Science Process Skills Instruction for Sustainable Development in Nigeria

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The focus of this paper is to encourage strategical positioning of science process skills at the heart of effective and functional science education in Nigeria. Sustainable development all over the world is hinged on sustained scientific research. Meanwhile, science process skills are the tools required for a successful science practice and research. Pertinent issues and insight affecting science process skill instruction, such as low enrolment into sciences, need for curriculum and timetable reform in favor of sciences, paucity of qualified teachers, need for emphasis on practical skills evaluation among others were examined and practical suggestions towards succumbing such issues were offered for consideration. Among them are: the need to review admission and time-table policies in favour of sciences, decongestion of science class, accountability on the part of teachers, adoption of team teaching of integrated science (basic science), taking advantage of area of specialization of teachers in case teachers who specialized in integrated science are not available or inadequate, among others.

***Key words**: science process skills, instruction, sustainable development*

Introduction

Science and technology education has been identified as the universal foundation for sustainable economic growth and stability (Abdullahi, 2007, Igbokwe, 2000). Considering the countless benefit of science, one is not surprise at the emphasis placed on science education by the Nigerian government as outlined in the national policy on education which stressed the importance of science at primary, secondary and tertiary levels (FRN, 2004). There has been an increasing emphasis on science teaching and learning all over the world (Akpan, 2003).

The teaching and learning of science in schools is aimed at producing individuals who possess the requisite scientific knowledge, skills and attitude towards enhancing the life of people in the society technologically. However, on the contrary, Ukor (2010) observed that Nigeria is in danger of a declining population of scientist. Noticeable yearly poor performances in SSCE, is recorded in the science (Ada, 2003, WAEC, 2008 & 2009). Reacting to this, Bajah (1983) as in Nsofor (2007) noted that the problem is not far from the amount of recognition given to the nature of science during instruction. Acquisition of science concepts and skills depends much on the way they are taught and learned (Lagoke, 1992). The use of appropriate instructional strategy plays crucial role in the meaningful

and useful teaching and learning of science in Nigerian schools in the context of realizing the Nation's objectives. There is no doubt the fact that sustainable development depends squarely on sustained scientific research and development. Science process skills are veritable tools for the country's scientific progress and sustainable development (Awolola, 2001). Sustainable development is defined by Shaker (2015) as a process of meeting human development goals while sustaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depends. He traced the root of sustainable development to earlier ideas about sustainable forest management and 20th century environmental concerns, however has the concept developed, it has shifted focus to more on economic development, social development and environmental protection for future generations.

The last two decades has witnessed the emergence of an array of increasingly vibrant movements to harness science and technology (S & T) in the quest for a transition toward sustainability; the research and applications program that has begun to emerge from these movements has been called sustainability science by the National Research Council (National Research Council, 1999). Activities to advance the sustainability science program are moving forward on a number of front and scales from the global to the local. The international council for science, third world academy of sciences, initiative on science and technology for sustainability and other organizations have form a consortium for promoting a coordinated international program of research, capacity building, and applications (International Council for Science, 2002).

Sustainability science is not yet an autonomous field or discipline but rather a vibrant arena that is bringing together scholarship and practice, global and local perspectives from north and south, and discipline across the natural and social sciences, engineering and medicine (Initiative on science and technology for sustainability, 2003). Science process skills aimed to let individuals make scientific analysis of the environment and the universe they live in (Kaptanv & Korkmmaz, 2001).

Science Process Skills Instruction Approach

Nowadays, increasing importance is attached to acquisition of science process skills by science teachers, because process skills are veritable tools for a functional professional science practice. In the opinion of Colley (2006) instructional strategies and curriculum sequences in sciences should be geared towards teaching of science process skills and considerable attention should be given to it in science education. Science process skills-based instruction makes much emphasis on helping students develop process skills through constant practice or hands on

activities; it emphasizes that teachers should encourage students to learn how to observe objects or events more closely as they use their senses to gather information from them (N.T.I, 2006).

Process skills according to Bilgin (2006) is classified into two levels; basic and integrated science process skills. The basic skills are the lower level process skills, they are used in the experiments of scientists and students, as well as into the everyday life of average person, to a degree. They allow scientists to conduct objective investigation and to reach conclusions based on the results. Basic process skills include observation; noting the attributes of objects and situations through the use of the senses.

Classification goes one step further by grouping together objects or situation based on shared attributes. Measurement involves expressing physical characteristics in quantitative ways. Communication brings the first three skills together to report to others what has been found by experimentation.

Inference and prediction are the more sophisticated of these skills. Beyond simply seeing and reporting results, scientist must extract meaning from them (Arslan & Tertemiz, 2004).

The basic process skills are aggregated to perform higher process skills generally called integrated science process skills; one of such skills is ability to identify experimental variables as either dependent or independent and to know which of the variables should be isolated and controlled. Designing new hypothesis to guide research requires experience and prior knowledge to make an educated guess as to answer or outcome of the experiment. All of the science process skills contribute to a larger skill; problem solving. Problem solving is the reason for scientific inquiry and form the essence of it. Conclusions are drawn from findings based on accurate data collected during the procedure which can lead to hypothesis being accepted or rejected. This also requires another process skills; finding patterns in the results of a series of experiments (Pemida, 2004).

In teaching and learning of science using the process skill-based instruction approach, Pemida (2004) highlights these steps:

1. Identify the process skills you expect the students to develop and the level of success you want them to attain in the course of practicing these skills.
2. State the behavioral objectives, themizing the skills to be attained.
3. Outline the activities that will inculcate the expected skills.
4. Provide the instructional materials to be used and to guide the students in carrying out the activities.

5. Activities should be sequentially arranged from simple to complex to enhance students understanding and learning.
6. The basic idea behind the process based approach is to choose a subtopic which can be studied and enhance some required skills. The science teacher will think in terms of students activities that will develop the process skills as well as the content of knowledge.

In the society, things can be classified as living or non living. The observation and classification (process skills) of these things within the environment will help in studying them at ease (Asun, Aina and Ndu, 1995). This clearly implies that the classification of things within the society will make teaching and learning simple, interesting and permanent because each member of a group have some features in common. This approach is advocated to provide the students opportunity to experience real scientific practice.

Science Process Skills and Sustainable Development in Nigeria

Sustainable development everywhere depends on sustained research and development (S & D) particularly in the area of science and technology. Quality science and technology education depends on recognition and development of attitude and culture of free but guided inquiring and scientific enterprise among students (Jimah, Jimah & Onwuka, 2011). If students are not assisted in developing sound investigative skills at a very early age, then there is no reason to believe that students will be able to think critically and scientifically as they grow older (Mukute, 2010). Hands-on activities must be encouraged as it makes learning of science more real and practical to the students, encouraging critical thinking and exploration, leading to a sustainable development (Hamiti & Wydler, 2014). This is not common in a typical Nigeria science classroom and has resulted in Nigeria being a country of dependence, being mainly importers rather than producers (Olorufemi, 2012). There is a need for the curricula to address issues that are typical to our environment and culture, then integrate science process skills to teach, and in this way, science education becomes more meaningful to the child (Otive, 2006). Science then becomes less abstract and the teaching environment and students can make connections between learning science in school and applying them in daily life (EFT, 2006).

This way, members of the society will be economically empowered and responsible to not damage the environment so that our children's future is not compromised (McKeown, 2002).

Issues and insight in science and science process skills instruction in Nigeria

Haven realized the significance of science process skills as veritable tools in realizing effective teaching and learning of science towards enhancing sustainable development in Nigeria, some issues that needs to be addressed are as follows:

Low enrollment into sciences

Unfortunately, throughout the world science is witnessing a decline as science departments are closed down (Main, 2005). This is happening when the whole world is yerning to train more scientist, especially the physical scientist. We will get more young people doing science after basic school; if more of them continue with interest up to 16 years of age. The challenge then is how do we keep young people continue the learning of science with high interest at UBE basic science level? Adeoye (2003) tested the effect of practical activity on achievement of integrated science among junior secondary school students and observed that many students are interested in integrated science especially where practical lessons were conducted.

Need for Curriculum and time table reform

Science curriculum in Nigeria emphasized the use of activity – based teaching approach (FRN, 2004) but school time table which suppose to be a reflection of course weight in the curriculum is not reflecting that. In most Nigerian school only 70 minutes (double period) is available for science practical session per week. Presently, science instruction at JSS is not more than 5% of the overall time table per week (Ukor, 2010). Meanwhile, science teaching at JSS level requires at least 20% time table allocation for effective activity base instruction (John, 1993).

Paucity of qualified teachers

Availability of qualified science teachers who can give quality science instruction through imbibing science process skills is a major determinant of quality of science instruction, because no educational system can rise above the quality of its teachers (Akinwunmi, 2007). According to Alluede (2009), teachers can make or mar a science lesson. Shuaibu and Iroegbu (2003) observed that classroom behaviour of teachers has motivational effect on learning process and on the performance of students. Teachers of student-teachers are not teaching science through activities based approach, most, teach science through lecture method or talk-and-chalk approach (Osborne, 2001). Student-teachers learn to teach science by emulating their teachers.

The position of the teacher in the implementation of curriculum programme cannot be over-emphasized as the success or failure of such a programme depends largely

on the ability or inability of the teacher to execute them as originally intended by the curriculum developers. Achimugu (2005) stressed that the teacher is the real agent that operates the educational system, who ensure that students gain sociological, economic, cultural and technological awareness. He helps in the development of various skills and competencies that will in turn helps to equip the individuals in the society for their various roles. **Shortage of instructional facilities and equipments** According to Balogun (1982) in Ayewa (2009) the term equipment embrace those things called scientific apparatus; biological materials, glass work, polythene wares, chemicals, graphics and electronic aids, and even books. He further recognizes the indispensable role of equipment in science teaching, and succinctly put it thus;

> *No effective science education can exist without these things (equipment). They are indispensable in good science teaching and learning. Because part of the objective for teaching science in schools is to communicate the spirit of science to the pupils, we cannot do this without relevant science equipment (Balogun 1982: 26)*.

We also need to bear in mind that at least some of the pupils would need to become professional scientist and engineers, such pupils need the equipments to begin to develop the necessary science skills process, attitude and practical manipulative skills.

As a result of the teaming population of the primary school graduates, expansion of secondary schools or building of new ones; because of some expediencies science equipments becomes grossly inadequate for effective teaching of science (Muloni, 2001). Some of the newly created schools were sited on political ground only to satisfy the yearning of the populace. She argued that these set of political motivated schools lack basic furniture to say the least; provision of standard laboratory equipments in these set of schools is a luxury. Where such equipments were provided, there may not be students to access them due to its isolated location.

Admission of students into schools increased without corresponding increase in infrastructural and instructional facilities (Akpan, 2003). Akpan (2003) alleged that even a devoted teacher in the midst of inadequate working materials will feel frustrated in his struggle to raise his teaching above the level of drudgery. Maduebum (2005) also complained of a good number of faulty laboratory

equipment which remains unattended to. He suggested that effort should be made to ensure that spareparts are provided for maintenance purposes.

Lack of continuous re-training of science teachers

In a study on "identification and analysis of topics which teachers perceive as difficult to teach in primary science", Njoku (2005) collected data from 120 primary science teachers using a 4- point rating scale while mean score and standard deviation were used for data analysis. It was found that 17 (35%) out of 48 (65%) primary science topics were rated difficult. Ayua (2011) in another study found that among the few primary science teachers, only 25% of them could improvise. The rest (75%) cannot, and the reason was that they lack professional training in the acquisition of basic practical skills for improvisation. These findings are pointing to the fact that there is a dare need for continous re-training of the few available science teachers in our schools.

Need for emphasis on practical skills evaluation

Science students have to be tested on their ability to carry out complete scientific investigation. The evaluation test commonly given to science students in Nigeria are closed type teacher-question which usually requires simple recall and encourage memorization of scientific principles, laws and theories (Adeoye, 2003). What is needed is something simple and less mechanistic, in which teachers are given scope to assess their student's abilities in key scientific skills such as measuring accurately, observing carefully and working out results and communicating results clearly (John, 1993).

Gender imbalance

Gender imbalance is conceived as the structural relationship of inequality between male and female as manifested in the labour market, political structures and other spheres of human life as well as in households (Nwahunanya, 2000). The males, in most cases, consider themselves as superior to the females. Offor (2007) noted that in Nigeria women have been surbordinated to men, functioning as appendages to men's life career than as fully equal individuals in their own right. Research findings showed that gender imbalance in science education is not a recent trend but stretches back to pre-historic culture (Obasi; 2007; Oshun, 2007). It has also been revealed that the subjugation of females is in-built in tradition, culture, customs and in a very real sense of the way of life of many human communities (Rhaman & Marcus, 2004). Other causes of gender imbalance in science education include opportunity cost of education, early marriage among girls, lack of female

role models, poor self concept, sex based careers such as mechanical engineering, architecture and industrial physics and so on, as been masculine and therefore no go areas for girls. Hence, the girls tends to shy away from science and technology – related courses (Osukoya, 2003). Many educationists and scientists (Muloni, 2001; Anagbogu, 2003; Isa, 2005) have suggested adopting strategies that are gender –friendly in order to motivate and increase the interest of the girl-child in science and technology based subjects and consequently increasing girls participation in those areas. One of such fundamental strategy suggested by science educationist is activity based science instruction. Thus, it is believed will reduce the perceived gender imbalance in science and technology – base course.

Ever-growing class size

Twenty five students per science class is the most popularly acceptable standard science class size (Osborne, 2000). Science classes in Nigeria are overpopulated, either at tertiary, secondary or primary school levels (Akpan, 2003). This problem is beyond the control of established education quality assurance or control agencies, like inspectorate divisions of federal and state ministries of education; national board for technical education (NBTE), national university commission (NUC), national commission of colleges of education etc. the challenge requires a policy transformation of educational funding in Nigeria which can meet up with UNESCO standard of at least 26% budgetary allocation. This is so, because an attempt to reduce class-size towards the standard of 25 per class implies; increase in number of classrooms, laboratories, equipments, furniture and as well as increase in teaching and non-teaching staff in our schools.

Large class is not favourable for science process skills instruction due to the fact that the process requires adequate supervision of each students by the teacher to facilitate activities. Large class is prone to many cases of laboratory accidents and so on.

Conclusion

Science and technology is the fulcrum of sustainable economic development all over the world. Nigeria cannot afford to treat science education with kids-glove if we are determined to transform our national economy within the shortest possible time. Science instruction will be ineffective without adequate instruction on science process skills. Because they are the skills require for future practices of science in all science and technology base careers.

Suggestions

1. The 60/40% Science/Arts admission policy adopted by Nigerian universities and other tertiary institutions should be extended to at least federal government owned senior secondary schools if not to all. This will give way for a science and technology driven sustainable economy.
2. School time tables should provide for at least 20% science instruction at primary and junior secondary school levels. While 60% time table should be maintained for senior class science instruction. This is the only way that practical science or activity-based science instruction can be effective.
3. A package of refresher programme should be designed which will take into cognizance key instructional challenges facing science teachers in Nigeria, particularly at primary and secondary school levels. This package should also be extended to cover teachers of teacher training institutions because they are in position to handle the problem at its neap. This will afford the teachers an opportunity to attend seminars, and conferences which will hopefully help in their growth and development as proficient science oriented teachers. Science teachers should be regularly exposeds to contemporal science pedagogies.
4. Accountability on the part of the teachers should be enforced to make them dispense their work conscientiously. Science inspectors should be more diligent to their duty in order to find out from time to time how teachers are handling science teaching.
5. Government should declare a state of emergency in the education sector of Nigeria. This will fast track infrastructural development and capital investment in education.
6. Instead of having one teacher of integrated science, we could adopt teamteaching approach whereby, a teacher who specialized in one area (e.g. physics) could teach that particular section. With such arrangement, it may be necessary to organize the basic science curriculum such that each section is scheduled for a particular term of the year. This will go along way to improve quality of teaching science at basic science level which is the nursery site of all future science careers.
7. Emphasis should be placed on formative practical skills assessment rather than summative cognitive test assessment. Students will begin to value mastery of science process skills and dignity for labour.
8. Gender friendly and non-discriminative science teaching strategies should be adopted by all science teachers. We recommend science process skill instruction in this regard.

9. As government is making effort to increase infrastructures and equipments to ameliorate over-populated science class, teachers should be encouraged to adopt grouping of students as the last alternative to do science process skills instruction at all levels of education.

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