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Teaching/Learning of Physics in Nigerian Secondary Schools: The Curriculum Transformation, Issues, Problems and Prospects

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ABSTRACT

This article presents the comprehensive progression of teaching and learning of physics in Nigerian Senior secondary schools since inception in the nineteenth century. Specifically, the paper discusses the origin of science education in Nigeria, philosophy and objectives of teaching and learning physics, essential features of physics, the curriculum packages/contents, and problems/prospects of teaching and learning physics. Also, contribution of West African Examination council, science Teachers Association of Nigeria and Nigerian Educational research and development Council; communication problems in physics teaching and learning, as well as expected goals of physics teaching/learning in this century and beyond were adequately discussed.

INTRODUCTION/ BRIEF ORIGIN OF SCIENCE EDUCATION IN NIGERIA.

Prior to 1859, no science was taught in any school in Nigeria. At the establishment of the first senior secondary School (the C.M.S Grammar School, Lagos) in Nigeria in 1859, arithmetic, algebra, geometry and physiology were introduced into the school curriculum (Omolewa, 1977; Adeyemo, 2003). A number of Secondary and Teacher training institutions were founded between 1859 and 1929, and their curriculum were science subjects friendly. These science subjects include astronomy, chemistry, physiology, geology and botany. Omolewa, (1977) reported that science teaching and learning suffered in the hands of teachers and students: entry and performance at external examinations were very poor.

When the Phelps-Strokes funded education commission visited West Africa in 1920, it found that the state of science education was deficient, consequently, a strong recommendation for the inclusion of science subjects in the curriculum of all secondary schools was made. Even then, very competent science teachers were available in a few schools for a long time, "the provision for, and method of teaching science were very unsatisfactory" (Omolewa, 1977, Adeyemo, 2003).

Before 1960, classics and arts subjects were emphasized in most Nigeria secondary schools; general science was being taught in lower forms of secondary schools. The government and mission schools taught biology, chemistry and physics in the senior forms presumably due to availabilities of science teachers and equipment. Health science was taught and taken at the school certificate examination as an alternative to biology in the final year of the secondary school course. The science content in schools was dictated by an external examination board (London Universities Examinations Syndicates) with little or no regards to peculiarities in Nigeria (Ivowi, 1984; Adeyemo, 2009). Science teaching and learning in schools was in fact a privilege. The ministry of education inspected and recommended schools for recognition of their science teaching and learning and for West African Examination Council's (WAEC) approval to present candidates for science subjects at the school certificate examinations. In most cases, the order of approval was usually biology, chemistry and physics, in a few cases; a school had approval for the three science subjects at the same time (Ivowi, 1983; Adeyemo, 2003).

The attainment of political independence in 1960 marked the start of a new era in a number of activities in Nigeria. Modification on the basis of nationalism became a common feature soon after 1960. In education, more institutions were established to cope with the increased demand for formal learning with special emphasis on increased demand for formal learning with special emphasis on science teaching and learning especially at the secondary school level. The numbers of courses available in our educational institutions were increased and these courses were made more

relevant to the needs of the country. In particular, science, agriculture and technical courses began to acquire their due position in the scheme of things. By the end of the first ten years of independent Nigeria curriculum development movements became established and concrete efforts at innovations had begun to manifest their reality (Ivowi, 1984).
The experiments in education soon after independence, typified by the events at the Comprehensive High School, Aiyetoro, the polytechnic (then Technical College) Ibadan, had proved so encouraging during the period that a number of activities aimed at improving education generally began. Curriculum development conferences and workshops were held between 1969 and 1975 culminating in the production of science curriculum materials for both primary and secondary levels and the national policy on education on document. Debates on the policy document and on other policy statements on education by our various governments were effected to have received appropriate attention in different communities of the country (Ivowi, 1982, Adeyemo, 2003).
The provisions for STEME consist of curriculum, personnel and equipment (Ivowi, 1993). According to (Ivowi 1984, Adeyemo, 2003), STEME policies may be put as follow:

I. Science shall be taught to all children in primary and secondary levels.
II. The teaching and learning of science shall be done in such a way as to develop the child in three domains (cognitive, affective and psychomotor) of educational objectives.
III. Equal opportunity in terms of the provisions of curriculum materials, resource persons and laboratory facilities shall be given to all.
IV. Every child shall take at least one science subject at the end of the secondary school course examinations.
V. Local production of science equipment and the practice of improvisation shall be pursued vigorously.

Although adequate strategies have been devised for the implementation of the policies, a closer examination of the implementation process shows that the objectives are far from being realized. A detailed analysis of the implementation strategies of the national policy is properly documented in Ivowi (1983), and a mismatch between policy and implementation are also identified. For example, while government wants all children to do sciences in schools, most schools have no laboratories at all. Apart from poor provisions for STEME in terms of facilities, the problem was compounded by the large population in school as far back as late 1970's (Ivowi, 1984).
Based on these major landmarks in STEME since 1960 in Nigeria, the emphasis of science education in this twenty-first century should be on quality assurance for science teachers, science students and Nigeria society at large. To achieve this and many more, a skill-focused study that is qualitative in its approach, purpose, objective and methodology is indeed timely.
Acquisition and reinforcement of skills and aptitudes through laboratories and workshop practice and other curricular and extra-curricular activities represent the most natural ways of stimulating education and real life work which lead to high productivity.
These considerations underscore the need to focus on skill development and assessment in our teacher education and in-service training programmes, more especially in the science based teaching subject areas of physics, chemistry, biology, integrated science agricultural science, introductory technology, wood work, metal work, electrical electronics, home economics, clothing and textiles.
This article therefore attempts to explore briefly, the concept of skill, aptitude, work, practical skill; their development and acquisition and how they are related with special consideration of their roles in science technology and mathematics education.

ESSENTIAL FEATURES OF PHYSICS CURRICULUM IN NIGERIA

Physics, which has been found to be the bedrock of scientific and technological development worldwide in both developed and developed countries alike, has some features which are generally accepted and believed to widen the knowledge and increase the horizon of understanding of physics by the learners. These features are made essential because it is believed that if they are duly and critically followed and applied in any given situation and at any given period of time will be able to make this subject easy to comprehend by learners and as a result nullify the misconceptions of people, students, teachers of physics, other subjects teachers, parents and community at large about physics.

Some of these essential features are as followed:

1. The method of teaching physics should be guided discovery method instead of the old and routine lecture method used in teaching the subject. This was recommended due to the fact that, learning efficiency and

effectiveness takes place during explanation, experimentation and discussion.

2. There should be interaction between the teacher of physics and the students. In this case, it is believed that it is genuine and helpful interaction between the teacher and the students, the students will be able to expose their minds and what and when, they find difficult in physics topics to their teacher and thereby reduce the difficulties they encounter
3. It was also recommended that each topic should have a target and specific objectives to be met at the end of this lesson and that lesson. This is necessary and important if physics is to be appreciated by the students and community at large. Before a topic could be appreciated, it must have attainable goods and objectives and if these objectives are not met, then it is said to be aimlessly taught and of course, have no contribution to the development of the students in terms of cognitive, affective, and psychomotor domains and also has nothing to add to the society.
4. Each topic should cut across other topic that is the knowledge guided in previously taught topic should be transferable. This means that it should have to contribute to this new topic and aids the understanding of the new topic. In a nutshell, topics should be sequentially arranged in a logical order so that each knowledge gained could be retained, transferable and applicable to any physical challenges.
5. Evaluation should not only be based on the recalling of facts but also on the affective and psychomotor. This is recommended so that students could be wholly and all round developed on the demands of their societies.
6. It was recommended that emphasis should be placed on the theoretical aspect as well as practical aspect of the subject. This is suggested and recommended so that any theory taught in physics could be tested and trusted to be consistent at any considerable situations
7. Above all, each topics should be taught in a way that I takes into consideration its relevance to the societal norms, values etc so that each student can appreciate the values, norms of his society in which he/she lives.

PHYLOSOPHY OF PHYSICS CURRICULUM IN NIGERIA

The major concepts which underline and unify the topics in the SSS physics curriculum content are motion and energy. Relevance of the physics topics to society in terms of application is stressed throughout. Only the topics which are directly derivable from the concepts and their sub concepts were selected. Generally, the approach in the curriculum is to treat the topics under a unifying concept in a general form and provide some elaboration in the applications in order to advocate relevance and use copious illustrations to aid understanding.

Apart from such attempt at functionality, a specific teaching approach has been advocated. The guided-discovery method of teaching that has been recommended is aimed at ensuring that learning, as an activity takes place while the student's mind is actively engaged through a series of well – structured experiences. These are typified with experimentation, questioning and discussion. The teacher is required to prepare his lesson properly and to guide the students very well so that learning can take place in the student.

Here, teaching must not be emphasize at the expense of learning: hence the usual lecture method, which is usual for the teacher and efficient for covering a lot of ground quickly (Bligh 1972), is not recommended. This is to avoid a rigid one way in the classroom and in its stead to put in place a real interaction among teacher, students and materials. The advantages of the guided-discovery approach have been discussed (Ivowi 1984). Like other science programmes, three factors have been emphasized in the SSS physics curriculum content. These understand of concepts, functionality and application. Ability to explain concepts and principles, and apply them in given situations is needed in the programme because of the crucial role which physics plays in the development of science and technology. Functionality entails the use of functional equipment in order to expose students to the various processes and to enable them to acquire relevant skills. A high degree of accuracy is not actually essential at this stage; but complete reliance on the precision of the instrument used needs to be stressed. The overall effect of application and functionality is to enhance understanding of the concepts being taught (Ivowi 1990).

Given the nature of physics and the paucity of teachers and equipment in schools, it is difficult to effectively implement the provisions of the SSS physics curriculum. This has resulted in a difference between the prescribed programme and what is actually implemented in the schools (Oludotun 1981)

The general objectives of physics curriculum as stated in the curriculum document of 1985 by Federal Ministry of Education (FME) and revised 1998 are to;

1. To provide basic literacy in physics for functional living in the society.
2. To stimulate and enhance creativity
3. To acquire essential skills and attitudes as a preparation for technological application of physics
4. To acquire basic concept and principles of physics as preparation for further studies

Besides, an array of performance, objective was also stated for each topic in physics.
Ivowi (1993) emphasized some factors on the senior secondary school (SS 3) physics curriculum content

1. Understanding the concept. That is, ability to explain concepts and principles of physics topic
2. Functionality: that is, the use of functional equipment in order to expose students to the various processes and to enable them acquire relevant skills
3. Application: ability to apply concept learnt skills acquired to relevant field.

HIGHLIGHTS OF MAJOR CONCEPTS IN PHYSICS.

Frantic efforts have been made from the various contributions of science educators as well as different educational concerned boards towards making physics simple and easy for students of physics. The first of such successful efforts is the unification of all the topics of physics into five major concepts.

In selecting topics, four approaches were possible-conceptual, thematic, modular and the traditional topical approach. After an exhaustive discussion of the rationale for selecting the conceptual approach at the national critique workshop of December 1984, this selection process was adopted. According to Ogunniyi (1985), the conceptual scheme represents the cognitive structures of organizational pattern of the discipline under consideration; hence it determines the curriculum content and the instructional procedures to e used. The advantages of using the conceptual scheme in content selection, according to him, include the following;

1. economy of thought
2. generalizability
3. dynamism and mutual relationships among concepts and principles
4. adaptability to varied learning settings
5. aiding the development and acquisition of valid viewpoints of science and mathematics

There is also the additional advantage of curtailment of topics to be studied (Adeyemo, 2003). The experience gained so far in the use of the conceptual approach to content selection has been quite rewarding. Topics have been brought together under broad generalization to show relevance and connectedness. Such generalization ideas which appear to persist more in later years are far more meaningful to students who go through such courses.

In organizing the selected content into a teaching scheme, the spiral or concentric approach has been adopted. In this approach, the content is grouped into five sections with each section occurring every year of the three-year programme. The scope and depth of the content with reference to each section increases as the year's progress. By this, students are given an opportunity to consolidate whatever was learnt in the previous year as new knowledge is built on the previous one. The major and minor concepts are therefore further probed each time appropriate topics are treated, thus lending an aid to learning.

As much as possible, the content is arranged in a logical, developmental and sequential order so that relationships among the topics can be generated and assimilated. By the nature of the subject, mathematics is a crucial language in physics. Since many students find mathematics difficult, and in order not to obscure the understanding of the physics content. Mathematics is used only to clarify the concepts and principles under consideration. Where the mathematical derivation of formulae is likely to constitute a serious problem to the students, such exercise is left out, but the result and its explanations are emphasized.

These concepts are classified into section as followed.

1. Concept of space, time and motion
2. Conservation principle
3. Waves
4. Fields
5. Quanta

Physics is perceives to be a difficult course because of the abstract nature of physics. In teaching the course, the guided discovery method of teaching was highly emphasized whereby the lesson is typified with experimentation questioning and discussion.

DISTRIBUTION OF THE MAJOR TOPICS IN PHYSICS OVER THE THREE YEARS

Section I: Concepts of Space, Time and Motion

1. Motion
2. Position, distance and displacement
3. Time
4. Speed and velocity
5. Rectilinear and derived units
6. Scalars and vectors
7. Equations of uniformity accelerated motion
8. Projectiles
9. Equilibrium of forces
10. Simple harmonic motion

Section II: Conservation principles

1. Work, energy and power
2. Heat energy
3. Electric charges
4. Linear momentum
5. Mechanical energy
6. Heat energy
   - i. temperature and its measurement
   - ii. heat energy measurement
   - iii. gas laws

SECTION III: Waves

1. Production and propagation of waves
2. Types of waves
3. Properties of waves
4. Light waves
5. Sound waves
6. Application of light and sound waves
   - i. light waves
   - ii. sound waves
7. Electromagnetic waves

SECTION IV: Fields

1. Production and description and property of a field
2. Gravitational field
3. Electric field
4. Magnetic field
5. Electromagnetic field
6. Simple A.C Circuit

SECTION V: Quanta

1. Particulate nature of matter
2. Plastic properties of solids
3. Crystal structure
4. Fluids at rest and in motion
5. Molecular theory of matter
6. Models of the action
7. The nucleus
8. Energy quantization
9. Wave – particle paradox

COMPARISON OF THE OLD CURRICULUM TO THE NEW CURRICULUM IN TERMS OF BROADNESS, USEFULNESS RELEVANCE TO THE SOCIETY

1. The old curriculum was topical in nature i.e. there was no cross linking of topics, each topic was handled in isolation but the new curriculum tries to cross link the topics in physics.
2. The old curriculum placed more emphasis on the theoretical aspect and little time was given to practical, but the new curriculum tries to strike balance between the theoretical path of physics and the practical aspect.
3. The old curriculum was just base on teaching without any specific objective to be trained but the new curriculum emphasis the importance of specific objectives for each topic so that the students and the society alike can appreciate it
4. The new curriculum emphasized the importance of application of physics in technological development of society unlike old curriculum that did not take into consideration any development that has relevance or contribution to society change.
5. The old curriculum had no form of activity between student and teacher but the new curriculum had series of activities will make learning more recallable that better understood
6. The old curriculum had little or no relevance to societal value but the new curriculum considered what the society needed and valued it.
7. The method of teaching of the old curriculum was the teacher direct method (lecture method) with little or no demonstration on experiment by the teacher to enable student to comprehend and enjoy what is being taught. The new curriculum takes different teaching method to enhance student learning to the subject matter.
8. The mode of evaluation of the old curriculum was more than the recall of fact while the new curriculum evaluates not only on the recall of fact but consider affective and psychomotor aspect of learning otherwise regarded as practical.
9. Emphasis of the new physics curriculum was placed on understanding of the concept, functionality and applicability but the old one was on memorization.
10. Entrepreneurial skill: this implies that the students would be taught skills in managing a business so that a physics graduate would be a "job creator" not a job seeker and he would be able to apply physics to business and hence be successful and useful to himself.
11. Capital management: This implies that the curriculum would inculcate in physics students prudence in managing available resources no matter the capital market/economic situation.

1. Moral and values inculcation: The new curriculum would emphasis more on moral instruction and societal values so as to also help the student develop into a responsible adult rather than just on religious studies. Unlike old curriculum that has no or little relevance to societal values, norms etc.
2. HIV/AIDS awareness: Human Immune Deficiency Syndrome (HIV/AIDS) is a scourge that is affected most youth in the society and has also led to many deaths. The spread of the disease can be traced mostly to ignorance. The new curriculum would therefore include HIV/AIDS as a subject in order to help students learn all they need to know about it i.e. how it is contacted, spread and how to help those who are affected. It would also explain its treatment as it is incurable so as to reduce and prevent its spread among Nigerian students.

CONTRIBUTION OF WEST AFRICAN EXAMINATION COUNCIL (WAEC) TO PHYSICS CURRICULUM.

For all scientific and technological development world wide, physics has been found to be the most basic science subject. Both developed and developing countries like USA and Nigeria respectively have realized the impact of impact of physics in national development. Based on the importance of physics subject and infact all science subjects to the society and its people, the impact of WAEC to development and improvement of physics curriculum can not be over – emphasized and underestimated.

Over the years from 1960 – 1995, WAEC influenced to a greater extent the development of science (physics) education in Nigeria. This board's concern to the physics curriculum was due to the poor performance in physics. So, starting from 1968, WAEC felt a need to revise the school syllabus, hence the same years Science Teacher Association of Nigeria (STAN) was invited to revise physics curriculum and even all other science subjects. This effort resulted to revised WAEC syllabus of 1974.

The revised syllabus put more emphasis on the utilization of practical work as against the rote learning of the rote learning of the previous years. Also, since WAEC set public examination papers in general science such as physics which has consistently and sufficiently influenced the content area of what is to teach in schools. This modernization in WAEC syllabus has always been reflected in the mode and type of examination questions set.

In summary, WEAC recommended the followings with hope that they will contribute to ameliorating the situation of failure in physics.

1. A situation contribution reform is necessary especially for teachers institutions, physics education should be developed to meet the challenges of teaching the subject for better results. Infact, departments of science and technology education should be created in universities in order to improve research and the development of new instructional methods.
2. Science equipment centers should be set up in each state for the local production and servicing of laboratory equipment. Rote learning is greatly discouraged when materials are available.
3. Much as government concern for scientific and technological growth has been demonstrated in the ministry of science and technology and research institutes, the concept of applied research should not be restricted only to what they do. Infact, research on various aspect of physics of science education, must be viewed as applied and basic, and should equally be funded if knowledge on relevant approaches to producing a corpus of indigenous scientists must be gained.
4. Integrated science should be abolished since no evaluation has been done to prove its usefulness in building a good scientific basis for learning the separate sciences. Alternatively, integrated science should be restricted to the first two years of secondary school in the 6-3-3-4 system. This will not only help the junior secondary graduates to be introduced to the separate science subjects, but will also give senior secondary school students more time to study these enlarged syllabi
5. There is need for a phased sciences policy for the nation, which will provide guidelines necessary for developing an indigenous corps of scientists.
6. The secondary school system should be organized strictly in terms of science and non science (or grammar) schools.

STAN CONTRIBUTION TO PHYSICS CURRICULUM DEVELOPMENT.

The STAN is a professional body inaugurated in October, 1957 towards development of science education.

The aims of the association (STAN 1988) as its inception were:

i. To promote cooperation among science teachers in Nigeria with a view to raising the standard of science education in the country.
ii. To popularize science
iii. To provide a forum for discussion by science teachers on matters of common interest.
iv. To help science teachers keep in touch with development in science and its application to industry and commerce.
v. To cooperate with and affiliate to other societies and bodies with related interest.

With these aims guiding the association, STAN devoted its efforts to innovation of the curriculum of each science subjects in which physics is included. By this, national and educational objectives were translated into curricula and teaching objectives through the development of curricula designed to help individual.

1. Attain cognition
2. Acquire process skills such as communicating ability, managerial skills, manipulating skills etc.
3. Develop positive attitudes towards physics.

These help students of physics widen the horizon of their critical thinking, manage and use available resources within their environment affectively.

Some of the other works done by STAN towards physics curriculum development are

a. selection of qualified professional physics teachers to ensure quality control and writing of physics workshop
b. production and distribution of teachers and pupils materials relevant to the revised syllabus of physics

c. revising and reviewing the existing physics curriculum

d. they also produced textbooks relevant on physics subject such as: STAN physics for senior secondary schools, published by Heinemann.

THE ROLE OF THE NIGERIAN EDUCATIONAL RESEARCH AND DEVELOPMENT COUNCIL (NERDC) TOWARDS PHYSICS CURRICULUM.

Above all, the contribution of NERDC established by decree 53 of 1988 by merging four curriculum development bodies together can not be underestimated in physics curriculum. The four bodies merged together are:

a. the Nigerian Educational Research Council (NERDC)
b. the Comparative Education Study and Adaptation Centre (CESAC)
c. the Nigerian Book Development Council (NBDC)
d. the National Language Centre (NLC)

With respect to physics as a subject in science, NERDC contributed to physics in the following areas:

i. It encouraged, promoted and coordinated educational research programmes in Nigeria in which physics is included
ii. Identified physics problems in which research is needed and establish the order of priority.
iii. Developed new techniques and approaches to physics curriculum development
iv. Produced syllabus and instructional physics materials
v. Formulated and implemented a national policy on physics book development
vi. Identified difficulties in communicating science language to the pupils and in carrying out research and finding solutions to such difficulties

Established and maintained a research and development library to which new physics books and other related publications may be deposited.

PROBLEMS FACING IMPLEMENTATION OF PHYSICS CURRICULUM.

a. The interface between physics and mathematics: The problem due to interface between physics and mathematics cannot be overemphasized in the teaching of physics. Some of the existing difficulties between mathematics and physics would seem to arise from two main sources which are:

i. Unsymmetrical nature of the two disciplines. Physics cannot exist without mathematics.
ii. Introduction of new mathematics without any real consideration of its effect on the teaching of physics

The above posed problems not only to the teachers but even also to the students who are the recipients of what is being taught by the teachers.

Infact, physics teachers these days often complain that their students can not estimate, cannot calculate with approximate numbers, cannot use ratios and proportions, cannot use decimals, cannot read graphs and not know how and when to make approximations.

The difficulties of students in applying mathematics to physics may not be solely the result of the 'new' mathematics. These difficulties may have grown worse in recent years for a variety of reasons, with the 'new' mathematics being only one of several.

Other possible reasons for the difficulties perceive in the mathematical abilities of students may include the fact:

i. that broader spectrum of students are taught at the same time;
ii. that more sophisticated courses are taught even at the secondary level;
iii. that we have an overloaded curriculum in both subjects
iv. that social changes have caused students to be less motivated towards mathematics and physics;
v. that teachers with little training were asked to teach new mathematics in the primary schools.

b. Scientific Language and Communication: In teaching physics, especially at the secondary level and scientific language and communication is essential for the transmission of knowledge.

The vocabulary used in teaching physics are so many that most of the technical words are meaningless and have no significant for many pupils and description of units or words of everyday language which are used in physics with a special precise meaning.

c. How Pupils interpret knowledge before being exposed to the teaching of physics.

Before any teaching takes place, the children have a certain number of previous pieces of knowledge resulting from their contact with the physical and social milieu. This knowledge has a certain number of characteristics which

differentiates it from notions of physics. The pupils' notions of quality and quantity tend to be oversimplified.
For example, they could say that when a force is exerted on a body, it makes it move at a high speed, and because knowledge evolves with age, in the course of initiation into physics, new knowledge does not necessarily modify previously held misconceptions. To justify a false intuitive belief, the pupils use precise but irrelevant scientific knowledge, or they seek a compromise between the two. For example:

1. Spontaneous belief: the pupils believe that a gas or a vapour has no weight;
2. School learning: all bodies have weight
3. If cigarette smoke has weight, it follows that it must contain solid bodies.

Based on the above misconception of students about physics proofs it is difficult to teach especially the aforementioned/listed topics which contain some facts that can not be compared to the initial knowledge already before the topics are taught.

b. Lack of Modern and Adequate Laboratory Apparatus.
Infact, topics like current electricity, light, force on equilibrium of body may not be fully understood without the practical knowledge of the topics. As it is generally known today that our secondary school are not all equipped with adequate apparatus and even those that have (for example federal government college, international secondary schools and few privates schools) are not working well they have all become obsolete and can not be used for practical purposes.
However, this makes the teaching of the above listed topics difficult, because students find it difficult to comprehend meaningfully the theory alone without the practical. Since the theoretical aspect may seem abstract to understand hence the introduction of practical is needed.

f. Inadequate finance: The problem of finance is a very significant problem. There are few schools compared to the number of the population funds to the education sector is small compare to the numerous needs of the sector. This problem has lead to various other problems which affect or hamper on the implementations of the curriculum.

g. Inadequate human resources: Human resources in education are the teaching and non-teaching staff. Due to lack of attractive salary, and adequate teacher training institutions and of students in external examinations for physics since there are few or no physics teachers.

h. Inadequate classroom facilities: This problem is linked to inadequate funds to provide enough land to build schools which further affect the availability learning environment for the students and to aid teaching and learning of physics.

i. Inadequate curriculum: The curriculum content for physics is rather shallow and odes not give an in-depth explanatory content for certain physics topics and also its objectives are not totally encompassing.

j. Inconsistency in government polices: Due to changing nature of government in Nigeria, change in government always implies a change in the curriculum as different leaders tend to bring different ideas thereby resulting in an inconsistency in the curriculum content and assimilation by the students. It also affects the realization of the performance objectives.

k. Inadequate laboratory facilities: laboratory equipment is unavailable in most schools and where they are, it is not functional. Without functional laboratory, physics would be ineffective because neither the teacher nor the student could acquire any knowledge because of the lack of instructional materials.

l. Unavailability of qualified teacher. The rate of qualified physics teachers in Nigeria has declined in recent years due to several reasons ranging from good salary etc, teaching is gradually becoming a vocation rather than a profession hence an abundance of unqualified physics teacher teaching physics as a result of the use of those available “hands” in replace of qualified teachers as the profession has been made unattractive to many.

m. Time limitation: since in the senior secondary school time allotted for each lesson varies, and that teaching of virtually all the topics in physics required time than that allotted on the time table. This makes it difficult to teach within the time allotted because each topic in physics has practical and theoretical aspects which cannot be taught within 45 minutes given in the time-table.

EXPECTED GOALS OF PHYSICS CURRICULUM IN THE 21st CENTURY – The STS goals.

1. **The physics curriculum should enable students to develop positive attitudes towards science.**

The Scientifically literate individual maintains a life long interest in science. Students should be able to develop positive attitudes towards science which they will continue to nurture throughout their lives. An interesting, relevant physics curriculum can provide students with good reasons for studying the subject, as well as good reasons for maintaining an interest in the subject once they have completed their formal education.

Some students may go on to pursue careers in physics or other related fields after they complete their secondary school physics program. Such an outcome is desirable, but it needs to be kept in proper perspective. The majority of students who complete the secondary level physics program will not pursue the subject much further. While it is true that some students may take post secondary programs in physics, the majority will not. However, the need to develop scientific literacy among all students remains of primary importance.

It may come as no surprise that many students in secondary science programs have become disinterested and even disillusioned with the study of science. While the underlying reasons for this are often extremely complex, as has been pointed out by the science council of Canada in science education in Canadian schools, volume 1, science is perceived by many students as being boring and irrelevant, and not in keeping wit real experiences that students have had in their lives. Physics is often perceived as being too difficult, and too heavily dependent upon knowledge of mathematics. Science experience in schools is not in keeping with the true nature of science, or the way in which science is actually practiced by people. A lecture approach to instructional delivery has predominated in the past.

1. **The physics curriculum should develop awareness and understanding, allowing students to apply and evaluate key concepts.**

Core material has been identified in the physics curriculum guide.

The key concepts that could be developed in each unit are specified in detail. Included with these key concepts are sets of learning outcomes. Students should be provided with opportunities to attain a wide variety of these outcomes. Teachers must ensure that opportunities have been provided for students to do so.

A student who has attained the majority of these outcomes would be deemed to have reached a high level of proficiency in physics. Thus, the learning outcomes also form the basis of students' assessment.

A common misunderstanding in interpreting the key concepts presenting in this guide is that teachers are responsible for ensuring student attainment of all of them. This is not their intent. The key concepts identified in the physics curriculum guide are the instructional guidelines within which the learning outcomes for each unit are developed. The foundational objectives of the curriculum and the development of the factors within the dimensions of scientific literacy provide the central focus. The key concepts identified help directed to the teacher towards the development of those factors and foundational objectives. The foundational objectives for physics and the common essential learning must be attained, and the factors of scientific literacy must be developed. Any of the key concepts identified within the instructional guidelines can be used to do so.

The sequence of presentation of the topics is not static. For good reasons, teachers might determine that certain topics have been presented in a particular order in the curriculum guide might be better taught in a slightly different order. Teacher discretion is needed in the sequencing of concepts, especially since the treatment of specific topics varies considerably in their development form one resource to another.

The sequencing of the core units may also be altered to suit a teacher's individual preferences for developing the program.

The learning outcomes that accompany the detailed description of key concepts are not intended to suggest a one to one relationship between the concepts and the outcomes. Some of the outcomes that appear in a particular section may be more generic and applicable to several sections of the course. Also, within a particular section, there may be one to many relationships between concepts and outcomes, or vice versa. Teachers have flexibility in rearranging the outcomes to other topics, if they so choose. It is important to recognize, though that the outcomes are considered to be essential to the successful completion of the physics program by the learner. The teacher should see that students are provided with opportunities to attain many of these learning outcomes

2. **The physics curriculum should provide students with opportunity to understand important**

interrelationships among science, technology, society and the environment.

The STSE thrust of the curriculum (dimension D) is in keeping with the need to make science relevant to the learner, by treating the subject within a larger context. The interrelationship can be brought out through such an approach which is complex but meaningful to the student.

Clear distinctions need to be made to allow students to be able to differentiate between physics and technology. They are different but related forms of human endeavor. The similarities and differences between physics and technology need to be emphasized.

The ways in which science and technology operate within a larger societal content should be stressed whenever possible. Advances in physics and technology are often responsible for initiating a public debate, until issues have been clarified. Technological changes alter society. In turn, an informed society has the responsibility of determining the direction that scientific research and technological development should follow.

The use of technology in the classroom may help to familiarize students within some of the ways in which physics and technology operate together. In particular, computers should be used in the physics classroom whenever possible, to aid in (but not replace) the analysis of laboratory investigations, to perform simulations, to assist in problem solving, and to explore a wide variety of micro worlds that are now made available through the use of innovative educational software.

Environmental considerations have been emphasized in the physics curriculum. Concerns regarding the loss in quality of life and health hazards resulting from widespread environmental damage have finally caught public attention. The role of schools in helping to promote awareness is extremely important.

The STSE emphasis does not reduce the need for a solid foundation of key concepts in physics. Instead, this new emphasis complements those other things that are part of the curriculum, adding an important dimension which may have been missing in the past.

Exiting resources differ in the extent to which they incorporate an STSE approach to physics. Teachers should search out potentially useful resources which may augment the physics program.

1. **The physics curriculum is inquiry and activity based, with a strong emphasis on problem solving**

It is important that a strong laboratory based physics program be used to add relevance and concrete examples to the study of a wide range of physical phenomena. Skills and important knowledge which can only be imparted through an inquiry based approach would otherwise be missing from physics program if these types of activities were omitted. A thorough coverage of all of the seven dimensions of scientific literacy can only be attained if laboratory activities are performed throughout secondary physics program.

The teaching suggestions, activities and demonstrations sections in the curriculum guide provide some suggestions which lead to inquiry based learning. All of the activities listed in those sections are not laboratory investigations, in the traditional sense. The term "activity" is used more broadly to encompass a wide variety of different kinds of instructional strategies. Activities could include such things as: laboratory investigations, field trips, demonstrations, simulations, interviews, public opinion polls, large or small group discussions, learning centers, independent research work, role playing games and so on. However, laboratory investigations must also be used to show students practical applications of formal classroom work. A minimum of 20 hours of the allotted time in the course should be centered on activity based learning, and the evaluation scheme used should reflect this emphasis.

The suggested activities identified in this curriculum guide provide teachers with a variety of activities to be performed. While there is a required time allotment for activities the teachers still needs to use discretion and professional judgment in the election of activities. No specific activities are mandatory in the physics program. Various considerations, such as the interests and abilities of students, or the availability of resource and laboratory equipment, necessitate flexibility in the activity based component of the program. The activities are a means by which the factors of scientific literacy and the foundational objectives for physics and the common essential learning are attained. Teachers need to select from the suggested activities accordingly.

If the activities are to encompass laboratory investigations, it is recommended that they be discovery and inquiry to reflect the true nature of science. Investigations which are limited to the verification of existing laws, or to he reiteration of concepts which have been developed in other ways are less useful.

Laboratory activities involve the cooperation of different people working together. Communication and a willingness to work with others are essential components of a good laboratory program

A concern for safety remains a crucial consideration in all science programs. Students need to be made aware of any potential hazards that could arise in a laboratory setting, or in other settings such as field trips which could be potentially hazardous. Whenever students are exposed to new situations with which they have only limited familiarity, or if they are working with materials or equipment that has the potential of been hazardous, proper precaution should be exercised with diligence and extreme care.

Problem solving plays an important role in the study of physics, and it should be one of the components of the course which is given strong emphasis. Students need to develop systematic, organized ways of investigating all types of problems. Part of the emphasis should be on giving consideration to the way in which problems are approached and solved. Rearranging and manipulating formulas, with little or no understanding of why the formulas are used or what they mean is of questionable value.

Moreover, students need to appreciate hat real problems are much more complex than the way in which problems are often presented in physics textbooks. Not all problems can be approached by plugging values into some equation to arrive at a numerical solution. In reality, many problems tend to be holistic in nature, encompassing a broad understanding of various different disciplines. Descriptive solutions to real world problems are also common, though not often portrayed in a realistic manner in textbooks. Many problems are approached collectively, and decisions are reached by consensus among scientists and other concerned individuals.

Finally, it needs to be emphasized that not all problems have solution. Instead, problems tend primarily to lead people to determine effective ways of going about investigating them. This is in keeping with an authentic view of science. Students need to realize that physics does not have the answers to all problems. Some problems fall outside of the realm of physics. Others only offer a glimpse at some of the ways in which to go about trying to explore them

1. **The physics curriculum must promote equity in education**

Much has been said and written about the need to promote equity in education. Science has been perceived by some as being dominated by white or East Indian males, and promoting male stereotypes. Young women need to be encouraged to consider careers in science.

Research shows quite convincingly that student performance in the physics is not dependent on gender, although, young women tend to have less positive attitudes about science, perhaps due to messages being received by parents, teachers and the media.

Wherever possible, applications that might be of interest to young women need to be included in the program. Females need to be encouraged and expected to be actively involved. Encouragement should be given to both females and males to consider vocational and avocational problems in physics. Counseling is another important way in which schools can help to promote positive attitudes towards science, regardless of gender. Some textbook publishers have recognized the need to remove various forms of bias from their books, although classroom resource materials should still be scrutinized carefully by teachers for bias and stereotypes by teachers.

Students of both genders, all races, and of varying abilities should be treated fairly. It is important to remain sensitive to the needs of all people.

COMMUNICATION PROBLEM AND THE TEACHING AND LEARNING OF PHYSICS IN NIGERIA

In this section, the emphasis is on the research evidence available in communicating problems in the teaching and learning of physics. Ivowi (1987), Adeyemo (2003), identify misconceptions, poor understanding of concepts, low achievement, low level of instruction and lack of application of science a major problematic issues. Ivowi (1987) maintained that the verbal communication are very important tool in an attempt to communicate physics to a Nigeria learner and that non verbal communication also serves as a useful communication to the verbal aspect of communicating physics and science in general. This according to Baiyelo (1987), Ogunleye (1987) and Adeyemo (1995) argued that both physics and the medium of instruction are foreign to Nigerian society. Children are born to environment largely devoid of English Language; the medium of instruction in educational institution is their mother tongue and the culture of physics. In effect, a child is subjected to study more than one language at such an early stage. Added to this handicap is the study of natural science and basic mathematics using a second language.

Although examples abound in our environment to illustrate science concepts and principles, these have not yet been properly articulated. Most of our homes do not have people who are literate in science. As a result, little or no help is given to our children at home with regards to their science learning. Anything they cannot learn in school is better lost to them. Unfortunately, knowledge in science has increased tremendously while the age at which children start learning science formally has also reduced. This ahs made it difficult for children to understand science taught through verbal communication only, the non-verbal aspect or better a combination of both has become an accepted mode of science teaching nowadays.

Here, attention is focused on the research evidence available in these areas (enumerated in the first paragraph) attempts made so far to improve on the factors problematic to science teaching and learning, and suggestion for possible solutions of the identified problems.

MISCONCEPTIONS

Two of the possible causes of misconceptions given by Yeamy and Padilla (1986) are normal language usage and everyday experience of the material world. Familiarity with normal language usage may obstruct proper understanding of a concept unless extra care is taken to absorb the context in which a word or group of words is used. The words power and energy are very good examples in this case.

Although, there is no empirical evidence for the sources.

LOW ACHIEVEMENT

Student's achievement in science has been known to be rather low and to be in the decline in recent years in Nigeria (Ehindero, 1987, Bajah, 1979, Ivowi, 1982 and 1984). Apart from misconceptions which contribute to some of the wrong answers given by students (Soyibo, 1983; Ivowi, 1984) misunderstanding of the questions also leads to wrong answers. An examination of student's scripts often reveals this type of cause of poor performance in physics. Maintenance of content validity by examiners, clear construction of sentences and a well defined response from candidates are needed in order to improve verbal communication.

LOW LEVEL OF INSTRUCTION

Instruction plays a very important role in an attempt to make students understand. A teacher needs to communicate in for students to make attempt at learning. No matter the efforts of the teacher, if he does not communicate effectively, it is difficult for learning to take place. In effect, emphasis is on teacher's methodology. Studies have also shown that teachers do not obtain adequate feedback from their students, hence, they do not know the level of their student's misconceptions in physics (Ivowi, 1986) and their successive students repeat exactly the mistakes of misconceptions in students and on-going research in this direction (Ivowi and Oladotun, 1987) indicate that personal experience, teacher and peer influence are very strong sources of misconceptions. If these give rise to misconceptions which in turn impede proper understanding of physics, then any attempt at improving student's achievement in science needs to take into consideration appropriate choice and use of words in classroom instruction and in instructional textbooks. Efforts at reducing these misconceptions are mainly in the restructuring of student's textbooks where deliberate explanations are given to counter known misconceptions.

POOR UNDERSTANDING OF CONCEPTS

Lack of proper understanding of physics concepts does not necessarily constitute a misconception. In many cases, these concepts are abstract and so a higher level of conceptualization based on meaningful experience is expected of students in order for understanding to exist. In order to raise the level of understanding of concepts, illustration by models must be taken beyond their physical limitations. This requires a level of intellectual development and appropriate to the absorption of such an abstract idea under consideration of their predecessors at the West African School Certificate Examination (now SSCE). Students look up to teachers and textbooks as authority and any wrong notions communicated to them are not easy to erase. Inability of making use of a variety of non-verbal teaching aids for a number of reasons (by teachers) tends to contribute to the low level of instruction of physics in schools.

LACK OF APPLICATION

Physics is an active subject and its concept find application in everyday life. In this age of science and technology, application of physics is easy to come by. Physics in action is a most effective way of communicating science concepts, principles and laws.

As part of our teaching strategies, examples of the application of physics concepts are expected to be given, discussed and appreciated in order to increase the understanding of such concepts. In the classroom, students can put into test the application of many physics concepts. This is part of the practical projects and other laboratory activities which they are expected to be engaged with in the guided discovery method of teaching physics in order to make progress in our physics teaching and learning. We need to insist on this method of teaching.

CONCLUSION

In Nigeria, physics has been a school subject in the science curriculum of secondary schools since the beginning of school education in the country. In fact, the subject "physics" is accepted by Nigerian as a very important subject. This is probably in consonance with the resolution of the 1960 International conference of physics education held in Paris which views physics thus

> "Physics is an essential part of the intellectual life of a man at the present
> day and the study of physics provides a unique inter play of logical and