INTERVENTION STRATEGIES FOR REPOSITIONING SCIENCE EDUCATION IN NIGERIA

Dr. Hycienth Leyiga Nkpone

Abstract

Science education was introduced in the Nigeria school's curriculum by the colonial masters whose objectives and interests were not the same as those needed for the development of the nation. If the development of science education in Nigeria, was .deficient, then science education in Nigeria must be repositioned in order to avoid making the same mistakes for which we are blaming the colonialists. This paper therefore is aimed at putting forward some intervention strategies for repositioning science education in Nigeria. The following minimum intervention strategies were suggested: improvisation of instructional materials, implementing appropriate conception change, emphasizing teaching for critical thinking, encouraging teaching for transfer of learning, building information & communication technology in the science curriculum, enriching socio-cultural learning, providing equal access for males and females and. emphasizing meta-analysis research in science education. Recommendations and implications for science teaching were proffered.

Introduction

Education, specifically science education, has been recognized as instrument for the socio-economic development of any nation, including Nigeria, since it is aimed at meeting the aspirations of the individual and the society. However, since 1859, when science subjects were introduced in the Nigeria schools' curriculum (IVOWI,1999), science teaching and learning in Nigeria have not contributed significantly to the socio-economic emancipation of the Nigeria society. As stated by Ivowi (1999), when the Phelps-stoke funded education commission visited West Africa in 1920, it found that the state of science education w?.s defective. To this end, a strong recommendation was made for the inclusion of science subjects in the curriculum of all secondary schools.

Thus science education *was*- introduced into our school curricula by the colonial administrators whose interests and objects were not necessarily the same as those needed for the development of the nation. In this way, the teaching of science was not coordinated, neither was it focused (Baike, 2000). If the development of science education in Nigeria school system was deficient, policy makers and those at the helm of our educational system, must reposition science and science teaching in order to avoid making the same mistakes for which we are blaming the colonialist.

The science policies as contained in the National Policy on Education (1981) state that

i. Science shall be taught to all children at the primary and secondary schools.

ii. The teaching and learning of science shall be done in such a way as to develop the child in the three domains: viz cognitive, affective, and psychomotor educational objectives iii.

Equal opportunity in terms and the provision 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 examination

v. Local production of science equipment and the practice of improvisation shall be pursued vigorously.

In order to achieve the objectives of the policies the National policy on science and technology (1986!2:3) outlined strategies for implementation of the objectives of science and technology education as follows;

1. Evolving programmes for the recognition, encouragement, development and promotion of scientific and technological talents at all levels.

2. Making it possible for the child to have early contacts with the concepts of and materials related to science and technology even before attaining school age
3. Ensuring a sound science foundations during the first six years of the 6,3,3-4 educational structure through:

i. Entrenchment of science teaching in primary school curriculum
ii. Provision of adequate teaching laboratory aids
iii. Provision of well trained and well motivated science teachers
iv. Introduction of gainful practical activities such as model making, handicrafts, gardening and farming.

A critical evaluation of the implementation of these strategies over the year shows that science and technology education policies are far from being realized/ implemented. If these strategies are well implemented, science education in Nigeria should have produced science graduates at the various levels of our educational system who will be able to contribute meaningfully to the national development. In this paper an attempt will be made to review and evaluate some intervention strategies for repositioning science education in Nigeria. Any paradigm or model aimed at'; repositioning science education in Nigeria must consider the following minimum intervention strategies:

- Improvising instructional materials
- Implementing appropriate conceptual change
- Emphasizing[1] teaching for critical thinking and problem solving
- Encouraging teaching for transfer of learning
- Building information & communication technology in the science education curriculum.
  Enriching socio-cultural learning
- Providing equal access for males and females participation in science learning
- Emphasizing meta analysis research in science education.

Improvisation of Science Instructional Materials

One intervention strategy for repositioning science education in Nigeria, for the new millennium is focused on improvisation of instructional science materials. Several definitions have been given to facilitate the understanding of improvisation. Eniayeju in Iwuozor (2000) defined improvisation in science teaching as the act of using alternative materials and resources to facilitate instruction, wherever there is lack or shortage 3f some specific first-hand teaching aids. To Gabriel (1985), improvisation is the act of using materials or equipment obtained from local environment designed either by the teacher or with the help of local personnel to enhance instruction. This means that improvised materials are made up teaching aids aimed at filling the gap between teaching and learning process and provide a frame of reference on which students can focus their attention during classroom instruction.

In a study by Elijah (2000) on the effect of improvised instructional materials on students achievement in some concepts in mathematics, there was significant difference in the performance of students exposed to improvised materials to those in the controlled group. Therefore, in order to reposition science education emphasis must be focused on improvisation of instructional materials, not only because of the short supply or non-existence of conventional laboratory teaching aids.

Implementing Conceptual Change in Science Teaching

A second aspect of repositioning science education in Nigeria consists of implementing conceptual change approach in science teaching. Conceptual learning refers to learning that occurs when the learner's understanding about specific concepts are restructured in a meaningful fashion. Lampe and Staver (1995) noted that a learner undergoes conceptual change when his or her cognitive structure is completely rearranged: Old views are discarded and new ones formed. This arrangement is referred to as accommodation (Piaget, 1985). Several non-scientific factors influence the teaching and learning of science. These include religion, social and cultural factors (Orukutan and Baiogim, 2000). These factors constitute preconceptions which the student brings into the science classroom.

Pre-conception referred to the knowledge and beliefs about the content to be learned and the learning process. Pre-conception can he equated to Ausubel's (1990) notion of prior knowledge or Bloom's (1976) notion of cognitive entry behaviour. Meaningful learning, for repositioning science education can be effective when the new knowledge interact or after the anchoring cognitive structure. For science education to be meaningful to the leaner and the Nigeria society, conceptual change learning must be emphasized in our science instruction. The teacher must provide instructional activities that will explicitly challenge students' prior knowledge. This should eventually lead learners to reconstruct their knowledge structures, to be more scientific that is, correct concept. Emphasizing Teaching, Critical Thinking And Problem Solving:

The third aspect of intervention strategy for repositioning science education in Nigeria involves', teaching for critical thinking and problem solving to from the moment the students enter school, their activities demand thinking, decision making and problem solving. Central to the definition of critical thinking is the notion that critical thinking is discriminatory, purposeful, intellectual exercise directed at the production of objective interpretation, analysis evaluation, inference aimed at the solution of existing problem (Wisdom, 2000). It is not enough for learners just to obtain knowledge, we want them to apply what they have learned to be integrated with other facts, we want them to plan what to do with the materials, all aimed at helping them to use critical thinking skills. To facilitate this discussion, for improving students critical thinking skills, the Author Costa model of critical thinking skills will be reviewed. Costa (1985) suggested a four-level hierarchy of critical thinking skills which are helpful in teaching and development of instructional materials.

Level 1: The discrete level of thinking. This involves students skills pre-requisite to more complex thinking. For example the teachers must ensure that the lesson plans are commensurate with student's abilities.

Level 2: Strategies of thinking. This involves a combination of a learner's discrete skills to formulate further strategies. For example, the teacher may wish to determine that students understand the idea presented and are able to combine them in a way that leads to problem solving.

Level: 3 Creative thinking. Which requires the use of effective teaching style to create new thought patterns and innovative solutions.

Level: 4 The cognitive spirit. This requires students to display a willingness, disposition, inclinations and commitment to think. For example, the teacher will want students to be sufficiently motivated to see problems as a challenge rather than an insurmountable obstacles.

What can the teachers do to foster critical thinking skills? Costa (1985) identified four categories of teaching behaviour which are particularly relevant for teachers. These are questioning, structuring, responding and modeling. Students derive their cues, for expected behavour from teacher questions and statements. For example, to aid input, questions that require students to name, describe, define and observe are effective tools. To help students process data, questions that require students to search for relationship, synthesis, analysis, compare and contrast are appropriate. Questions that force students to apply data in a novel and predict. Structure refers to how teachers control the classroom environment. Structuring a classroom to improve student's thinking skills demands clear objective they can understand. Costa Stated that such structure emerges from three structural goals namely:

i. Instructional clarity
ii. Structuring, time and energy and
iii. Careful organizing interaction with students

Responding which are extremely influential in shaping student behaviour fall into two major categories: closed responses and open response. Closed response include criticism and praise. Open responses include silence, accepting clarifying and facilitating. It is emphasized that teachers should

give students time to answer questions be non judgmental: clearly indicate when the students do not understand an answer and provide feedback. In modeling, a teacher should avoid inconsistencies between what he say and what he does. Students are remarkably perceptive and will quickly discern any discrepancies. One aspect of critical thinking is problem solving. One model which offers several meta-cognitive strategizing for aiding students in problem solving is called DUPE

see figure 1

D -	Define the nature of the problem
U -	Understanding the nature of the problem
P -	Plan your solution select appropriate strategies
E -	Evaluate your plan for its suitability and success

Source: Ettiot, Kratochwill, Cook and Travers (2000).

The need for critical thinking and problem solving skills dominates our lives and should be emphasized in science classroom instruction with a view to repositioning science education in Nigeria.

Encouraging Teaching for Transfer of Learning

Educators have embraced the idea that science education will not become one element of our genera] culture until teaching for transfer of leaning is encouraged. The concept of leaching for transfer of learning in science classroom will involve activities which the student perceives as useful, meaningful, when learning is well organized, and there is a psychological sound basis for materials, methods and sequences of instruction. Science education will presumably be repositioned through established specific and well defined procedures and when desirable changes in classroom instruction will be carryover into new situation. Several theories have been put forward to explain how transfer of learning occurs. These include theory of formal mental discipline, theory of identical components, theory of generalization, theory of transportation, transfer and advanced organizer (Nkpone, 2000). The methods of teaching is an important factor in securing transfer, thus repositioning science education in Nigeria. The main implications for the science teachers are discussed below;

1. Science education should be taught and learnt in close context with its implications. This means that teachers should relate instruction to actual life problem to which the principle applies.
2. . All problems and issues raised by students should be discussed thoroughly in science classes, not just to give them a routine solution, but to suggest how to deal intelligently with the problem.
3. Students should be encouraged to perceive common essential features of situations, which appear superficially to be different while imparting instruction.
4. Science teachers should encourage students to develop power of generalization. And call their attention to the underlying principles, by referring to various concrete examples.
4. There is the need for teachers to provide in the lesson plan opportunities for transfer in terms of students goals and purposes.

Enriching Socio-Cultural Learning

A review of related literature in science education shows that teaching-learning environment of a school and some psycho-Social factors contribute to the learning outcome variance in schools. Other social-cultural variables which exert significant influence on science achievement and interest include authoritarianism, goal structure, traditional African worldviews, societal expectation and sacredness. Thus, social and cultural factors are major forces for repositioning science education "in Nigeria and for shaping development. Talking about culture, Burner (1996: 4) stated:

> Culture then, though man made both forms and makes possible the working of distinctly human mind, on this view, learning and thinking are always situated in a cultural setting and always dependent upon utilization of cultural resources. Even individual variation is the nature

and use of mind can be attributable to the varied opportunities that different cultural settings provide, though these are not the only source of variation in mental functioning.

It was Burner's contention that science learning will be more profitable and successful if science teachers understand and capitalize on the rich traditions of the learners. One way for enriching socio-cultural learning in our science curriculum is to encourage the teaching and learning of the history of science, scientists and mathematicians along the development of technology in Africa and the developed world. This will help students appreciate the fact that science is a common activity designed by human beings, thus removing the myth that science is meant for some intelligent people.

Building Information of Communication Technology in the Science Education Curriculum

Science education, as a genre of our national life will be repositioned by building appropriate Information and communication Technology (JCT) in the school curriculum at the primary, secondary and tertiary levels. As an instrument for instructional strategy, Information Technology (IT) can be used to teach science subjects more effectively and building sustained scientific attitudes in students. London (1997) defined communication as the process of transmitting information and understanding from one individual to another. Information, as opined by London (1997) is a general term for news reports, intelligence or anything which/can be communicated from one individual to another. Imogie (1998) views technology as the systematic application of scientific or organized knowledge to practical skills. Aggregating the above concepts, information and communication technology can be considered as an electronic based technology generally used to collect, store, process and package information as well as provide access to knowledge. Okwor (2002) described information technology as the use of computer and telecommunication system in the collection, collation, analysis, processing, manipulation, storage, retrieval, transmission and communication of data in different forms which may include audio, visual, and audio-visual format. According to World Bank report (1999), information and communication technology greatly facilitates the acquisition of knowledge, offering developing countries, including Nigeria, the opportunity to reposition their educational system, improve their policies formulation and widen the range of opportunities. As contained in the report, the task facing our science educational system include; Acquiring and adopting global knowledge and creating knowledge locally. Investing in human capital to increase the ability to absorb and use knowledge. Investing in technologies to facilitate both the acquisition and absorption of knowledge.

Information and communication technology revolution poses a number of challenges to science education in Nigeria. These include preparing students to live in a world increasingly rich in information. This is necessary because science information explosion is irrevocably changing traditional values, assumptions, misconceptions about the nature of science.

Providing Equal Access for Males and Females Participation in Science Learning

Educators and psychologists (Arvidson, 1982; Becker, 1987) have expressed concern over the low participation and under achievement of women in science education and science related careers, and have advanced several reasons for encouraging women participation in science subjects. First, it is argued that the lack of participation and poor attitudes of women in this important area of knowledge might result in disadvantageous consequences both for themselves and the nation. Second, women are disadvantaged when considering career that require the physical sciences as entry requirements, Finally, this lack of participation of women in science education may contribute to the relative exclusion of women from scientific fields and can affect the national economy. When female students decide not to enroll in science subjects, they are seriously hindering their career opportunities and the nation creative resources, when ah expanding pool of qualified workers are needed to compete in the international market. The low enrolment of women in science and science related careers has been explained from different theoretical perspectives including; psychological view points, socio-cultural influence, social learning theory, social and experiential factors (Nkpone, 2004; Becker, 1987).

The following recommendations for providing equal access in science education and encouraging women to be more actively involved in science and science related career, thus reposition science education Nigeria are proffered.

1. Instructional and behaviour intervention strategies have been shown to be effective in encouraging women in science and science related careers and improving their attitudes toward science. Specifically, the programme should highlight the following variables toward science subjects: confidence (anxiety), perception of the usefulness of mathematics, career awareness, stereotyping of science and mathematics as a male domain, achievement in science 'and mathematics, spatial visualization, encouragement to pursue science and mathematics and role models. These programmes should be targeted at the junior and senior secondary school levels.
2. Professional organizations, such as the science Teachers Association of Nigeria (STAN), the Nigerian Association of Women in Science, Technology and Mathematics (NAWSTEM) should play important role in increasing the participation of women in science and technology. Such groups should provide a forum for discussion and disseminating of information on issues related to. women in science and technology.
3. Solving Problems of Access to Career in Engineering and Science (SPACES). The SPACES programme should be built in the primary and secondary schools science curriculum. The SPACES project consists of a number of enrichment activities designed to develop career awareness and important mathematical problem solving skills (Becker, 1987). The career awareness activities explore variety of professional and skilled positions available to people with good mathematics background including other related fields such as: construction, the sciences and engineering. The mathematics skills to be developed include gathering and organizing data and spatial visualization
4. Visiting women scientists: Professional Associations and groups should organize women scientists to visit secondary schools. Speakers, mainly female mathematicians and engineers should visit secondary schools to discuss how they use mathematics, to meet with women students informally, and to confer with teachers and counselors. Like the career conferences, the programme provides career information, encouragement for young women to persist in mathematics and role models.
5. An Integrated Programme: Multiplying options and subtracting Bias (Fraser, 1982, Becker, 1987), aims to increase mathematics course selection by increasing females knowledge about sex-related differences in mathematics, by improving females attitudes toward mathematics, and by changing the attitudes of teachers, parents counselors, and peer of both sexes. The programme further highlights on how much mathematics is needed for various careers, the number of women employed in mathematics related careers, stereotyping of mathematics classes, counseling, and family interaction, sources of females lack of confidence in mathematics, and ways to change student course-selection behaviour.

Providing the capacity to lead, measure and sustain science and mathematics interest and achievement for all students in Nigeria is a community responsibility: Ownership and Accountability, problems and solutions must be widely shared across stakeholders, groups at all levels in order to reposition science education in Nigeria.

Emphasizing Met a-Analysis Research in Science Education

Another means of repositioning science education in Nigeria is investing more in meta-analysis research, which is the integration of research findings in science education. When policy decisions are based on the findings of research studies, such decisions are generally not based on one research study but on the consensus of many researches. Not only on statistical significance alone, but on the evaluating of its practical significance. This implies that the findings of single studies are often inadequate in providing definite and .'reliable answers to many problems in science education. Therefore, it is essential to synthesize or integrate all the studies on a particular problem, in order to determine' whether they support a general conclusion or not. Given the controversies and the basic limitations inherent in

the findings of single studies, there is the need for a comprehensive review of existing research on current issues in science education, using a more powerful method of combining results than summary impressions. The best methodology, for this purpose is called meta-analysis,

Glass(I976) in his presidential address at the American psychological Association describes meta-analysis as "analysis of analyses". Glass contended that meta-analysis is as process and formal methodology for drawing conclusion about a body of research surrounding a particular conceptual focus. In the years since Glass's address, a number of researchers have used this method to synthesize results of psychological and educational researches. For steps involved in meta-analysis research, see Nkpone (2003).

Summary and Conclusion

The purpose of this study was to review and evaluate some intervention strategies for repositioning science education in Nigeria. It made far-reaching recommendations and alternative strategies for repositioning science education in Nigeria via: Improvisation of science instructional materials, implementing conceptual change in science teaching, emphasizing teaching for critical thinking and problem solving, encouraging teaching for transfer of learning, Building JTC in the science education curriculum, enriching socio-cultural learning, providing equal access for males and females participation in science and emphasizing meta-analysis in science education research.

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