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Review

Reforms in Nigeria's science education: implications for science teachers

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In this paper, the reforms in science education were discussed with special reference to the country Nigeria. Issues such as science curriculum development in Nigeria, features of American Association for the advancement of science, challenges of the science education reforms, and implications for science education in Nigeria were discussed. However, the paper particularly delved into highlighting the implications for the professional development of science teachers in Nigeria. In particular, attention was given to science literacy, society and technology as basic indices of science education at all levels of the educational system. Hence, conclusions and recommendations were made.

Keywords: Science, Science Education, Reforms, Science Teachers, Implications.

INTRODUCTION

Science Education reforms curriculum connote the science development efforts which were sparked off during the 1960s and 1970s by the sudden launching into space of the satellite “Sputnik” by the defunct Soviet Union in 1957. This development created the curiosity and consequent questioning of the mode of science teaching/learning and the nature of the science curriculum existing in the United States of America and other nations of the world. subsequently, a metamorphosis of several new science curricula evolved which included the Physical Science Study (PSCS), Chemical Educational Materials Study (CHEM study), Biological Science Study (BSCS), all in the U.S and the Nuffield Science Projects in the U.K. Furthermore, the Nigerian nation became a part of these curriculum development efforts with the birth of Basic Science for Nigerian Secondary Schools (BSNSS) undertaken in 1962 at the Comprehensive High School, Aiyetoro. This was followed by the Nigerian Integrated Science Project (NISP) in 1971, a project of the Science Teachers Association of Nigeria (STAN). In 1969, the historic national curriculum conference further paved way for the involvement of some government agencies such as the defunct Comparative Education study and Adaptation Centre (CESAC), the Nigerian Educational Research Council (NERC), which later merged to become the Nigerian Educational Research and Development Council (NERDC) to fully participate in many other science curriculum development projects both at the primary and secondary levels of our educational system. However, the bottom-line of these curricular reform efforts hinged on the fact that there were total dissatisfaction with how science was still traditionally being taught. This traditional approach related to the

decreasing popularity of science among students as evidenced by the declining number of students choosing science subjects. Furthermore, many research studies have shown that students exposed to the traditional approach end up with poor understanding of scientific concepts. In addition, the traditional approach it was argued did not adequately prepare future citizens to understand science and technology issues in a rapidly evolving study.

The New Reforms in Science Education

The new reform initiatives in science education which started in the 1980s and 1990s, squarely positioned science as a social process and cultural practice with particular ways of knowing and doing science. Consequently, a series of influential publications in the United States (AAAS, 1993; NRC, 1996) have advocated a nation-wide reform in science education. For instance the American Association for the Advancement of Science (AAAS, 1985, 1993) established a curriculum reform project code-named "Project 2061". The conceptual basis for the reform has some basic features with the following aims:

(i) To achieve scientific literacy as the central goal of science education (i.e. "science for all Americans). It was considered particularly important to focus on students understanding of the nature of science, for instance by studying the history and the philosophy.

(ii) To relate an understanding of major concepts, principles and habits of thinking in science, mathematics, technology to events/activities in the society.

(iii) To achieve science standard for all students including girls, language, ethnic minorities and all ability groups in an attempt to encourage all students to succeed and to embrace excellence and equity.

(iv) To design science education to reflect that science is an active process, so that both "hands-on" as well as "minds-on" activities should constitute the core of the education process. Thus, emphasis on content should be "less is more" i.e. teach less content with greater depth of understanding.

(v) To focus on inquiry as a central element of the curriculum to promote students to actively develop their understanding of scientific concepts, along with reasoning and thinking skills, through group based approaches and greater cooperation among science teachers and students while de-emphasizing competition in the classrooms.

(vi) To explore the use of alternative assessment techniques to paper and pencil test.

In their report on a new vision for "Science Education Beyond 2000", Millar and Osborne (1998) advocated the wide use of narratives in teaching. After criticizing an over concentration on the detailed content of science in U.K. schools, they proposed that:

> *Science Education should make much greater use of the world's most powerful and pervasive ways of communicating ideas in the narrative form-by recognizing that its central aim is to present a series of explanatory stories.*

Thus, in accordance with the "Science Education Beyond 2000" report, a new GCE syllabus was introduced in Britain, called "Science for Public Understanding (NEAB, 1998). This new syllabus aims to increase students:

(i) Understanding of everyday science

(ii) Confidence in reading and discussing media reports of issues concerning science and technology

(iii) Appreciation of the impact of science on how we think or act.

Similar goals can also be found in many articles and reports documenting new science education reforms in other countries of the world. Typical examples include the implementation of a new science curriculum in Australia (curriculum Corporation, 1994), Science Technology and Society in Canada (Aikenhead and Ryan, 1992), the introduction of Public Understanding of Science in the Netherlands (Devos and Reading, 1999).

Therefore, the new reforms in science education all emphasize the importance of scientific literacy and understanding for all students especially for those students women and ethnic minorities who traditionally have been neglected by and deprived of science. Consequently, a great number of science education researchers have examined how their own identities as women and/or people of colour cohere or conflict with their implementation of an inconclusive science content and strategies used in school, university science and teachers education settings (Barton, 1998; MC Ginnis and Pearsall, 1998; Osborne, 1998; Rodrigher, 1998).

Furthermore, science education reforms have also focused on some of the following themes such as:

(i) Constructivism
(ii) Thematic Approach
(iii) Assessment and Evaluation
(iv) Equity
(v) Science, Technology and Society (STS)
(vi) Cooperative learning
(vii) Hands-on Activities
(viii) The Nature of Science.

However, from a teaching perspective, these reform efforts have some implications for teaching science. Kennedy (1998) found that instead of transmitting content knowledge in a rigid manner, the emphasis in teaching will be on designing situations and a variety of activities which enable students to learn actively. In this respect, the teacher needs to investigate what the students already know, identify possible misconception

then design an appropriate educational setting. In their views, Millar and Osborne (1998) said, a shift toward reflection on science rather focusing solely on the content of scientific ideas is implied. Thus, teachers will be asked to pay more attention to aspects of science they usually ignore or do not feel very comfortable with. Such include, philosophy of science, or the relation between science and societal issues.

In general, teachers will be confronted with the challenges of teaching science in a way which appeals to all students both from a cognitive and affective perspective and not just students with high abilities or high motivation for science. There is also the shift towards the teaching of inquiry skills, which is definitely more complex than the traditional training of practical skills.

Challenges of the science Education Reforms

From the different perspectives of the science education reforms, the challenges posed by the debate include:

The Nature of Science and Knowing Science

The new reforms in science education views scientific knowledge as constructed through social acts, where individuals interact in distinctive ways with society and culture to create something for some purpose. Thus, scientific knowledge is linked to the social use of science. Knowing and doing science are therefore historically, socially and politically situated processes.

According to Jusco (2001), what scientists know, how they have come to know it are artefacts of the context in which scientists work, as one can never know or do science separate from his or her own history (individual and societal). Science is therefore a social activity and involves human values and characteristics combine to shape scientific knowledge. Scientific concepts are therefore culturally and need based explanations of natural phenomena to be applied in everyday activities. Such a perspective about knowing and doing science is therefore in contrast to the traditionally accepted vision of science as an objective enterprise.

Science and Technology Education

Definitions of technology vary greatly in education. For some, it consists entirely of teaching students to use computers, while others regard technology as a branch of vocational education. Technology could also be interpreted as the artifacts teachers use in teaching i.e. educational technology. Technology in its broad meaning according to Benenson (2001) begins with problems that children find significant. It engages them in using all the intellectual resources available and in developing new ones in order to solve the problem. These resources include the abilities to collect and analyze data, understand spatial and arithmetic relationship, communicate in oral and written form and make sense of social relationship.

Technology can also be seen from a wider perspective thus we use technology to try to change the world to suit us better. The changes may relate to survival needs such as food, shelter, or defence, or they may relate to human aspirations such as knowledge, art or control (AAA, 1989).

Current science education reforms proposals are therefore seeking the introduction of technology studies in the education of all students from primary school to university. The reform movements all urge an education that will enable an understanding of the concepts and principles of technology such as design, control and systems as well as the key ideas about technology in specific areas such as materials energy, manufacturing and information (AAS, 1993; NRC, 1996). One important and relatively recent notion is that of science literacy, which intrinsically includes understanding technology (AAS, 1989; 1993; NRC, 1996). This conception of science literacy therefore raises fundamental challenges for science education. For example, what exactly should be the role of understanding technology in science education? What specific technological ideas and skills are fundamental for science literacy, or what changes are needed if we want students to have an understanding of technology? It is therefore important that science and technology be designed to provide all students with conceptual tools to make sense of a highly technological world. Such programmes would help all students to learn about design, the interaction between science and technology and the limits and strength of technology.

Gender equity

Wills (1996) posited three perspectives on gender and science education as follows:

- The way and manner science is taught and assessed
- Problems created whereby some students by virtue of their gender are less well prepared than others to benefit from science education.
- The nature of science curriculum itself as the content and sequence reflect the kinds of dominant values, which are stereotyped with respect to gender.

However, during the science education reforms of the 1980s, it became evident that both the pedagogical practice and the presentation of science in many classrooms reflected social and cultural stereotypes

which were masculine, resulting in curriculum better suited to boys only. Research studies became concerned with how well the needs, learning styles and values of girls were considered in the science classrooms and to find ways and means by which curriculum and pedagogy could cater for these needs and learning styles. Today, understanding of gender equity has grown and diversified as the framework used for thinking about the issues have changed. Invariably, the new science education reforms interpret gender equity in terms of the ways in which science is used in society and in school to privileged members of dominant cultural and social groupings including gender.

Krockorer and Shepardson (1995) equally drew attention to what they called “the missing links” in gender equity research in science education. They emphasized the need for ethnicity, race, class and socio-cultural identities to be included in understanding participation in science.

Performance assessment

Ayodele (2002) had argued that if the teaching and learning of science are culturally and historically contextual and involve the dynamic and reflective interactions among teachers, students, science and society, then any performance assessment, must also be viewed as embedding dynamic and recursive processes that raise understanding of issues of access, enactment etc.

Furthermore, the new curriculum in science education harps that teaching science cannot be reduced to only the acquisition of knowledge or mastery of skills/techniques but must also be defined within a discourse of human activities, as the teaching of science occurs within the larger contexts of culture, community, power and knowledge. Thus the science education reform support a pedagogical position that views student achievement in the cultural and historical content of the domain, the classroom, the community and positive lives. Hence, assessment that represent knowledge as a final product is only regarded as one-sided view to students and so does not account for science or science learning as a recursive process.

Performance assessment therefore plays an important role in challenging how we define good science learning and achievement in the classroom by raising fundamental questions about what it means to know and do science in individual and contexts. Science differences exist in students’ experiences, beliefs and understanding, performance assessment must be consequential to:

- Include issues of equity and diversity and reflect the collective process of creating culture and history.
- Include action and change within the process of determining what students know and understand.
- Be closely tied to individuals and collective responses, needs, concern and problems of the lives of students involved.

Implications for science teachers in Nigeria.

Discussion on the new science education reforms should definitely include the professional development of science teachers and the alignment of education policies at both the federal and state levels as well as the alignment of curriculum instruction and assessment in the classroom. The role of teachers in the context of curriculum change has usually be perceived as executing the innovative ideas of others (policy makers, curriculum designers, researchers and the like etc). In recent times, however, there has been a growing consensus that educational reform efforts are doomed to fail if, the emphasis is on developing specific teaching skills, unless the teachers’ cognition including their beliefs, intentions and attitudes are taken into account.

In order to understand the implications of these reforms for the professional development of science teachers in Nigeria, we need to re-examine the challenges posed by these reforms in a manner consonant with providing remedial learning situations for science teachers; as enunciated above. The question of how to involve teachers in curriculum reform efforts so that the chances of a successful innovation are enhanced has, of course, been asked in earlier innovations. Ever since the birth of the science curricular reform movement in the late 1950s, a large portion of science teachers education has been connected in some way in attempts to introduce curricular changes (Anderson and Mitchener, 1994).

This process include:

- The core elements of the innovation were defined by curriculum developers or policy makers.
- A description is made of the teaching behaviour expected of teachers who would loyally implement the innovation, or of the skills teachers should acquire.
- A series of training sessions or supervision activities were designed aimed at developing the desired teaching behaviour.
- The implementation was not adopted by the teachers in the manner intended or initially observed changes in the teachers’ behaviour did not persist.
- These steps or processes were repeated, but in a modified manner.

CONCLUSION

Reforming science education means providing opportunities to learn, opportunities to teach, opportunities for conversation about science learning in classrooms and other social settings. Therefore, the focus of this paper was to highlight the new reforms in science education, worldwide, dovetailing to Nigeria as a case study. The processes involved in the evolution of the reforms were also described in order to emphasize the massive nature of the reform. However, the reforms required new student roles, different student work patterns, and significant changes in science teachers' values, beliefs and practices. The changes also called for new standard of performance assessment in our schools and new training and retraining of our science teachers. These reforms also call for a general overhauling of our science curricular to take care of content reduction, equity and social relevance. A country like Nigeria that aspires to achieve scientific and technological development needs to pay attention to these details.

RECOMMENDATIONS

It is recommended that science education teachers should have access to innovative classrooms, materials, opportunities to practice new ways of teaching, practical experiences, possibilities to discuss elements of reforms with peers, coaches and supervisors. Others include collegial cooperation or exchange between science teachers, networking science teaching and learning.

Science teachers practical knowledge can be seen as the core of a teachers professionalism and it should accordingly be given the necessary attention in the preparation and in-service training of science teachers.

The idea that teachers are the most influential factor in any educational change is not controversial. Reforms normally call for radical change in teachers knowledge and beliefs about subject matter, teaching, children and learning.

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