IMPLEMENTING SENIOR SECONDARY PHYSICS CURRICULUM: MATTERS ARISING

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Abstract

The paper observes that Physics education at the senior secondary school level is in limbo, arising from the recurring, the bedeviling issues of acute shortage of professionally trained physics teachers, gross inadequacy of laboratory/instructional materials. These problems conspire with a serious limitation of time to sustain the teachers’ use of the traditional lecture method rather than the recommended inquiry-oriented modes of teaching, and the assessment of cognitive domain of education objectives to a negligence of the affective and psychomotor aspects. The paper attributes students’ poor performance in senior secondary physic to this sorry scenario. In order to arrest and reverse the trend, the paper recommends intensification of effort in subtle areas such as the production, retraining and retention of physics teachers.

Physics is, perhaps, the most pervasive of the reservoirs of human knowledge that have been classified as modern sciences. It has come to play an extraordinary and prominent role in shaping much of what is today branded ‘modern society’, making it almost mandatory for informed citizenry in the 21st century to have a basic understanding of what it stand for. Traditionally, Physics may be defined as “the study of the laws that determine the structure of the universe with reference to matter and energy of which it consists” (Isaacs, 2000). Since the turn of the century, Physics has often been defined as “the branch of science concerned with matter and energy and their interactions in the fields of mechanics, acoustics, optics, heat, electricity, magnetism, radiation, atomic structure and nuclear phenomena (Geddes and Grosset, 2005).

The ultimate goal of physics is to explain the physical universe in terms of basic interactions and simple particles (Metcalfe, 1984). Physics has it’s birth in mankind’s quest for knowledge and truth (Nolan, 1993)
Why we Study Physics?

The effect of Physics can be felt in all areas of human activities. Colette (1995) submitted a long list effect of these as follows:

1. The principle of quantum mechanics and atomic physics are used in chemistry to understand chemical bonding; and the principles of electricity are used in biology to understand many biological processes, including nerves.
2. Newton laws of motion applied to the flow of fluids are used to understand the human circulatory system.
3. Principles of electricity are used to explain household electricity and electric shock.
4. Optic principles are applied to the human eye and to the microscope.
5. Quantum physics is used to understand lazers.
6. Nuclear physics is applied to carbon dating of ancient archeological specimens.

Thus, a knowledge of Physics is essential for chemists, biologists, physicians, dentists, engineers, geologists, architects and physical therapists.

Abbott (1989) acknowledged that Physics underlies physical chemistry and biophysics which have led to big advances in medicine and surgery. Solid state Physics has led to the development of miniaturization in circuits for calculators, computers, sound and vision equipments as well as a host of other purposes.

Awe and Okunola (1992) recognized that:

1. the clinical thermometer, X-ray machine, bicycle, motor car, camera, radio and television are a few of the many inventions of man which require Physics knowledge for their understanding, and
2. many natural phenomena such as the eclipse, rain, thunder and lightening find explanation in physical principles.

According to Nolan (1993)

1. Meteorology is the application of Physics to the study of the atmosphere.
2. Engineering is the application of Physics to the solution of practical problems.
3. The science of biology, which traditionally had been considered independent of physics, now uses many of the principles of Physics in its study of molecular biology.
4. The health science uses so many new techniques and equipments based on physical principles that even there, it has become necessary to have an understanding of Physics.

Based on the analysis of the foregoing reasons for studying Physics, the following three categories of objectives are to be satisfied by the senior secondary Physics curriculum (WAEC, 2011-2015).
1. **Knowledge and Understanding:** Candidates should be able to demonstrate understanding of;
   a. Specific phenomena, facts, laws, definitions, concepts and theories.
   b. Specific vocabulary, technology and conventions including symbols, quantities and units.
   c. Use of specific approaches, including techniques of operations and aspects of safety.
   d. Scientific quantities and their determinations.
   e. Scientific and technological applications with their social, economic and environmental implications.

2. **Information Handling and Problem-Solving:** Candidates should be able, using visual, oral and written (including symbolic, diagrammatic, graphical and numerical) information to:
   a. locate, select, organize and present information from variety of sources including everyday experience,
   b. translate information from one form to another;
   c. analyze and evaluate information and other data;
   d. use information to identify patterns, report trends and draw inferences;
   e. present researchable explanations for natural occurrences, patterns and relationships and,
   f. make predictions from data.

3. **Experimental and Problem-solving Techniques.** Candidates are expected to.
   a. follow instruction and
   b. carry out experimental procedures using apparatus;
   c. make and record observations, measurements and estimates with due regard to precision, accuracy and units;
   d. interpret, evaluate and report on observations and experimental data;
   e. identify problems, plan and carry out investigations, including the selection of techniques, apparatus, measuring devices and materials;
   f. evaluate methods and suggest possible improvement and,
   g. state and explain the necessary precautions taken in experiments to obtain accurate results.

**Senior Secondary Physics Curriculum Implementation: Recommended Guidelines**

In an attempt to ensure purposeful and result-oriented Physics education delivery in Nigerian schools, Ladipo (1985) provided definite guidelines in his “introduction to the national curriculum for senior secondary physics”. He wrote:
In order to achieve the objectives of the Physics education at the senior secondary level, the guided-discovery method of teaching has been recommended. So teachers are strongly encouraged to employ the student activity-based and inquiry-oriented mode of teaching. Ample opportunity for laboratory activities and discussions has therefore been provided in every unit of the course. To stimulate creativity and develop skills in students, opportunity is also provided for the construction of workable devices in appropriate units of the content. It is recommended that any evaluation of this course should cover the three domains of educational objectives; namely, cognitive, affective and psychomotor domains.

Matters Arising

Analysis of the above quoted guidelines throws up several interrelated key issues both explicit and implicit bothering on curriculum process. Explicit in the quotation is the recommended teaching strategy; namely, guided-discovery/inquiry oriented method of teaching. Also explicit is the recommendation of a holistic evaluation procedure. Implicit in the guidelines is an encouragement to use demonstration-, project- and discussion teaching strategies. Most implicit are the issues of inadequate funding and operational time.

The Guided-discovery/Inquiry Teaching Methods

The guided-discovery/inquiry strategy encourages learners to discover relationships and method of solutions by themselves, make their own generalization and draw conclusion from them and thus, be better prepared to make wider applications of the materials learnt (Ajewole, 1991). But many issues seem to overshadow these advantages. Inquiry oriented method:

1. is time-consuming (Otuka, 2000; Onwuka, 2000). Thus the amount of time (generally 70 minutes per week) allocated for teaching of senior secondary Physics cannot allow for effective use of inquiry oriented methods.

2. is very expensive in the sense that it require a lot of instructional materials (Otuka, 2000; Onwuka, 2000). According to Okebula (1997) cited by Olayiwola (1997), the World Bank evaluation of the secondary education sector in Nigeria conducted in 1991 revealed that only laboratories at Federal Government Colleges were adequate. This sorry state has persisted. Tukur (2007) and Udoh (2011a) acknowledged that Nigeria, in particular, is poorly resourced in terms of availability and adequacy of instructional materials.

This offers possible explanation for the overwhelming verbal acceptability of guided-discovery method, relative to the lecture method, when, ironically, it is the latter that is predominantly implemented in practice (Udoh, 2011b). This deduction was made by earlier researchers such as Ali, (1998), Ogyleye, (1999), Ivowi, (1999) and
Science being an activity, it has been designed that it be taught through a series of activities in schools. Science curriculum improvements have demanded a complete integration of both theory and practical in science teaching at school. Studies carried out so far in the teaching of Physics reveal that teachers do not completely comply with the provision of these subjects. The most commonly cited reason is the lack of science equipment in schools…Until science laboratories and equipments are adequately available in schools, the defects in science teaching and learning may continue.

Demonstration Method

Closely related to the inquiry-oriented approach is that of demonstration approach. By definition, “a demonstration is one of the methods of teaching science which involves manipulating equipment in order to present or illustrate scientific concepts or principles in a way that the students are directly involved in the teaching-learning process” (Otuka, 2000). This may simply involve techniques of using and manipulating equipment, illustration of certain scientific process and verification of an experiment. Demonstration can be carried out to show the arrangement of batteries in series to increase voltage (Otuka, 2007). It can be argued that one obvious advantage of this method is that it helps reduce cost of purchasing instructional materials since fewer materials are required by the teacher doing the demonstration. (Otuka, 2000); and that it may be an effective means of monitoring the acquisition of certain skills when participants conduct the demonstration (Nwagu, 2009). However, Olayiwola (1995) regretted that “demonstration strategies have been over-used and abused … in the wake of lack of basic instructional facilities and materials especially for practical lessons”. Also, it does not allow the pupils to develop manipulative skills as most often, the demonstration is handled by the teacher (Otuka, 2000).

Project Methods

In project approach, a central theme or problem is selected by the teacher, the students or both. The task is subdivided into sub-tasks. Guided by the teacher who acts as a facilitator, the students are encouraged to investigate, gather materials, analyse and construct things (such as simple periscope and vernier calipers) on their own. Generally, the students work in groups, at the senior secondary school level. Nonetheless, the recurring problem of time constraint, serious infrastructural facilities deficit, paucity of professionally trained personels, among others, would render the project approach non-workable. Onwuka (2000) probably had this in mind when he listed several pit falls associated with the approach to include: being time consuming, being expensive as it requires many resource materials, including difficulty to schedule a project as it may disrupt the school time table.
Central to the project method, at the secondary school level, is the need for discussion with group members, in order to clearly sort out what procedure to follow as well as items of equipment to be used.

**Discussion Method**

Discussion involves the sharing of ideas or argument between members of a target group of about 3-12 individuals who have a common problem or purpose. The aim of the discussion is to come upon with a solution from within the group. Usually, the teacher who by his/her position is a member of the group, guides the group or class discussion and acts as a resource person, providing expert advice when needed. It is a way of helping most or all the pupils to actively contribute to the learning process (Nwagu, 2009). But the workability of this approach is dependent on the availability of adequate well trained teachers, with a capability to predominately use questions to lead learners into a meaningful discussion. Incidentally, the availability of this human resource is insignificant.

Nwagu (2009) posited three reasons with a potential to discourage adoption of this approach;
1. The discussion may be rowdy and may result in discussing irrelevant topics, misinformation or, worse still, producing no results.
2. It does not favour those who are shy and quite.
3. Class control becomes a problem.
4. Sometime, it may be difficult to achieve a consensus of opinion.

**Insight from Chief Examiners’ Report**

West African Examination Council (WAEC) Chief Examiners’ Report (2004-2009) indicate lapses/weaknesses in candidates manipulative skills, including poor understanding of underlying principles in senior secondary Physics. This report is reminiscent of learning that is the outcome of the traditional lecture method, rather than interactive methods of teachings. Researchers (Aghanta, 1982; Ajewole, 1990; Nbina, 2010) have shown that the lecture method of teaching is deficient in training the requisite number and quality of students with commitment for science and technology as an interest or vocation. “Pupils have tended to memorize facts and principles most of which they do not understand, only to regurgitate them during examinations” (Ajewole, 1990). Thus, key methodological requirements for effective curriculum implementation have suffered serious setback. Next, is an emerging issue of continuous assessment.

**Continuous Assessment Implementation**

One of the key requirements of the National Policy on Education (2004) is the implementation of Continuous assessment. Thus, assessment of Physics education is expected to be continuous, catering for the three domains of educational objectives; viz,
cognitive, affective and psychomotor domains. A variety of assessment techniques ought to be used such as, tests, observations, interviews, questionnaires, projects and experiments. But our current assessment practices reflect lop-sidedness such that it is product-oriented and not process-conscious. Udoh’s (2011c) research report revealed that Physics teachers assess the cognitive domain of learning (relying only on tests) to the serious negligence of the affective and psychomotor domains.

Studies show that, teacher-made tests suffer from various vices, including lack of validity and reliability; Teachers tend to inflate scores thereby, making nonsense of predictive validity of test scores. Adejanju (2007) reported that:

Most of our schools still operate the traditional assessment practices of the last century. This involves assessing pupils with the sole aim of preparing them for examination. Emphasis is placed on obtaining high marks without regard for understanding or ability to apply the concept learnt in solving real-life problems. For these reasons, an overwhelming emphasis is placed on pencil and paper assessment. Even then, the dominant practice is to concentrate on assessing the ability of the pupils to reproduce facts or steps in solving problems. Very little attention is given to the “highest mental tests” of thinking and application skills. These include the ability to apply the knowledge in real world; to analyze the information; to synthesize new information based on what was learnt; and to evaluate the outcome of knowledge applied.

Hence urgent attention is required in this respect if the great expectation to use Physics education to drive the technological advancement of Nigeria is to be realized.

Summary and Conclusion
Effects of Physics can be felt in all areas of human activities. The knowledge of Physics is essential for the chemists, biologist, physicians, dentists, medical doctors, engineers, geologists, architect, etcetera. As such, the teaching and learning of Physics must be a matter of national concern.

In an attempt to ensure purposeful and result-oriented Physics education delivery in Nigerian schools, strategies such as activity-based, guided-discovery, demonstration, project-based and discussion methods, including assessment of learning outcomes which should cover the three domains of educational objectives, have been recommended. Incidentally, the levels of their effectiveness in achieving the desired objectives of Physics education have given cause for concern.

Researches have shown that attempts to effectively implement senior secondary Physics curriculum have been bedeviled by the recurring problems of acute shortage of trained personnel, gross inadequacy of laboratory/instructional materials and a serious limitation of time. Consequently, rather than use inquiry-oriented methods of teaching,
the traditional lecture method is still predominantly used with all it’s major trappings of non-holistic learning. Accordingly, assessment of students’ learning is lopsided, emphasizing the cognitive domain to the serious negligence of the affective and psychomotor aspects. Worse still, because most Physics teachers lack sound training in educational evaluation, continuous assessment of students’ outcomes has been subjected to a great deal of abuse such as inflation of test scores, thereby making nonsense of the possible predictive validity of such scores.

Recommendation

In order to salvage physics education from it’s persistent quagmire, efforts should be intensified in subtle areas such as the production, retraining and retention (including good remuneration) of Physics teachers; concerted effort should be targeted at bringing our laboratories to international standard in terms of size, number, type, furnishing and maintenance. Since no school subject is even a half as crucial as Physics in bringing about sustainable national development, the school time-table should be re-constructed to double it’s present time-allocation for Physics education at the senior secondary school level. These issues must be addressed, accordingly, in order to enhance the quality of, and restore faith in, senior secondary Physics education. Until this is done, senior secondary Physics education will continue to be in limbo.

References


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