interviews of science teachers and their students show that while the teachers see the curriculum as being very comprehensive, they are in the reality of school and classroom environment unable to actualize this comprehensive curriculum. Several comments of the science teachers suggest that they teach with the intention of getting their students through the major examinations (WASSCE, NECO, JAMB) irrespective of other considerations! A major goal of the science curriculum is for students to meaningfully learn science and eventually perform well.

Research findings with respect to science teaching at both primary and secondary levels strongly confirm what Paulo Freire called the “banking concept” of education. According to him:

The teacher talks about reality as if it were motionless, static, compartmentalised, and predictable. ... he expounds on a topic completely alien to the existential experience of the students. Education, thus, becomes an act of depositing, in which the students are the depositories and the teacher is the depositor. (Freire, 1972 p. 24).

The consequences of Freire's submission as actively 'practiced' in our classrooms are grave and as at today, this is yet to drastically change. Analysis of this 'banking' concept of education in the area of science teaching and learning gives a reflection of what goes on beyond the surface official curriculum in the science subjects.

Mr. Vice-Chancellor Sir, the foregoing scenario is not what is enclosed in the surface content of the curriculum. Teachers themselves have learning priorities. At the surface level of the official curriculum construct, the teacher plans and provides various encounters for the learner; this is the perceptible form and hence the discernable aspect. A 'deeper' level however constitutes the organising content that the science teacher operates on. The actual intentions of the science teacher, his learning priorities, goals and concerns are brought to bear at this level beyond the surface. I wish to submit in this lecture that, (i) this surface content is the 'what' of curriculum while (ii) the organising content is the 'what for' of curriculum. The latter is what is actually valued and promoted behind the classroom door. There is much discrepancy between (i) and (ii).

Policy makers and official curriculum developers have too often relied on the perceptible form of curriculum and have forgotten or chosen to ignore the real/actual interactions in the classroom. Is there usually a connection between what a science teacher perceives as his priorities? and, what is actually taught to students? How it is taught? and, what are the inhibitors to effective science teaching and learning? These have bothered me and have consequently challenged me to examine teaching and learning which take place beyond the surface curriculum settings at both primary school science and secondary school chemistry levels (Olorundare, 1990, 1993b; 1996b, 1999).

I have undertaken and also participated in several studies that involved large numbers of practicing science teachers at both primary and secondary schools to ascertain the veracity, or otherwise of this slippage cum filtration phenomenon. Clinical interview methodologies were freely utilized to determine the characteristics of interactions between the teacher and the students during science lessons. Findings from these studies portray the fact that while majority of them (4 out of 5) know and appreciate the mission and focus of science teaching/learning for their schools, only less than 30 percent were actually conscious of the vision for the teaching/learning of science at the various school levels. Except for some private schools and few public institutions, vision statements of schools are either not stated or imbibed upon by the practicing teachers. For many that are involved in the vision contained in the official curriculum for their subject area, such vision unfortunately do not shape their actual classroom practice. (Olorundare, 1985a, 1985b; 1986; 1990; 1999; 2011b).

Current Status of Science Education

It has been stated elsewhere in this lecture that science has very important and even a dominant role to play in the various events that shape man's modern day living. Yet the teaching of science can be challenging because of the abstract and theoretical nature of the subjects as well as a myriad of challenging situations which face its teaching and learning. Innovative, desirable and workable methods of teaching science subjects have been discovered, however, it is the duty of the science classroom teachers to continue to update their knowledge on the teaching subject, skills or methods at impacting this knowledge across to their students.

Mr. Vice-Chancellor Sir, the teaching of any of the science subjects in the Nigerian school today, offers a challenging prospect to the Nigerian teacher. Some of these challenges include: low student interest, varying levels of students' mathematical literacy, difficulties encountered by learners of science themselves and the need to deal which abstract concepts in the physical sciences of physics and chemistry (Olorundare, 1989; Fowowe, 1997; Babatunde, 2009). The science curriculum as presently packaged is oriented towards making students gain maximum and enough information to pass examinations especially the external difficult ones of WAEC, NECO and UTME. This implies that the best students by our own standards are those who can accumulate scientific facts and produce them quickly on demand during examinations (Olorundare, 2010a; 2011e; Babalola, 2013).

A major challenge for every aspiring youth who wants to become a scientist is the fact that what is taught in the school is actually different from what the Ministry of Education expects us to teach and what obtains in the real world of work. It has been empirically submitted that what science learners learn or experience in our typical science classroom is usually not what was originally planned, desired or intended for them from the perspective of the Officially Prescribed Curriculum. Similarly, the way science is taught is not exactly the way it is supposed to be taught (Olorundare, 1985a; 1985b; 1987a; 1996a; 1996b; 2010a).

There has been much criticism of our educational system in the area of quality as attention continues to be fixed on students' poor performance in public examinations such as UTME, WASSCE and SSCE. If students fail on a large scale, the teacher concerned is a failure in discharging his responsibilities. The teacher is always the key.

Mr. Vice-Chancellor Sir, the future of Nigeria is at stake. The education of future leaders and scientists of this country is in our hands. We are, thus, duty bound by our professional calling to learn the best, most desirable and most suitable methods of teaching science meaningfully in our classroom. I shall now highlight and discuss vignettes of a few but very important situations which have significant impact on the quality and success of science education in our school system.

Science Education, Teaching and Classroom Teachers

A widely held ‘scientific’ confusion among non-education scholars and even the general public is the claim that, if a student has not learnt, then, the teacher has not taught or has taught incompetently. This assertion is what makes the generality of the citizens to say that the responsibility for students' poor performance should be placed on the classroom teachers. The question is, should the teacher be solely held responsible for the performance or non-performance of his students? Mr. Vice-Chancellor Sir, the answer is no.

Our teachers are generally overlooked, despised, 'downtrodden', they are not treated which honour or respect as the average doctor, lawyer, engineer or banker. They are poorly paid compared to others and oftentimes, when salaries of workers/civil servants are unpaid or delayed teachers are usually the primary target victim! Several university graduates use teaching as the first port of call for other future career. Those who are in the field claim that they are in the teaching 'business' because that is all they could lay their hands on for the time being. They are therefore often not stable, committed and enthusiastic classroom teachers!

Many classroom teachers are 'hungry' and the society as well as the government and hence the ruling class should be held responsible. The unfortunate outcome of this ill-treatment is the prevalence of poorly motivated, half committed and unenthusiastic teachers in our school system public or private. It is a common but surprising saying that: those who can (and are able) work; those who cannot (are not able) teach! Causal discourse with unemployed university graduates reveals their desire to be given any job, even if it is teaching! Hence, teaching is the last resort when all other efforts fail. This situation and its implications cast great shadow on our educational system and whether we like it or not, it does negatively affect the products of the system (Olorundare 2009b; Abiala, 2013; Babalola, 2013).

Mr. Vice-Chancellor Sir, the effect of the aforementioned negative perception and low status awarded to teachers is that, oftentimes, the official curriculum is not implemented according to the specifications of the designers. Students are in large part denied of robust; up-to-date and competent and willing teaching force, which has led to poor learning experiences and consequently, poor performances in examinations.

There are other consequences of the poor status accrued to our teachers but in whatever form, the resultant effect is that education of our children and the youth is undermined at both primary and secondary levels of our education system. The situation expectedly flows into what obtains in tertiary institutions where respective academic unions of COEASU, ASUP, ASUU, in Colleges of Education, Polytechnics and Universities respectively, have had running battles with the Federal and State governments on the need to properly fund education and adequately treat teachers (lecturers) with respect in areas of welfare, wages and infrastructure.

Mr. Vice-Chancellor Sir, one way to avoid this, is for decision makers and political leaders to take positive and practical action …fund education, fund education, fund education adequately (!) and, take very good care of those who actualize the intentions of the nation's educational policies through curriculum at the primary, secondary and tertiary levels. We need to move beyond theory, beyond the surface if we are to bequeath a pragmatic education system to future generations.

The concerted effort of the Teachers Registration Council of Nigeria (TRCN) in properly positioning of teaching at all levels is most commendable. The Council has in the past five years put in very strategic procedures at ensuring that teaching at all levels of our education system is accorded the honour and pride of place it deserves amongst other professions. Registration of teachers, establishment of programmes for teacher development (PDE, PGE), formulation, establishment and enforcement of teaching standards are some of the highlights of TRCN's effort. This lecturer has been privileged to play very active roles in these efforts of the TRCN. The NUT, NTI and NERDC are stakeholders that cannot and should not be overlooked in the virile effort of repositioning the profession of teaching in Nigeria (TRCN, 2012; Abiala, 2013; Arubayi, 2010; Babalola, 2013).

It is a 'funny' assumption that our classroom teachers are to implement the curriculum wholesomely. The Officially Prescribed Curriculum (OPC) is not often fully put into practice at the classroom level! The student suffers for it. An analogy of the demand being discussed is the case of a building. The architect, designs the entire edifice. It is handed over to the contractor whose work it is to implement the provisions of the design and bring up a beautiful edifice as intended, conceived and designed. The quality, beauty and, eventual usefulness of the building depend largely on the expertise, experience, integrity and commitment of the contractor. Like the contractor, teachers are shouldered with the responsibility of 'reproducing' the OPC as originally designed. What they eventually do and consequently what the learners experience depend to a large extent on how they have been able to appropriately implement the provisions of the designed curriculum. Does the teacher for instance know very well the provisions? Is he properly grounded in the subject matter content, the subject matter content to be taught or the most appropriate instructional method/materials to utilize?

Our studies have found that very often, science teachers have uphill tasks in ensuring students are able to learn the subject meaningfully (Olorundare, 1987b; 2000b; 2000c). The dynamic nature of knowledge growth in the sciences require frequent/constant professional development, the near absence of laboratory equipment apparatus as well as materials and resources for needed experiments make the teaching of science unfriendly and frustrating! Teachers that are determined to make good whatever is available have been found to be actively involved in improvisation of scientific materials, apparatus and equipment (Olorundare, 2010a; 2010b; Upahi & Olorundare, 2012).

Science Education and Improvisation

In order to practically implement the science curriculum and go beyond the surface, science teachers must engage in improvisation of resources/apparatus. Theoretically and officially, the provision and utilization of science equipment, apparatus and materials are the core provisions for the implementation of the average science curriculum in our schools. In practice, this is not often the case as it has been found that as important and crucial as practical exercises are in the sciences, science teachers do not and probably are unable to fully lead their students to learn science by doing.

In our studies on the major factors responsible for teachers' poor or non-implementation of the science curriculum, it has been found that most schools do not have laboratories for each of the sciences (chemistry, physics and biology)and that, even those that are available are poorly equipped and maintained (Olorundare 1993b; 2001a; 2010a). There is a general non-availability of appropriate equipment/apparatus and conducive environment for the conduct of experiments, though, the private secondary schools seem to have fairly well-equipped science laboratories. Unfortunately, the private schools represent less than 15 per cent of the entire students' population and consequently, the teaching and learning of science largely remain unchanged reliance/dependence on the competency of the classroom teacher and use of textbooks.

Several institutions are unable to purchase and maintain the needed laboratory equipment. Improvisation has become a necessary and practical reality for science teachers in the present educational environment. Teachers' awareness and commitment to the process of improvisation has been found to be the way out of the experiences in which purchase of required science materials and equipment is far out of reach of most schools. Improvisation is 'an adaptation of locally and readily available/ made material. Equipment or apparatus for the purpose of achieving the same objectives as when the “ideal” imported, standardized factory made equipment is utilized.

In a series of UNESCO-NIGERIA sponsored workshops, this lecturer led and directed selected secondary school chemistry teachers across several states in the North-Central and North-West geo-political zones of the country to identify construct and utilize basic improvised materials and equipment for teaching difficult topics in chemistry. The workshops focused on effective learning techniques in science classrooms. Over 90% of the chemistry teachers expressed frustration at being unable to improvise required materials and apparatus. Several materials/apparatus were produced and have become a resource for chemistry classroom teachers (Olorundare, 2001a, b; 2006a, b; 2010a, 2010b; 2011e).

Many teachers are unwilling to engage in improvisation, because of time consumption and the extra financial demand. Without improvisation, many science concepts and topics are not treated as required of the curriculum developers. Improvisation has a powerful effect on making science real to both students and teachers.

Science Education and Textbook Dominance

Factors influencing students' performance in the sciences are varied. Prominent among these is: educational consumerism. This is the public demand for its participation in the formulation of educational policies as well as its further demand that classroom teachers and school administrators should be held responsible for students' performances. As 'fairly' reasonable as this may seem on the surface, the real reasons for students' poor performances are beyond teachers and school administrators. The learners themselves, as the major stakeholder have innate and environmental hurdles to overcome in order to learn meaningfully and consequently perform well. Besides, the enormous influence of the textbook cannot and must not be underrated. Regardless of what we may want to create with respect to curriculum materials, the textbook (at present) still holds a dominating and an unparalleled place of importance influencing the content of what is target in our schools at all levels of education!

Our research findings show that due to the variety of demands on classroom teachers they (at least 70%) welcome and utilize textbooks, workbooks and other reference materials in deciding what their students will study, in what order and, for what ends. This is irrespective of the overtly stated curriculum content (Olorundare 1985a, b; 1986; 1993a; 1998b). Thus, in theory, the curriculum content is expected to be taught and learned in detail; unfortunately, and in practice, the textbook now becomes a form of pedagogical dependency for the teacher. It is the textbook that defines content of what should be taught and learned as well as its organization (around various topics/sections). Many textbooks even provide teachers with nature and sequences of their own activities what questions to ask, assignments and take home tests, activities that that students should engage in to ensure appropriate coverage of the curriculum.

We have analysed the significant role of the teacher in the successful implementation of the official curriculum. Unfortunately, no matter the scale of reforms that are being introduced to promote improvement in students' learning, our classroom teachers still rely upon science textbooks for determining specifics of curriculum to implement.

Students' Performance and Learning Difficulties in the Sciences

The actualization of the policy provisions for the school system in Nigeria has been developmental. Since the time of the colonial authorities, the science curriculum in Nigeria has witnessed several and remarkable development initiatives. As at present, effort are still being vigorously made to ensure that our science curriculum meets global standards. There are very recent modifications in the secondary school curriculum that are expected to improve citizen's general literacy levels and individual self-reliance (Obioma, 2005). As well intentioned as these developments efforts are, there is an identified underlying and recurring problem: students' poor performances in the sciences. Due to the pursuit of national development and security, the issue of students' performance has recently attracted an alarming concern from major stakeholders: parents, governments at every level, classroom teachers, administrators, policy makers, educational experts as well as politicians and private sector officials.

Performance of students in the sciences and especially at the end of secondary education has not improved in the past decade as reflected in the Chief Examiners' Annual Reports of both the West African Examination Council, WAEC 2007-2012; and National Examination Council, NECO our regional and national educational examination bodies respectively. Students' performances are generally below expectations and such that this "monster" of failure has taken over, unleashing its fury on our students year after year. Besides, the harvest of academic failure has brought many students to their knees in tears. Every academic year, the nation is grieved by the below average performance of thousands of students in examinations conducted by the West African Examinations Council (WAEC), the National Examinations Council (NECO) and the Joint Admissions and Matriculation Board (JAMB) where only 20 per cent of the candidates pass at acceptable credit level to be comfortably able to obtain admission to further studies at university level.

Mr. Vice-Chancellor Sir, performance in the context of this lecture refers to the fact that too many students score low marks close to or even below predetermined cut off point. It is when majority or generality of candidates obtain low or failing grades in this case below credit level (Olorundare, 2014). The situation of poor performance has become so bad that students fear public examination bodies like a dreaded plague and for most of them, the fear of the examination bodies such as WAEC and JAMB is the beginning of wisdom. Statistics released by the Joint Admission and Matriculation Board JAMB revealed that from 2007 to 2009, a total of 2,993,197 candidates sat for the University Matriculation Examination, but only 427,777 of them secured admission in universities nationwide (JAMB, 2011; Oyelekan, Olorundare & Anyimigbo 2013). The figures today as at May 2014 are more pronounced as well as scaring! This is in spite of the very large increase in the number of universities in the country five years later. Similar reports also from WAEC indicate that the level of attainment of candidates in all school subjects over the years has been appalling. Recently released WASSCE and NECO results for the last exercise do not bring cheering news either (Ahmed, Danmole & Olorundare, 2014; Babalola, 2013; Olorundare, 2014; Oyelekan, Olorundare & Anyimigbo 2013).

An examination of past performances of students in secondary school indicates that in 2005, only 27.53 per cent obtained five credits in core subjects, while 15.56 per cent passed in 2006. In 2007, 25.54 per cent scaled the line; with the worst performance of 13.76 per cent passed the examination, a figure that went down in 2010 to 20.04 percent (JAMB, 2011; Olorundare, 2010b; Olorundare, 2011e; Oyelekan, Olorundare & Anyimigbo 2013)

Table 1a

WAECs' School Certificate Results for Biology, Chemistry, Physics, Agricultural Science and Mathematics: May/June2008-2012

Year	Subject	Total Entry	Total Sat (%)	Distinction & Credit (%)	Pass 7-8 (%)	Total 1-8 (%)	Failure F9 (%)
2008	Biology	1,285,048	1,259,965 (98.1)	427,644 (33.9)	329,961 (26.2)	757,605 (60.1)	484,071 (38.4)
	Chemistry	428,513	418,423 (98.0)	185,949 (44.4)	114,697 (27.4)	300,646 (71.9)	110,417 (26.4)
	Physics	424,893	415,113 (97.7)	200,345 (44.3)	91,116 (22.0)	291,461 (70.2)	116,776 (28.1)
	Agricultural Science	1,025,513	985,740 (96.1)	436,751 (44.3)	207,336 (21.0)	644,087 (65.3)	326,339 (33.1)
	Maths	1,292,890	1,268,213 (98.1)	726,398 (57.3)	302,266 (23.8)	102,866 (81.1)	218,618 (17.2)
2009	Biology	1,364,655	1,340,206 (98.2)	383,112 (28.6)	413,014 (30.8)	796,126 (59.4)	471,312 (35.2)
	Chemistry	478,235	468,546 (98.0)	204,726 (43.7)	114,020 (24.3)	318,746 (68.0)	119,260 (25.5)
	Physics	474,887	465,636 (98.1)	222,722 (47.8)	141,595 (30.4)	364,317 (78.2)	79,919 (17.2)
	Agricultural Science	1,096,682	1,059,983 (16.7)	491,972 (46.4)	238,215 (22.5)	730,187 (68.9)	279,199 (26.3)
	Maths	1,373,009	1,348,528 (98.2)	634,382 (47.0)	344,635 (25.6)	979,017 (72.6)	315,738 (23.3)
2010	Biology	1,325,408	1,300,418 (98.1)	427,644 (33.9)	329,961 (26.2)	757,605 (60.1)	484,071 (38.40
	Chemistry	477,573	465,643 (97.5)	236,043 (50.7)	109,944 (23.6)	346,003 (74.3)	988,165 (21.1)
	Physics	475,414	463,755 (97.6)	237,756 (51.3)	122,417 (26.4)	360,173 (77.7)	84,716 (18.3)
	Agricultural Science	1,062,496	1,024,039 (96.4)	483,888 (47.3)	133,069 (22.8)	716,957 (70.0)	277,013 (27.1)
	Maths	1,331,374	1,306,535 (98.1)	548,065 (42.0)	363,920 (27.9)	911,985 (69.8)	355,382 (27.2)

Table 1b

WAECs' School Certificate Results for Biology, Chemistry, Physics, Agricultural Science and Mathematics: May/June2008-2012

Year	Subject	Total Entry	Total Sat (%)	Distinction & Credit (%)	Pass 7-8 (%)	Total 1-8 (%)	Failure F9 (%)
2011	Biology	1,532,770	1,50,5199 (98.20)	579,432 (38.50)	474,664 (31.46)	1,054,096 (69.96)	421412 (27.93)
	Chemistry	575,757	565,692 (98.25)	280,250 (49.54)	151,627 (26.80)	431,877 (76.34)	129,102 (22.82)
	Physics	573,043	563,161 (98.28)	360,096 (63.94)	115,158 (20.45)	360,173 (77.7)	66,236 (11.76)
	Agricultural Science	1,238,496	1,190,796 (96.14)	626,417 52.60	273,312 (22.95)	899,729 (75.55)	276,939 (23.26)
	Maths	1,540,141	1,508,965 (97.98)	608,866 (40.35)	474,664 (31.46)	1,083,530 (71.81)	42,1421 (27.93)
2012	Biology	1,687788	1,646,150 (97.53)	587,044 (35.66)	465139 (28.26)	1,052,183 (63.92)	555827 (33.77)
	Chemistry	641,622	627,302 (97.77)	270,570 (43.13)	192773 (30.73)	463343 (73.86)	148,344 (23.65)
	Physics	638838	624,658 (97.78)	429415 (68.74)	120,369 (19.27)	549784 (88.01)	57,440 (09.20)
	Agricultural Science	1,367,713	1,318597 (96.41)	691,499 (52.44)	278,293 (21.11)	969,792 (73.55)	320,084 (24.27)
	Maths	1,695,878	1,658,357 (97.79)	838,879 (50.58)	278,293 (21.11)	1,117,172 (71.69)	320,084 (24.27)

Source: *West African Examinations Council (WAEC) Office, Yaba, Lagos (2014).*

A perusal of students' recent performance in the sciences as shown in Tables 1a & 1b is worrisome. With a criterion performance at credit level, students consistently performed poorly in biology between the ranges of (28-38%), while the performances of students in chemistry ranged from 43-50%. In physics a range of 44-64% ensured but with an increased performance to 68%. Performances in Mathematics decreased from 57-40% but increased to 50 percent in 2012 results. These figures show undulating performances in such a manner that we cannot affirm improvement in students' general performances. Performances in physics are generally better with respect to percentages and this can be understood in the sense that fewer students enrol for physics with the general belief that it is more difficult than others. Consequently, only students who are confident of themselves usually enrol for the subject.

Students' performance in chemistry is not as encouraging as it is obtained for physics. Larger numbers of students enrol for biology because of the erroneous perception that it is an easy subject and since until recently, every candidate must offer at least one science subject. It is no wonder the overall performances in biology are disappointedly worse than other subjects. Mathematics is compulsory subject for all candidates. In whatever perspective these figures may be examined, these performances are not encouraging. Previous years are not much different. The secondary school students are not performing well in the sciences (Busari, 1995; Olorundare & Upahi, 2012; Olorundare, 2014).

Could this be as a result of teachers' ineffectiveness in classroom interaction with students or students' innate characteristics, structural and instructional faults/inadequacies the nature of the facilities and learning environment (classroom ecology) or socio-cultural factors? These questions are continually being asked by individuals, organizations and especially educational researchers.

As a science educator and curriculum expert, I have been actively involved in collaboration with colleagues and other scholars to unravel factors that could be responsible for students' poor performances in science subjects. Findings from our studies as well as from those of other researchers reported within and outside Nigeria show that this situation could be adduced to certain pedagogical and socio-psychological intervening factors (Okebukola, 1997; Olorundare 1989a, 1989c, 1999; Odimayo, Nwabuisi, Fawotade & Olorundare 2010). For instance, it is not unusual to find students in many secondary schools who never witnessed regular chemistry laboratory preparations of simple compounds such as Hydrogen (H2) and Carbon(IV) oxide, at the time they were ready for their school certificate examinations. It is at such a time their schools hurriedly source for relevant materials and equipment from external or established institutions (Colleges of Education, Polytechnics) to get their students prepared. Besides, most science courses in our schools are taught in ways that the students are made to become superficial conservators of science knowledge.

Mr. Vice-Chancellor Sir, my research focus has been to identify and confront factors that are not obviously and overtly considered in the official science curriculum. There have been found behind the surface, factors that hinder students' understanding and achievement in science subjects. Our efforts have been able to unravel *deep* or even *hidden* causes of students' poor performance in the sciences. These are learning difficulties experienced by them in the process of learning and understating of science concepts as presented by the science teacher. These difficulties were either not envisaged by developers of official curriculum or were ignored. Both the classroom teacher and his students confront these difficulties and would have to overcome them if any meaningful learning is to take place. Unfortunately, many science teachers are unable to properly help their students overcome these difficulties.

Research evidence abounds to show that there are difficult concepts in the various science subjects which students find difficult to learn and even for teachers to teach. Efforts have been made to catalogue many of the difficulties and also, determine reasons behind such students' difficulties. Mr. Vice-Chancellor Sir, we have been able to undertake investigations into the type of difficulties students face in learning chemistry, the specific areas in chemistry where most of these difficulties are and, the reasons for such difficulties. Our findings consistently showed that in secondary school chemistry curriculum for instance, the following concepts/topics are difficult for students to learn and even some for teachers to teach!

Electrolysis/electrochemical cells, oxidation-reduction (Redox) reactions, stoichiometry mole concept, stoichiometry, ionic equation molecule, energy effects in chemical reactions electronic configuration, atomic orbitals as well as principal quantum numbers, functional groups of organic compounds, volumetric analysis and solubility have all been identified as difficult to learn (Olorundare, 1989, 1990; 2014; Upahi & Olorundare, 2011; Oyelekan & Olorundare 2009; Adebayo 2008; Babatunde, 2009; Upahi 2010; Oyelekan, 2006; 2008; Oyelekan, Olorundare & Anyimigbo 2013; Ige & Olorundare, 2013; Aluko & Olorundare, 2011).

Learning Difficulties and Superstitious Beliefs

It is today an obvious fact that we live in a world that is continuously fashioned and dominated by science; technology and their products and, which are also largely responsible for the changes and increasing complexity of our world and culture. The appropriate teaching of science in our schools is expected to assist our teaming youths in coping with these changes and thus live productive lives as adults and responsible citizens of our country. A major signal in the crisis in science education is the apparent decline in scientific knowledge among school children and the general citizenry. It has earlier been alluded to in this lecture that, there exists a continuous low enrolment in science courses coupled with students' poor performance in external examinations (WASSCE, NECO, and UTME).

Mr. Vice-Chancellor Sir, I wish to submit that findings from our studies have shown the prevalence of superstitious beliefs as a major inhibiting factor to children's learning of science concepts. In the investigations undertaken and which would be discussed shortly, it was found that learners' embracement of superstitious beliefs negatively affected their capability of understanding scientific concepts and phenomena (Olorundare 1985a, c; 1987b; 1990; 2000a, b; 2011b, d; 2014).

It had been suggested by Okebukola (1997) that even though knowledge in science is universal, the mode by which learners acquire this knowledge is anything but universal across cultures. He affirmed that cultural and environmental factors exist and that these could significantly influence children's learning of science. In a much earlier discourse, Abimbola (1977) had shed great light into the presence and influence of superstitious beliefs especially among African children seeking to learn science. He observed that:

...The problem is that the African child comes to the school with a load of mysteries that plague his mind. If care is not taken, these mysteries usually tagged 'superstitions' are capable of causing blockage to any scientific knowledge the child might acquire as a result of schooling... (p. 23)

The concept of superstition entails an individual holding a belief rooted in magic, chances, cultural idiosyncrasies, misdirected or even misinformed attitude and conception towards nature or events in nature. There is usually no factual evidence to back or support such attitudinal positions. Much of superstitious beliefs proceed from ignorance, unreasoning fear of the unknown or, the mysterious and surprisingly, they influence the individual's perception of reality.

I have since been interested in determining how prevalent superstitious beliefs are among practicing teachers of science and their students, the source of these beliefs and how they actually affected science teaching and learning especially at the lower cadre of educational system. Findings from my studies in this area are confounding in the sense that, not only are superstitious beliefs prevalent among and 'harmful' to children in their learning of scientific concepts and phenomena, the classroom teachers were found to often possess these 'unfounded' beliefs, and hence taught the children accordingly!

In a topic on "classification and characteristics of soil types", pupils in one of the primary schools refused to accept the teachers scientific classification because they believe that certain *"...evil spirits or gods"* were responsible for the constituents of sand, clay or loamy soils. In yet another school, pupils resisted their teacher's attempt to relate and explain the chemical formation of soaps. They told him they could not use soaps on Wednesdays because if they did so, they would have bad luck! In their view, their science lessons usually held as double periods on Wednesdays were a waste of time. In one school, a teacher reported how uneasy his students always felt each time he taught lessons relating to atoms, space. According to him:

> ...these children don't like the subject because of what beliefs they brought here. I mean, they believe all these superstitious beliefs. They said that they have been told by their priest that scientists are trying to discover the work of God... They don't want to offend the teaching and beliefs of their old people. If they do, that means bad luck... (Olorundare, 1985a; p. 200).

In the studies earlier referred to, teachers who were 'victims' of these monistic world views or beliefs also misrepresented scientific facts or processes in their classrooms. Such situations as these created much gap and even discrepancies between what was officially prescribed curriculum on the surface and what actually transpired beyond the surface.

Mr. Vice-Chancellor Sir, permit me to present a few vignettes of the several superstitious beliefs we found to be commonly held by children and a sizeable number of their teachers of science (Olorundare, 1985a; 1999; 2000a, b, c).

1. *"Children are told that if they cup their hands to collect water drops of rain, the god of thunder (Sango) which they worship will smash their heads."* There is no scientific evidence to back up this superstition. Traditional education allows no room for criticism and

verification. The African child has been a victim of his environment in which his life is regulated by ancient taboos, medicine men, "juju" black magic and witchcraft and share folklore.

2. *"Only wicked people are struck by lightning".* As a consequence, whenever lightning strikes a person dead or it descends upon a house, it is generally believed that such a person has committed some atrocities and that the household so struck is evil. The same belief goes for thunder; but here, the god of thunder is offended by the evil doers and consequently, the god strikes back." Scientifically, lightning thunder, tornadoes, hurricanes and the likes take place due to weather conditions. Thunder is not an individual who gets annoyed when offended. Winds are violent within the thunderstorm, as warm air races past cold air and the electric field created within the cloud becomes highly charged. Lightning therefore flashes, and the sound of thunder is heard across the land.

3. *"The eggs vomited by a Crocodile is the cause of the rainbow (Imi Osumare in Yoruba). They also believed that if someone is able to use magical means to collect the eggs without the knowledge of the crocodile, such an individual will become a wealthy man within his society".* Scientifically, the rainbow is formed when drops of water in the atmosphere are refracted by rays of light. It has nothing to do with a 'spirit' drinking water!.

4. *"If one mishandles a chameleon and it hisses, the god of thunder (Sango) will cause thunder to kill the person."* Scientifically, if the chameleon hisses nothing will happen. It is a natural defence mechanism. All animals react in one way or the other when threatened.

5. *"When the sun is shining very brightly and at the same time the rain is falling, people believed that at this particular time, a particular leopard is delivering her*

cobs somewhere." Scientifically, it is caused by a type of rainfall called conventional rainfall; which takes place in regions that are intensely heated, either during the day as in the tropics, or in the summer as in temperate regions.

6.. *"There is an African belief that a child must be able to stand up and walk within twelve (12) months of birth; where a child fails to walk within 12 months, the mother is charged with infidelity."* There are now many scientific instruments; in form of toys made for the children at that age to get up and learn to walk without any traditional bias behind it.

7. *"Sacrifices should be made to the 'earth' because it is on it that we plant and harvest our food crops. Any year of low productivity is to be regarded as annoyance of the earth. The latter should be appeased by pouring or throwing the portion of our (wine) drinks and food on the ground. Sometimes it is dead relations who are angry with the living".* Scientifically, the low productivity of the crops may be as a result of infertility of the soil, lateness in sowing of planting crops or the crops planted may be unsuitable. Agriculturally, the soil needs to be fertilized; the crop seeds need to be planted on time too.

It will interest this august audience to note that, both pupils and teachers hold deep-rooted superstitious beliefs. For instance, 85% of pupils and 65% of teachers had at least two of the above superstitious beliefs which they strongly held and were not ready to discard. Most of the science pupils (72%) viewed superstitious beliefs as competing values with scientific knowledge. Only 37% of the teachers viewed them that way.

Over the years, I have been actively (and still) involved in several workshops across many states with teachers of science at both primary and secondary school. In those workshops the issue of superstitious beliefs were raised, discussed with practical strategies; teachers could utilize in reducing their students' hold on superstitions (Olorundare, 1990; 2000b; 2001a; 2001b; 2006a; 2006b; 2011a; 2011c).

Learning Difficulties and Misconceptions: the Constructivist Interface

It is a fact that students have serious difficulties in learning science topics and especially the difficult areas even if their teacher taught and dispensed knowledge as appropriately as required of him by the curriculum. This view has made science educators to more carefully re-examine the nature of the learner and how children actually learn. It is now known that learners respond to formal instruction based and shaped by their preconceived or pre-existing ideas, perspectives or beliefs. As a consequence, the individual learner would construct a sense of knowledge for himself that guides his learning behaviour. Many of students' learning difficulties are rooted in this perspective. This is because, they do not only gain access to new scientific information but have to appropriately integrate such information with "something" 'wrong' 'naive' or even 'unscientific' ideas. This is why learners' past-experiences do affect their success or otherwise when it comes to integrating and understanding the new information. Failure to do this would bring contradiction and even confusion.

The central 'thesis of the constructivist theory of learning is rooted in Ausubel's famous and generally accepted submission/assertion that, "the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, 1968 p. 4). The implication of this assertion for science teaching and learning is a driving force for research in student's learning difficulties by the academic disciples of the theory of constructivism, of which this lecturer is one.

Mr. Vice-Chancellor Sir, our current research in science education has shown that a students' inability to get "it right" might not be due only to the fact that he failed to assimilate a piece of information due to lack of understanding but, because of the interference of his preconceptions which in most cases are 'misconceptions' or 'alternative' conceptions or erroneous interpretation, none of which is scientifically correct. These situations play prominent roles in meaningful learning and problem solving in science. This nature of the learner is a constructivist view of learning. It recognizes the central role of content as well as the fact that, learners build conceptual frameworks that are both complex, highly organized and which are very much tied to specific subject matter (Olorundare, 2001a & Kelly, 1991).

Constructivism is a multidisciplinary approach to understanding the learner and how and why he learns meaningfully. It is based on observation and scientific study about how people learn. Learners are active creators of their own knowledge and, in order to do this, they must ask questions, explore and assess what they know. This view of learning is based on the perception that knowledge cannot just be given to a learner by the teacher but that rather; it is constructed by the learner through an active, mental process of development. Besides, the learner takes full responsibility for his own learning.

In a constructivist learning environment, the teacher makes effort to understand his students' pre-existing conceptions as well as lead them to be actively involved and constantly assess how their activities are helping them to gain understanding. These characteristic features differentiate constructivist learning situation from traditional classroom. In the former, learners are actively being involved, class is being learner-centred, learning environment being democratic, class activities being interactive and the teacher being a guide or facilitator for learning (Olorundare, 2000b; 2001a; 2001b; 2011a; 2011d).

Mr. Vice-Chancellor Sir, research in science education has one of its major foci: improvement in the teaching and learning of the sciences. If there is no 'pay-off' in the classroom, then there is no fair reason to engage in research in education.

Our research on students' difficulties in the learning of science has been premised on the constructivist's view that students construct their own individual conceptions and those ones that differ from scientific concepts do seriously interfere with their learning of science concepts. When the two are not in consonance, difficulty arises on the part of the student since, what is presented by the teacher 'contradicts' his already settled conception. Thus, it is of utmost importance that students' misconceptions, naive or alternative conceptions are identified and properly addressed when designing and implementing the science curriculum.

Misconceptions are a major source of difficulty for students in learning meaningfully science concepts. As has been demonstrated from our research, have teachers even have misconceptions of their own and these further compound what is actually taught to the students (Olorundare, 1985a; 1987a; 1990; 1993; 2000b).

The preceding developments have in effect led to various strategies for the improvement of learner's performances in science. Active participation of the learner coupled with the changing role of the classroom teacher is an evidence of the paradigm shift in the practice of education. The trend today is to use strategies that promote active and effective learning that eventually lead to meaningful and purposeful learning in the classroom. The quality of teaching is being improved through the gradual changing of teaching styles toward liberal and learners-centred instructional methods and practices.

Effective teaching and hence effective learning are important foci for educational researchers and practitioners. Various instructional strategies have emerged from recent developments in educational research. These include active learning pedagogies of concept-mapping, analogy, competitive cooperative learning, Concept Test etc. These have been used in our studies and we have found them to enhance learning and also lead directly to improved students' performance and educational outcomes. These instructional strategies have also been shared with classroom science teachers during workshops in chemistry teaching (Olorundare & Aderogba, 2009; Adebayo, 2008; Musa, 2010; Olorundare 2001a, 2006a, b; 2013a; Aluko & Olorundare, 2011; Akande & Olorundare, 2012).

Mr. Vice-Chancellor Sir, recent advancements in the teaching and learning of science have placed a great deal of emphasis on 'Effective Teaching/Learning'. It is radically different from the age-long teacher-dominated status quo. The new shift encourages active participation and involvement by students, thus leading to their better understanding of science concepts. This emphasis also encourages more learning than teaching and does not require undue extra time. It is also more enterprising and leads to the development of self-reliance skills in the learner. The new shift actually brings about a change in student-student, student-teacher relationship and interactions, and as such, creates safe and conducive intellectual learning environment. I have presented and advocated for this new shift elsewhere as shown in table 2 (Olorundare 2006a, b; 2010b; 2011d Aluko & Olorundare, 2011;).

Table 2
Shifts in teaching for effective learning

Less emphasis on	**More emphasis on**
Rigidly following curriculum	Selecting and adapting curriculum
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge and inquiry processes; learners construct knowledge.
Presenting scientific knowledge through lecture, text and demonstration	Guiding students in active and extended scientific inquiry – disadvantage caused by non-availability of resources & funds.
Teaching students for factual information at the end of the unit or chapter	Continuously assessing student understanding – evaluation of students' understanding should be multi-faceted and continuous.
Maintaining responsibility and authority	Sharing responsibility for learning with students i.e. cooperativeness.
Supporting competition	Supporting a science classroom community built on cooperative learning is very effective, shared responsibility, and respect.

In table 2, the role of the science teacher is being transformed from one of primary dispenser of knowledge to one of being a facilitator of learning. This is a more demanding role in many ways. The teacher provides information in the context of a rich learning environment, in which the student is an active learner. Rather than the teacher telling the students what they are to learn the teacher sets up an environment where the student can be active in acquiring knowledge, mainly through the process of experimentation and discourse (Olorundare, 2006a, b; 2010b, c; Olorundare & Upahi, 2013).

We have undertaken several investigations with respect to identification of students' misconception in science at the primary school level as well as those held by chemistry students at both secondary school and College of Education levels. These studies have spanned over two decades and have mainly targeted science and chemistry concepts and topics that have been found to be difficult to learn by students at each level (Olorundare, 1985a, 1996a, b; 2000). The studies employed various research methodologies ranging from surveys, clinical interviews of participants, quantitative and qualitative classroom observations and intervention as well as quasi-experimental methods. Findings from these studies were very instructive as they provided rich information as to the nature, types and sources of misconceptions commonly held by students and which have created difficulties for their learning and understanding of scientific concepts. Results from these studies have been used to inform and sensitize classroom science teachers during the different workshops I have been privileged to actively participate and even directed. These workshops involved practicing chemistry teachers from secondary schools across several states in the country as well as primary school teachers in two states. Kwara and Niger. Findings from our studies and corresponding implications were shared with these science teachers during the workshops (Olorundare 1985a, b; 1990; 2000b; 2006a, b; 2010a, b, c, 2011a, b; 2014).

The findings from our studies generally confirmed the existence of misconceptions and their negative effect on students' understanding of the difficult concepts. We were also able to confirm that even classroom science teachers were not 'free' from misconceptions!

There is therefore a major difference between teachers (curricular) intentions and learning that actually takes place. The difference between what the learners learn and what was given to them to learn can be due to differences between the ideas they brought to the lessons and ideas which teachers themselves assumed the children would have brought to the classroom situation. These are definite scenarios of ‘beyond the surface phenomena’. What transpired in practice was not what was required theoretically (Okebukola, 1997; Olorundare, 1985a; 1990; Olorundare & Upahi, 2013)

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Learning Difficulties and ICT Utilization

Classroom interaction thrives on communication and because of this, the field of education had become the place where various communication technologies converge and are tested. The new trend for education worldwide is to gradually explore the advantage which Information and Communication Technology (ICT) creates for both teacher and learner. And as we proceed in this new millennium, classroom walls will gradually give way to virtual classes that accommodate everyone, everything and every situation! Teachers at all levels of schooling will do well to be prepared for such radical revolution otherwise, they will be caught unawares. This is because our students have already embraced this technology and are waiting particularly for their teachers to catch-up. Even, JAMB one of the major examination bodies in Nigeria has embraced the use of ICT to conduct Unified Tertiary Matriculation Examination (UTME).

Right here in the University of Ilorin (the University that is Better By Far), the provision of individual student with mini iPads/PC Tablets provision and use of smartboards for lectures and seminars and the conduct of students' entrance and sessions' examinations purely using ICT facilities, are dividends of the revolutionary developments on the academic front. I salute the courage and dedication of our amiable Vice Chancellor, Professor Abdul Ganiyu Ambali. Your predecessors have laboured to lay very good foundations and you are doing an excellent work in advancing development at every front. Modern teaching of science topics would need to focus on the use of electronic support for collaborative learning and work.

In order to achieve the preceding, science teachers at all levels must be internet complaint, This is necessary because, given the vast information network of the net at their disposal, students often tend not to take their studies seriously as assignments and exercises can be done easily and in record time through surfing the electronic superhighway. Assignments are no longer as challenging or as involving as before. The greater risk, however, is that unless and until concerted effort is made to properly orient students, scholarship and high academic standard may be compromised. An average Nigerian youth knows more about the European Football League; than the challenges and successes of West African or Nigerian Football. He can spend hours chatting away on facebook; tweeting on twitter; pinging on Blackberry Messenger, and yet cannot stand to address his own colleagues on topics taught in class, other than music or African magic movies. The revolution in ICT is stealing away the youths from worthwhile education. The GSM technology promises to further frustrate intellectual scholarship especially in the area of written English! (Olorundare, 2011).

The internet and ICT tools are gradually changing the age-long perceived role of the classroom. Internet is now the unrivalled source of information on virtually any topic and subject. Its' use will undoubtedly create a lesser role for the teacher and a more creative one for the learner (Olorundare, 1983, 1988a, c; 2011d; Yusuf, 2005).

Furthermore, education is no longer limited by the four walls of a classroom and the authority of the teacher but by the freedom of cyber space. Fig. 4 shows how teacher, learner and resource centre (in this case, the worldwide web; cyberspace) relate in the ensuing e-episode.

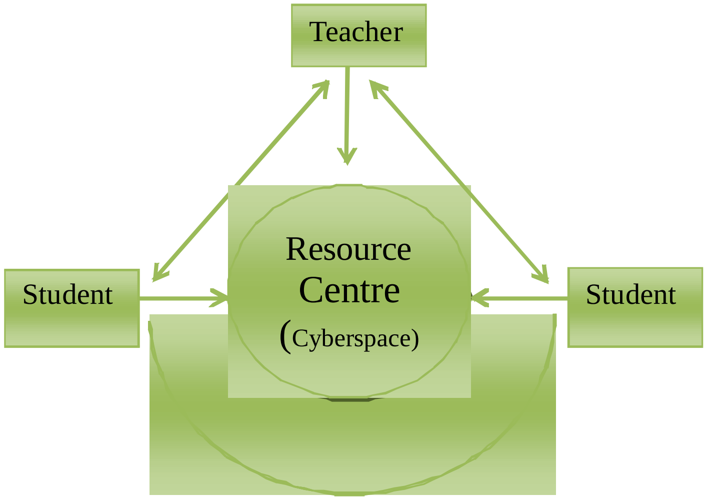

Figure 4: Teacher-learner interaction cone in modern perspective

From the diagram, it is clear that the teacher is fast losing his central position to the internet. He is no longer the bridge between knowledge and the learners since he has just as much capacity to access online information as his students. Besides, learners themselves could easily engage more in cooperative learning as they gain confidence and independence from the teacher. He must now facilitate his classes from the horizontal (equality) point of view, rather than from a vertical (high-up) point of view. These emerging issues must be cultivated by all stakeholders in the school system.

In the 'new' ICT e-teaching and e-learning dispensation, students could be seated to face each other in pairs and groups as they work on the same theme. Such classroom structure allow for talking and even movement as students to consult with each other and resort to the 'resource centre' to solve naughty issues (Olorundare, 2011a; 2011d; 2013c).

Mr. Vice-Chancellor Sir, I am happy to inform you and this august audience that our recent research endeavours in my Research Team has focused on the design, installation and utilization of ICT tools for teaching and learning difficult concepts in chemistry. While this effort is still actively on-going, it may be of interest to you to hear that the Nigerian Universities Commission (NUC) National Award for the Best Doctoral Thesis in Education in all Nigerian Universities in 2009 was given to one of my former Ph.D. supervisee, Dr. Solomon Oyelekan. The one encouraging thing about this research is the fact that, it utilized purely ICT tools to help resolve learning difficulties students have in the area of electrochemistry. We are already actively extending the scope and techniques of this research into other areas of chemistry.

Figure 5: NUC's National Award of Best Ph. D. thesis to Dr. O. S. Oyelekan (from left-right: Dr S. O. Oyelekan (the Awardee) Professor I. O. Oloyede (the immediate Past Vice-Chancellor of University of Ilorin), Professor A. S. Olorundare (the Supervisor), and Professor C. O. Bewaji (The Dean, Postgraduate School).

Enhancing Scientific Literacy through Science Education

One of the major signals of crisis in Science Education is the severe decline in scientific knowledge among the general citizenry of this country as well as among students. Citizens need more knowledge about the rapidly changing scientific and technological environment in which they live, not less. Democracy is good and should be the main focus of governance but, democracy cannot and would not function optimally and effectively without citizens who can reason about science, not just to recite facts about science. If citizens are to achieve their individual full potential, they have to be provided with scientific and technological education that appropriately meets their needs.

The general citizenry have obligation to be scientifically literate and an important and primary goal of Science Education is the development of a scientifically literate general populace. Education in science such that the average individual is empowered to understand the interrelationship of science, technology and society and how these influence one another. It is always hoped that citizens would utilize scientific knowledge for everyday decision making.

Scientific literacy, like many other educational labels, is at best an educational slogan in the science education parlance. Different authors and science education scholars explain it as different combinations in whole or in part of the science curriculum emphases primarily, the goals of science education. It is interpreted by some as trying to sell science to all, while others see it as a spirited effort at providing the generality of citizenry with a science education that is different from the very few in society who are or would be professionals (scientists engineers, physicians) but for the larger percentage of the population are not really engaged directly with science. These are ordinary working citizens. No citizen can be said to be literate in our modern society unless and until he possesses a basic understanding and appreciation of science and its work and methodology of knowledge generation (Olorundare, 1983, 1988a, 1988d 1996c, 2001a, 2011d; Oyelekan & Olorundare, 2009).

Scientific literacy cannot be construed as only the production of scientific and technical manpower. In whatever perspective we view scientific literacy; it should be an essential component of our general education for the general population. Scientifically literate individuals would have specific characteristics which include but not limited to an understanding of the basic nature of and concepts in science, ethics which control the behaviour of the scientist and the relationships of science and society on the one hand and of science and the humanities on the other hand. Such individuals would also have basic understanding between science and technology (Pella, O'Hearn, & Gale, 1966; Olorundare, 1986, 2011c; Olorundare & Upahi 2013). This means that the knowledge which makes up the contents of the library of science becomes functional in the lives of people.

In oceanic voyages and naval parlance, it is generally accepted that 'a rising tide lifts all ships'. This is analogous to the concept ideology and role of science education in fostering and building a scientifically literate citizenry. We must not ignore the magnitude of the task of improving science education in all of its aspects. Scientific literacy is both the outcome of; and a condition for science (teaching and learning) education (figure 6).

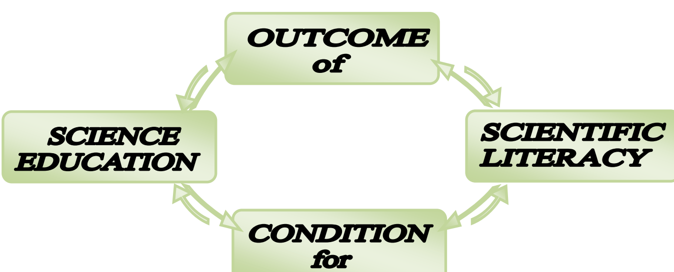

Figure 6: Interrelationship of Science Education and Scientific Literacy

At this stage of our country's development, with our country 'boasting' of being the largest economy in Africa and even hosting the World Economic Forum for Africa (WEFA) in May this year, science education for non-specialist citizens must be rescued from its present waning status. Nigeria needs leaders who have basic knowledge of scientific principles and technology.

Mr. Vice-Chancellor Sir, a major and disturbing educational phenomenon in the recent years, however, is the drift from science. There is a decline in recruitment of youth into science. Our young adults who expectedly are to provide this nation with the scientific workforce and thus spearhead original scientific research for the 21st century and beyond are mostly going the way of the humanities, social sciences and business studies rather than the basic sciences. There is an urgent need to discard this national complacency. As important and central to our welfare as science and technology are, the attention given to science education in our education system (60% Science and 40% Humanities admission) is inadequate and at best, superficial.

At the primary school level, science is not a substantial curricular requirement or pursuit and at best it is taught superficially (Olorundare, 1988c; 1987b, c; 1990; 1996a, b). In the secondary schools, the main focus remains getting students to pass the external examinations of WASSCE, SSCE, UTME, among others. There is an urgent need to address the prevalence of this problem.

Mr. Vice-Chancellor Sir, I wish to submit that the severe shortcomings in science education, prevalent at both primary and even secondary school levels represents a pressing practical problem. There is a subdued and even seemingly negligent attitude and commitment by stakeholders to technical and polytechnic education. As at present, polytechnic lecturers have been on strike since over nine months and no visible practical and effective response to stem the gradual drift to a state of technical comatose! In theory, the country *'boasts'* of several polytechnics but in practice, the situations within these institutions are an eyesore! Our problem is beyond the surface dressed curriculum we project. Recently, the Federal Government through the NERDC introduced 39 new subjects to our secondary school curriculum. Under this new organization, English language, Mathematics, Civic as well as trade/Entrepreneurial Studies constitute the core courses while science, humanities, business and technology are the *other categories!* Science is not a priority. This is a disturbing direction and of great concern for science educators. It further shows there is still apathy to science teaching and learning.

My other Contributions

Mr. Vice-Chancellor Sir, I have in the course of this lecture presented and discussed investigations my research colleagues and I carried out. I have also stated how our findings have been positively utilized to improve teaching and learning in the primary science and secondary school classrooms. In this section, I wish to outline some other important but indirect contributions as a Science Educator.

1. The problem of poor and inadequate science materials, equipment, apparatus and well-equipped laboratories for teaching/learning of science is worrisome. This is more pronounced at the secondary school level where majority of school laboratories are not well-equipped. In most primary schools it is worse. One major way out of tackling these problems is for the fabrication, production and utilization of improvised materials/equipment by classroom science teachers. I have served as a Chief Resource Persons for UNESCO organized workshops for science teachers. Specifically, I conducted workshops for in-service classroom chemistry teachers drawn from several states across two geopolitical zones of Nigeria. These workshops involved designing and developing improvisation materials or apparatus for teaching various topics in chemistry including identified difficult ones. Innovative effective methods of teaching difficult topics

in chemistry were also shared with the chemistry teachers. The latter had over the years been sharing their experiences with other teachers. We have been able to catalogue improvised materials, equipment or apparatus that teachers could use.

2. I have actively participated in curriculum development workshops and training for primary school teachers. I developed training modules for pre-primary school teachers and caregivers of ECCDE centres on modern techniques of teaching as well as improvisation and utilization of teaching aids in Niger State.

3. I served as Resource Person to World Bank Assisted Project for primary school Head-teachers' Cluster Analysis Survey (HCNAS).

4. I have participated actively as a Consultant and Resource Person to UNESCO-NIGERIA on Effective Learning Techniques in science, mathematics and technology. I coordinated the Chemistry Groups. Also, I was a member of the panel of experts that developed and produced the modules UNESCO Reference Book titled: *Effective Teaching and Learning in Higher Education in Africa*.

5. In the past 35 years I have been able to actively participate in the training of several hundred undergraduates in Education. I have specifically supervised over 320 undergraduate research projects in curriculum science, and mathematics education. At the postgraduate levels I have been privileged to successfully supervise to completion and degrees awarded 65 Masters of Education (M. Ed.) students in curriculum studies and Science Education. Ninety per cent of these graduates work were done on the teaching and learning of chemistry.

   I have successfully supervised to completion and degree awarded **17** Doctoral candidates. These individuals have made positive impact on my work as a science educator and curriculum expert. I have been able to collaborate with many of them in the design and conduct of many investigations into the teaching and learning of science at all levels of education.

6. I have served as an External Assessor for the appointment and promotion of high level academics in various Colleges of Education and Universities within and outside this country. In particular I have assessed several Principal and Chief Lecturers in Colleges of Education and 25 Associate Professors and Professors in Universities in and outside Nigeria. Through these exercises, I have been able to share my intellectual viewpoint in both curriculum and Science Education with emerging leaders.

7. I have regularly participated in efforts and projects that affect the professionalization of teaching in Nigeria. Matters that have to do with Teachers Professional Development Professional Standards and Teaching Standards for Teachers are areas of my involvement. These are all projects of the Teachers Registration Council of Nigeria (TRCN); the Federal Government's Regulatory Body in all matters that relate to teaching at all levels, and the teaching profession in general. As the current National Chairman of the Committee of Deans of Education in Nigerian Universities, I am automatically a member of the Board of this prestigious Council.

8. The University of Ilorin received the Nigerian Universities Commission (NUC)'s recognition in 2012 for producing the best Ph. D. Thesis in Education in all Nigerian Universities for the year 2009. Consequently, I was also honoured and awarded as the supervisor of the best Ph.D. thesis in Education.

Conclusion

Science has a very important and dominant role to play in events that shape our welfare and day-to-day living. As important as it is public priority and commitment to its teaching and learning in our schools is disappointingly low. Besides, there is a noticeable drift from science by secondary school graduates to social sciences and other courses considered financially rewarding. Students' performances in science subjects in the major examinations are also generally discouraging.

A major problem affecting teaching and learning in our school system is the contradiction of what is in the official curriculum as opposed to what is actually going on behind the classroom and laboratory doors. On the surface, the science curriculum is well laid out, but in actual practice, gaps and discrepancies are the reality. Students and teachers of science have to confront "hidden" situations that create difficulties in their learning and teaching. The science educator has as his main goal of tackling these hindering forces/factors such that, students can experience meaningful learning, which will consequently, improve their performances in science subjects. A curriculum on paper and a curriculum in practice are too entities which, though, have some form of correspondence to each other, but many times that correspondence is rather remote.

In the words of Paul the Apostle as recorded in II Timothy 3:5, what obtains in our school system is like *"...having a form of godliness, but denying the power thereof..."* On the surface, it is very okay but beyond the surface, there is no power! It is a problem our society is still battling with. Since the school system is a reflection of our culture, what we now see happening is consistent with and a reflection of our culture's proclivity for surface dressing!

Recommendations

1. There currently exists an unhealthy gap between the activities of the scientific community in the various science based faculties, Science Educators and classroom science teachers in the secondary schools. I recommend the creation of a forum where these individuals and experts converge to share ideas about recent developments in their discipline and how these could be harmonised into teaching/learning of science at the secondary school classroom.

2. I wish to recommend the establishment of a National Institute/Centre for Science Education Research that is already well overdue. This Institute should relate directly with university Scientists, Science Educators and other scholars whose activities are relevant to the improvement of the teaching and learning of science at all levels of the education system. It should be an autonomous and a well-funded Research Institute and should organise a yearly 3-4 weeks active training programmes of workshops and seminars for in-service science teachers.

3. I recommend that the professional preparation of our science teachers at both College of Education and University levels should be re-examined and retooled to provide practical opportunities for prospective science teachers in their being aware of the prevalence, nature, sources and effects of non-scientific conceptions of superstitious beliefs and misconceptions.

4. Our teachers are still poorly remunerated and are generally not given a place of respect/honour by the society. These are obvious reasons behind the poor motivation among the teaching force. Thus, I recommend preferential treatment for all categories of qualified teachers by way of actually (not just proposing) establishing and implementing a special teachers salary scale.

The preponderance of sharp and unwholesome practices in which for instance, graduates of geology, engineering and other science-related courses are assigned to teach science subjects and mathematics in our schools should stop. This recommendation requires a coordinated political will to help stem the drastic and acute shortage of qualified science teachers in our school system and also provide a reliable scientific base for the country.

5. Democratic and political leaders who have little or no clue as to the role; complexities; benefits and even risks of events that draw on knowledge of science and technology, will be unable to offer pragmatic leadership. To be scientifically literate should henceforth, be an important part of being a Nigerian citizen! In order to achieve this, I recommend that:

(a) there should commence a vigorous science education campaign in our print and electronic media, primary and secondary schools and in various cities and town to draw attention of the general populace, the science non-specialist citizens to the nature and importance of science, its developments, inventions and the activities of scientists that help to promote a scientifically literate disposition in our citizens;

(b) there should be a compulsory general course in Basic Science for all undergraduate students across our universities. The present exposure to scientific knowledge through General studies is inadequate;

(c) science should be a core subject at the primary school and should be examined separately as it is done for English and Mathematics.

6. It is recommended that practicing science teachers begin to engage in the practice and process of action research. The latter involves the classroom teachers engaging themselves as teacher-researchers, such that even though they are practitioners, they should also be producers and consumers of the curriculum inquiry. Teachers are to combine activities of research and teaching into one.

7. I wish to recommend that pre-service science teacher should be made to undergo mandatory course and certification in

relevant ICT as an additional requirement to qualify and graduate as a science teacher from our Colleges of Education and Universities. This will empower every science teacher with necessary literacy and experiences in the use of the ICT in the classrooms and science laboratories.

8. In order to further explore ways of bridging the gaps created by filtration of official curriculum, I recommend that there should be a renewed emphasis on qualitative and ethnographic research activities on the side of science educators. While surveys and brief one-short quasi-experimental studies are to be encouraged, there is the need for closer and deeper investigations that would actively unveil the realities of curriculum implementation at the school and classroom levels. Better understanding of what creates difficulties in teachers' and students' work would further reduce the various discrepancies noticed.

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Ladies and Gentlemen, Thank you for Listening!

References

Abiala, E. O. (2013). *Quality education in Nigeria: The imperative of teacher motivation and job satisfaction.* Published by Solemilia Resource Centre (SRC) Ibadan.

Abimbola, I. O. (1977). African world-view and school science. *Journal of Science Teachers Association of Nigeria,* 16 (1), 15-28.

Adebayo, S. A. (2008). *Effect of concept-mapping under three learning modes on senior school students' academic performance in Chemistry in Ilorin, Nigeria.* Unpublished Ph. D. thesis. Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Ahmed, M. A., Danmole, B. T. & **Olorundare, A. S.** (2014). Impact of computer assisted instruction on students' achievement in biology in Ilorin West, Kwara State, Nigeria. *Journal of US-China Review* (In press).

Akande B. S. & **Olorundare, A. S.** (2012). A critical analysis of the NCCE sponsored restructuring programme for colleges of education. *Ataba International Journal on Contemporary Issues, 1* (2), 29-40.

Aluko, K. O. & **Olorundare, A. S.** (2007). Effects of cooperative and individualistic instructional strategies on students' problem solving abilities in secondary school chemistry in Ilesa, *Nigeria. African Research Review: An International Multi-disciplinary Journal, 1* (1), 121-130

Aluko, K. O. & **Olorundare, A. S.** (2011). Application of cooperative instructional strategy to enhance problem solving abilities of secondary school chemistry students. *Paper presented at the 1st Annual International Conference on Education* at Osun State University, Ipetu-Ijesa. Feb.

Arubayi Eric A. (2010). The future of the nation depends on today's investment on the teacher. A *Keynote address presented at*

National Delegates of Nigeria Union of Teachers, 5th May, 2010, Asaba, Delta of Nigeria.

Ausubel, D. P. (1968). *Educational Psychology:A cognitive view*. New York: Holt, Rinehart and Winston.

Babalola, Afe, SAN (2013, October 17). The Falling Standard of Education: the Role of Teachers." *The Nigerian Tribune*, p. 56

Babatunde, V. O. (2009). *Effect of competencies in mathematics on Nigerian secondary school students' performance in mole concept problems in chemistry.* Unpublished Ph. D. thesis. Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Busari, O. O. (1995). Diagnosing students' errors from their response selections in senior secondary school organic chemistry, *The College Review* 6 (1) 7-14.

Fowowe, P. A. (1997). *Influence of selected classroom variables on mathematics achievement of junior secondary school students in Kwara state.* Unpublished Ph. D. thesis. Department of Curriculum Studies and Educational Technology, University of Ilorin, Ilorin, Nigeria.

Freire, P. (1972). *Pedagogy of the oppressed.* London, Sheed and Ward.

Ige, A. O. & **Olorundare, A. S.** (2013). Effect of cooperative learning strategy in solving electrolysis problems among chemistry students. (In Press).

Joint Admission and Matriculation Board (2011). Unified Tertiary Examination Result Statistics; Abuja, Nigeria

Kelly, G. A. (1991). *The Psychology of personal constructs. Volume one -A theory of personality*. London: Routledge.

Musa, O. D. (2010). *Misconceptions and alternative conceptions of organic chemistry concepts held by students in Nigeria* *colleges of education.* Unpublished Ph. D. thesis. Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Obioma, G. (2005, September 1). NERDC embarks on curriculum review. *Vanguard Education Weekly,* pp. 56-57.

Odimayo, M. S., Nwabuisi, C., Fadeyi A., Fowotade, A. & **Olorundare, A. S.** (2010). Factors influencing students' performance in medical microbiology in University of Ilorin, Ilorin, Nigeria. *Journal of Medical and Pharmaceutical Sciences,* 6 (1), 8-12.

Okebukola P. A. O. (1997). Forty years of intervention of the science teachers association of Nigeria (STAN) in science education and the road ahead. *Keynote Paper presented at the 40th Anniversary lecture of STAN.* August 20, 1997.

Olorundare, A. S. (1983).The use of computers for instruction in science education. *Journal of Science Teachers Association of Nigeria,* 21 (2), 37-41.

Olorundare, A. S. (1985a). Transmission of knowledge in elementary school science: A case study of the relationship between official curriculum and actual classroom practice. *Dissertation Abstracts International,* Vol. 47/03/p. 777A.

Olorundare, A. S. (1985b). New philosophy of science and its implications for science teacher education. In M. A. Nkpa, S. O. Olaitan, V. A. Nwachukwu & S. O. Ayodele (Eds.), *Issue in curriculum evaluation and vocational education in Nigeria* (pp. 250-261). Curriculum Organization of Nigeria.

Olorundare, A. S. (1986). Curriculum evaluation in science education programmes in Nigeria: A critical overview. *Ilorin Journal of Education,* 6, 72-77.

Olorundare, A. S. (1987a). The value of science in the elementary school curriculum. *Nigerian Journal of Curriculum Studies,* 5 (2), 1-11.

Olorundare, A. S. (1987b). Impediments to science in elementary school: Roles of languages, beliefs and socio-cultural factors. *28th Annual Conference Proceedings of STAN,* 28,145-149.

Olorundare, A. S. (1987c). The Structure of the disciplines and the curriculum. *Journal of Curriculum and Instruction,* 2 (1 & 2), 1-20.

Olorundare, A. S. (1988a). Computer literacy and Nigeria's educational advancement: Some basic considerations. *Journal of Educational Media and Technology,* 1 (4), 350-366.

Olorundare, A. S. (1988b). Of what value is the inclusion of science in the primary school curriculum? *Journal of Research in Curriculum,* 6 (2), 241-249.

Olorundare, A. S. (1988c). Scientific literacy in Nigeria: The role of science education programme. *International Journal of Science Education,* 10 (2), 151-158.

Olorundare, A. S. (1989a). Problem solving in mathematics and science education: A needed attention. *ABACUS: Journal of the Mathematical Association of Nigeria*, 19 (1), 1-18.

Olorundare, A. S. (1989b). Educational controversy over the validity of scientific method: John Dewey and his antagonists. *Journal of Studies in Education,* 2 (1), 1-22.

Olorundare, A. S. (1989c). An investigation into the "difference" between men and women in science. *Ilorin Journal of Education,* 9, 103-120.

Olorundare, A. S. (1990). Discrepancies between official science curriculum and actual classroom practice: The Nigerian experience. *Journal of Education Policy,* 5(1), 1-19.

Olorundare, A. S. (1993a). Evaluation of science instructional materials. *Nigerian Journal of Educational Foundations,* 4 (1), 170-183.

Olorundare, A. S. (1993b). Improving educational standard in primary science education: The roles of supervisors and inspectors. *Journal of Science Teachers Association of Nigeria (STAN),* 28 (1 & 2), 28-36.

Olorundare, A. S. (1996a). Interpretive research paradigm in science education. *Nigerian Journal of Sociology of Education,* 4 (1), 163-175.

Olorundare, A. S. (1996b). Desirable directions for research in elementary science. *Journal of Trends and Issues in Primary Education, 1* (1), 256-261.

Olorundare, A. S. (1996c). Technological literacy through microcomputer use in the science classroom. *African Journal of Information Technology,* 2 (1), 74-82.

Olorundare, A. S. (1997 revised). *Notes on curriculum planning and development.* Monograph Book. For use with all final year Education Students in the faculty of education, "Introduction to Curriculum Planning and Development" Course.

Olorundare, A. S. (1998b). Textbook Selection: A critical process in the education enterprise. *Journal of Educational Theory and Practice,* 4 (1 & 2), 1-10.

Olorundare. A. S. (1998a). Superstitious beliefs as constraints in the learning of Science. *Nigerian Journal of Guidance and Counseling,* 6 (1 &2), 133-149.

Olorundare, A. S. (1999). Impediments to science in the Nigerian elementary school: Roles of languages, superstitious beliefs and socio-cultural factors. *Nigerian Journal of Theoretical and Applied Research: Humanities and Sciences (NJOTAR).* Vol. 4. No. 1.

Olorundare, A. S. (2000a). Scientific literacy and improvement of the quality of life for a stable democracy in the 21st century, *Journal of the Nigerian Association of Teachers of Technology,* 3 (2), 395-410.

Olorundare, A. S. (2000b). Constructivism and learning in science. *Ilorin Journal of Education,* 20, 38-49.

Olorundare, A. S. (2000c). The effective practicing science teacher. In A. I. Idowu, S. O. Daramola, A. S. Olorundare, O. O. Obiyemi, N. Y. S. Ijaiya & K. Lafinhan (Eds.). *A guide to teaching practice* (pp.313-337). Ilorin. Faculty of Education, University of Ilorin.

Olorundare, A. S. (2001a). Science, technology and mathematics (STM) education for national development: Matters arising. *Lead paper presented at the 1st National Conference on STM Education. Federal College of Education, Okene.* September 24th- 27th September, 2001.

Olorundare, A. S. (2001b). The use of simulation and games in science and mathematics instruction. *Lead paper presented at UNESCO/NCCED Workshop Sponsored "Train the- Trainers workshop on Competencies Required by Teachers of Science and Mathematics Education.* Kano, Yola & Kotangora Nigeria. October-December.

Olorundare, A. S. (2006a). Effective learning techniques (ELT). UNESCO-NIGERIA workshop in science, mathematics and technology (pp. 42-45) in Maru, Pankshin. November December, 2006.

Olorundare, A. S. (2006b). *Teacher training Chemistry module.* Ilorin, Nigeria: Inform-Ed Consultants.

Olorundare, A. S. (2009a). Innovations in teaching and learning: Team teaching and departmentalization. In I. O. Abimbola & A. O. Abolade (Eds.), *Fundamental principles and practice of instruction* (pp. 181-198). Ilorin, Nigeria: Departments of Science Education, Arts & Social Sciences Education, University of Ilorin.

Olorundare, A. S. (2009b). Theories and models of instruction I: Philosophical foundations of Instruction. In I. O. Abimbola & A. O. Abolade (Eds.), *Fundamental principles and practice of*

Instruction, (pp. 24-43). Ilorin, Nigeria: Departments of Science Education, Arts & Social Sciences Education, University of Ilorin.

Olorundare, A. S. (2010a). Best practices in the teaching of science in secondary schools in Nigeria. Lead paper presented at the Nigerian Educational Research and Development Council NERDC: *Capacity Building Workshop for Kwara State Teachers on New National School Curriculum.* 6th-8th December, 2010.

Olorundare, A. S. (2010b). Where is 'STEM'? Reflections on the missing context in science, technology, engineering and mathematics Instructions. *Lead paper presented at the 1st Annual Conference and Convention: Science Teachers Association of Nigeria (STAN),* Kwara State Branch, University of Ilorin, Ilorin, Nigeria. 22nd-23rd November, 2010.

Olorundare, A. S. (2011a). Advancement of the theory and practices in science education within the content of the Nigerian educational system. *Lead paper presented at 1st Annual International Conference on Education* at Osun State University Ipetu-Ijesa. Feb. 7-10, 2011.

Olorundare, A. S. (2011b). Correlates of poor academic performance of secondary school students in the sciences in Nigeria. *Paper Presented at the International Institute for Capacity Building in Higher Education, Virginia State University, Petersburg, Virginia, USA.* 20th -31st June, 2011

Olorundare, A. S. (2011c). Effective teaching and learning methods in higher education. In J. S. Shabani & P. A. O. Okebukola (Eds.), *UNESCO-BAMAKO Guide to effective teaching and learning methods in higher education in Africa* (pp. 76-102). UNESCO-BAMAKO Cluster Office, Bamako.

Olorundare, A. S. (2011d). Teacher education in a changing Africa: what counts as quality teacher education for a changing Africa. A Nigerian perspective. *Paper presented at Distance*

Education and Teacher Education in Africa, DETA 2011 Conference in Universidade Eduardo Mondlane, Maputo. MOZAMBIQUE. August 3rd-6th, 2011.

Olorundare, A. S. (2011e). Utilization of information and communication technology in curriculum development, implementation and evaluation. In D. O. Durosaro & A. A. Adegoke (Eds.), *Higher Education and Globalization* (pp 11-30). StirlingHorden Pub. Ltd., Ibadan.

Olorundare, A. S. (2013a). Promoting standards for quality assurance in teacher education in Africa. *Paper presented at the 4th International Conference of Collaboration of Education Faculties in West Africa, CEFWA held at University of University of Cape Coast, Cape Coast, Ghana, West Africa.* September 9-13, 2013.

Olorundare, A. S. (2013b). Science and technology education for sustainable development in Africa. *A Lead Paper presented at the 3rd Joint International Conference organized by the University of Cape Coast, Ghana and University of Ilorin, Nigeria.* Sunday, 11th August- Friday, 16th August, 2013.

Olorundare, A. S. (2014). Learning difficulties in science education: An analysis of the current status and trends. *KWASU International Journal of Education,* 1 (1), 1-12.

Olorundare, A. S. & Aderogba, G. A. (2009). Comparative effects of concept-mapping, analogy and expository strategies on secondary school students' performance in chemistry in Ilesa, Nigeria. *Journal of Curriculum and Instruction,* 7 (1&2), 112-126.

Olorundare, A. S. & Kayode, D. J. (2014). Entrepreneurship education in Nigerian universities: A tool for national transformation. *Asia Pacific Journal of Educators and Education.* Publication of University Sains Malaysia,Vol 29.

Olorundare, A. S. & Medahunsi, S. O. (2004). Principles and practice of instruction in tertiary institutions. In E. A. Ogunsakin (Eds.).

Teaching in Tertiary Institutions (pp. 31-46), Ilorin, Nigeria: Faculty of Education, University of Ilorin.

Olorundare, A. S. & Oni, M. O. (2004). Secondary school teachers' perception of difficult biology concepts. *Journal of Research in Curriculum Studies.* 3 (1), 62-73.

Olorundare, A. S. & Oyelekan, O. S. (2009). Secondary school students' level of understanding of selected chemistry concepts. *Nigeria Journal of Education & Technology (NJET).*

Olorundare, A. S. & Upahi, J. E. (2013). Global best practices in the teaching and learning of science. *An Official Journal of the Collaboration of Education Faculties in West Africa (CEFWA),* 2 (1), 54-68.

Omosewo, E. O., **Olorundare, A. S.,** Abimbola, I. O., & Upahi, J. E. (2012). The needed resources for UBE and STM education in Nigeria. *European Scientific Journal*, 8 (13), 202-212

Oyelekan, O. S. & **Olorundare, A. S.** (2009). Development and validation of a computer instructional package on electrochemistry for secondary schools in Nigeria. *International Journal of Education and Development using Information and Communication Technology*, 5 (2), 88-104.

Oyelekan, O. S. & **Olorundare, A. S.** (2012). Information and communication technology in Nigeria's universal basic education programme: A consideration of some objectives (pp. 295-299). *Proceeding of the Annual Conference of the Science Teachers' Association of Nigeria.*

Oyelekan, O. S. (2006). Secondary school students' level of understanding of selected chemistry concepts in Osun State, Nigeria. *'The African Symposium', an online Journal of African Educational Research Network,* 6 (3&4), 68-75. Available Online at www.africanresearch.org

Oyelekan, O. S. (2008). *Development and validation of a computer instructional package on electrochemistry for secondary* *schools in Nigeria*. Unpublished Ph. D. thesis. Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Oyelekan, O. S., **Olorundare, A. S.** & Anyimigbo, A. O. (2013). Teachers' perception of secondary school difficulties in understanding gas laws. *Journal of Science, Technology and Mathematics Education* 9 (3), 194-206.

Pella, M. O., O'Hearn, G. T. & Gale, C. W. (1966). Referents to scientific literacy. *Journal of Research in Science Teaching,* 4 (3), 199-208.

Rule, I. A. C. (1973). A philosophic inquiry in the meaning(s) of curriculum. Doctoral Dissertation, New York University. *Dissertation Abstracts International,* 34, 671A. 194.

Spencer, H. (1860). *Education: Intellectual, moral and physical.* New York, NY: Appleton.

Teachers' Registration Council of Nigeria (2012). *Professional standards for Nigerian teachers.* TRCN Headquarters, Abuja.

Upahi, J. E. & **Olorundare, A. S.** (2012). Difficulties faced by Nigerian senior school chemistry students in solving stoichiometric problems. *International Journal of Education and Practice,* 3 (12), 181-189.

Upahi, J. E. (2010). *Difficulties encountered by senior school chemistry students in solving stoichiometric problems.* Unpublished M. Ed. project, Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Yusuf, M. O. (2005). Information and communication technology and education: Analyzing the Nigerian national policy for information technology. *International Education Journal Adelaide Australia,* 6 (3), 319-321.