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A Discourse on the Essentials of Transformative Science Teacher Professionalism and Scientific Literacy in the Challenges of Global Economic Crisis

BRAIMOH, Durojaiye S [1], ORUKOTAN, Akinyemi F [1], OKEDEYI, Abiodun S [2] and OGUNMADE, Taiwo O [3]

1. Curriculum Studies Department, Adeniran Ogunsanya College of Education, Oto/Ijanikin, P.M.B.007, Festac Town, Lagos, Nigeria
2. Physics Department, Adeniran Ogunsanya College of Education, Oto/Ijanikin, , P.M.B.007, Festac Town, Lagos, Nigeria. E-Mail: biodunoked@yahoo.com
3. Chemistry Department, Adeniran Ogunsanya College of Education, , P.M.B.007, Festac Town, Lagos, Nigeria

Absract

The economic development of a nation is correlated with the scientific and educational development (EL-Khawas, DePietro-Jurand, & Holm-Nielsen, 1998), thus the yearnings and concerns for developing new ways of science teaching and learning, and to further improve the experiences in science teachers professional development. This study emphasised on how the characteristics of transformative science teacher professionalism can support science teacher professional development and develop scientific literacy, such that science teachers' professional transformation could provide skills, behaviours and attitudes which are essential for social development and economic growth. Data in the study revealed that science teachers have negative experiences of the characteristics provided in the Scientific Literacy and Transformative Science Teacher Professionalism Questionnaire (SLTSTPQ). The findings in the study provide insight into how science teachers' professional learning and professionalism could make them become creative and innovative pedagogues for the benefit of the society and for dispersing 'best practices' in science teaching profession to overcome the global economic crisis. This article concluded with a number of recommendations on national re-orientation and re-birth, and for reclaiming our national pride through scientific literacy with the development of transformative science teaching profession.

Introduction

The National Science Education Standard (1996) defined scientific literacy as "… the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civil and cultural affairs … and economic productivity" (p.22). The vision of scientific literacy is to provide students with lifelong learning which will help them to effectively participate in and understand the technology, polity, culture and economy of their nation and the world around them. The interpretive nature of the Basic Science Education (BSE) framework in Nigeria provide the vision for Nigerian children, regardless of gender or cultural background, to develop opportunities in scientific literacy in the contexts of the National Economic Empowerment and Development Strategies (NEEDs) and the Millennium Development Goals (MDGs) (NERDC, 2006). The curriculum for basic science in Nigeria (NERDC, 2006), is an evolving combination of science related attitudes, skills and knowledge, which are used by students to develop inquiry, problem solving, and decision making abilities to become lifelong learners.

Project 2061 of the American Association for the Advancement of Science (American Association for the Advancement of Science, 1993) described scientific literacy thus:

> …science literacy requires understandings and habits of mind that enable citizens to grasp what those enterprises are up to, to make some sense of how the natural and designed worlds work, to think critically and independently, to recognize and weigh alternative explanations of events and design trade-offs, and to deal sensibly with problems that involve evidence, numbers, patterns, logical arguments, and uncertainties. (American Association for the Advancement of Science, 1993, p. 1)

Goodrum, Hackling and Rennie (2001) believed that a scientifically literate person would - be interested in, and understand the world around them; would engage in the discourses of and about science; be skeptical and question claims made by others about scientific matters; be able to identify questions, investigate and draw evidence-based conclusions; and make informed decisions about the environment and their own health and well-being. A scientifically literate society is necessary for national transformation. The dynamic nature of society

results in social changes which affected science, school, learners and processes of learning science, consequently the National Research Council (1996) discouraged the existing conventional process of learning specific skills and training in science teacher education programmes and advocated experiences relating to intellectual growth in scientific literacy which span through the internship period of science teacher education and the entire lifelong career of science teachers.

Diverse learning experiences and expected learning outcomes in the NERDC's basic science curriculum framework is an endeavour towards the interrelationships among science, technology and society, for students' personal lives, careers and future. Thus, indicating a need for paradigm shift in science teacher continuing professional development, and further evident upon the needs for transformation of science teachers, such that new science teachers will be equipped with the best and most important teaching which aims at transforming society through the contributions made to the formation of human beings, and teachers that can think critically to explore, analyse, evaluate, synthesis, appreciate and understand the challenges of variety of social issues around them including the global economic meltdown.

The notion in transformative science teacher professionalism is to explore issues in science teaching effectiveness, efficiency, 'bottom line improvement', measurability accountability to the benchmarks and standards provided in the National Policy on Education (Federal Republic of Nigeria, 2004) and the basic science curricula (NERDC, 2006). Mockler (2005) explained that a transformative science teaching profession sees its primary responsibility in terms of the development of critical literate, social aware citizens with strong sense of their own civil responsibility, and through them the generation of social capital and propagation of the civil society. However, Sach (2003) warns that:

> … transformative professionalism should not become an orthodoxy which is imposed on the teaching profession … the move for transformative professionalism must come from the membership of the profession and be supported by other interest groups and stakeholders … its singular strength is that it is concerned with mutual engagement around a joint enterprise, namely improving student learning outcomes (Sach, 2003, p. 16).

These characteristics attempt to quantify and codify science teachers' professional knowledge but provide insights of instrumentality to developing highly professional and transformative teachers, that integrates contextual, emotional, reflexive, and iterative, elements into science teaching which develops productive citizens and scientific literates as proposed in national policy documents (Federal Government of Nigeria, 1980; Federal Republic of Nigeria, 2004; National Planning Commission, 2004). The bottom line is to systematically begin the codification of science teachers' technical skill for the purpose of cataloguing, and subsequently dispersing 'best practices' in science teaching profession to overcome the global economic crisis.

The transformative science teacher professionalism as incorporated in this study to provide ways which science teachers professional learning can support the development of scientific literacy, such that science teachers professional transformation could provide skills, behaviours and attitudes which are essential for developing scientific understanding and the application of science and technology to circumventing the challenges of the global economic crisis. Consequently, this study sought to investigate how transformative science teacher professionalism would improve the present level of scientific literacy in Nigeria, thus alleviating the scourge of the economic crisis on people.

Research Methods

This is a qualitative study involving 32 experienced basic science teachers in junior secondary schools (JSS) chosen from a local government area of Lagos State. These teachers have taught basic science for more than five years and they all voluntarily gave their consent to participate in the research. The participants responded to a structured questionnaire which is the only instrument in the study i.e. Scientific Literacy and Transformative Science Teacher Professionalism Questionnaire (SLTSTPQ). The items of SLTSTPQ were based on characteristics that have intrinsic potentials for improving science teachers professional learning and opportunities in producing scientific literate citizens.

The questionnaire was developed by the authors and focused on the teachers' positive and negative experiences of science teachers professional learning characteristics (Loucks-Horsley, Katherine, & Hewson, 1996; Mockler, 2005). The instrument was revised through several cycles of appraisal with three other lecturers from a neighbouring university. Importantly, the statements in the instrument involve items pertinent to producing scientific literate citizens from transformative experiences which science teacher achieve in their professional learning and professionalism.

Participants responded by ticking either 'positive experience' or 'negative experience' to the items in SLTSTPQ. The ten item questionnaire was administered at the end of the third term of 2008/2009 academic session and personally distributed to respondents and collected at various times within 7days after distribution. All completed questionnaires were dully returned back given a return rate of 100%, consequently, responses were

recorded and coded for commonalities (Hittleman & Simon, 2006; Patton, 2002). The administration of instrument and calculation of percentages of frequencies of data were made easy with the scoring of items in the instrument. The construct validity of instrument was achieved through a pilot test with five JSS science teachers from schools around the researchers' college of education.

Context

The study comprised of (12/32; 37.5%) males and (20/32; 62.5%) females. Total number of participants (n) is 32. Sixteen per cent of the respondents taught basic science between 5 and 10 years; 37.5% between 11 and 15 years; 19% between 16 and 20 years; and 27.5% have taught basic science for more than 20 years. Consequently all participants in the research are experienced basic science teachers. All these participants are qualified science teachers and attended colleges of education, further a notable number of the teachers (22/32; 69%) are university graduates.

Results and discussion

The findings in this study indicated low percentages of positive experience responses to almost all the items in SLTSTPQ. The teachers only showed that they have positive experiences of knowledge about developing appropriate incentives and rewards (59%). Incentives and rewards have high tendencies in teachers' motivation. The performance of science teachers is not only enhanced by their training and equipments but essentially by the ability of superior motivational seal. This findings is in consonance with those of Alleman & Rosaen (2001) and Yasar & Anagun (2007) who are of the opinion that the development of teachers must be motivated to enhance their experiences and influence further development of children's growth as emerging citizens and not as deficient or incomplete citizens.

Table 1
JSS science teachers' perception of their experiences in transformative science teacher professionalism as in the pathways for scientific literacy

S/N	Statements about JSS science teachers experiences of transformative science teacher professionalism	Positive experiences – n (%)	Negative experiences – n (%)	Undecided – n (%)
1.	Knowledge in developing and enhancing the notion of inquiry and evidence-based science teaching practices.	3 (9)	29 (91)	-
2.	Knowledge of formal placement of programme within the philosophy and organisational structure of schools.	11 (34)	21 (66)	-
3.	Opportunities for sharing methodologies that are appropriate to practitioners' inquiry as a mean of transforming teacher professional learning.	5 (16)	27 (84)	-
4.	Abilities in building research within and between schools by engaging teachers and students in research processes.	6 (19)	20 (62)	6 (19)
5.	Knowledge about developing appropriate incentives and rewards.	19 (59)	13 (41)	-
6.	Opportunities to build both discipline knowledge and pedagogical expertise.	8 (25)	19 (59)	5 (16)
7.	Opportunities to develop an understanding of the science pedagogical content knowledge and the implications of this context for classroom practice.	7 (22)	25 (78)	-
8.	Knowledge in developing an interactive community of practice using appropriate technologies.	2 (6)	30 (94)	-
9.	Knowledge of developing appropriate participant involvement in goal setting, implementation, evaluation and decision making.	14 (44)	18 (56)	-
10.	Opportunities for making contributions to broader professional knowledge base and professional learning community.	9 (28)	16 (50)	7 (22)
	Total (%)	**(26)**	**(68)**	**(6)**

Data in this study found that only 34% of the participants expressed that they have positive experience of the knowledge of formal placement of programme within the philosophy and organisational structure of schools, while the remaining 66% gave negative experiences of the item. SLTSTPQ in the table above revealed 84% of the respondents have negative experiences and 16% of positive experience of opportunities for sharing methodologies that are appropriate to practitioners' inquiry as a mean of transforming teacher professional learning. Further, there was an evident in the study that showed 91% of negative experiences and 9% of positive experiences of science teachers' knowledge in developing and enhancing the notion of inquiry and evidence-based science teaching practices. Meanwhile, Loucks-Horsley, Katherine and Hewson (1996) and Crawford (2000) emphasised on science teachers' professional development and the understanding of professional learning experiences. These authors believed that teachers' professional development should involve strategies in inquiry-based learning, problem-solving, students' investigation and discovery, and application of knowledge. Thus, teachers need to new ways for teaching science to develop productive citizens and scientific literates. Indeed teachers are not expected to have all the answers but are expected to be transformed to believe that trying multiple times before experiencing success is part of learning.

Mifsud (1996) in his work on the preparation and competence of beginning science teachers, noted the importance of the development of pedagogical content knowledge (PCK). Appleton and Harrison (2001) described PCK as "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding, that represents the subject in a way that is comprehensible to others"(p. 1). Professional learning engages the science teacher in conceptualising the characteristics of subject matter knowledge and how best it can be transformed into the processes of teaching for effective learning. The respondents indicated 22% of positive experiences and 78% of negative experiences of the opportunities to develop an understanding of the science pedagogical content knowledge (PCK) and the implications of this context for classroom practice. Also, 59% of these teachers revealed that they have negative experience of the opportunities to build both discipline knowledge and pedagogical expertise, and 16% of them informed that they cannot decide whether they have positive or negative experiences on the issue. However, PCK is the most useful forms of representation of ideas, the most powerful analogies, illustration, examples, explanation, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others (Shulman, 1986). Further, PCK is the key to distinguishing the knowledge base of science teaching and it lies at the intersection of content and pedagogy, in the capacity of a teacher to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented to the students (Shulman, 1987).

A large majority of the teachers (94%) indicated that they have negative experience of the knowledge in developing an interactive community of practice using appropriate technologies. Technological resources are integrated into teaching and learning, in order to strengthening the teachers' pedagogy and to improve students' learning. The curriculum for junior secondary school science education in Nigeria emphasises inquiry based instruction (NERDC, 2006). This objective could be achieved, only when students "… are given opportunities to represent and re-represent their developing understandings using a wide range of texts and information communication technologies (ICTs)…" (Hackling & Prain, 2005, p. 25). The computer and internet provide a wide range of resources for science teachers. There are abundant digital resources available on the internet such as computer simulations and animations that enhance science teachers' professional skills and understanding. Competence with information and communication technologies (ICT) enhances science teachers' confidence, self-efficacy and creates opportunities for self-training in their professional practice. There are videos, computer programmes and CD ROMs that facilitates science teachers' professional learning, and understanding of new methods and techniques in science pedagogy.

Professionalism has been described in terms of lifelong learning and a measure of control and security for professionals (Friedman & Phillips, 2004). Lifelong learning deepens science teachers' subject matter knowledge and expands their pedagogical expertise (Putnam & Borko, 2000). The structure of science teachers' professional learning community essentially determines the effectiveness of their lifelong learning. Half of the respondents (50%) in this study indicated that they have negative experiences of the opportunities for making contributions to broader professional knowledge base and professional learning community. Meanwhile, a vibrant school-based professional learning community helps science teachers reshape their existing school culture, address issues of equity and diversity and improve their science teaching (Bianchini & Cavazos, 2007).

Conclusion

In Nigeria, there is a high expectation for national economic development and nation building. The National Economic Empowerment and Development Strategies (NEEDS) is a national planning endeavour of the Federal Government of Nigeria towards overcoming the deep and pervasive obstacles in Nigeria economic development and national growth. Consequently, the National Planning Commission informed that "NEEDS recognises

education as the vital transformational tool and a formidable instrument for socio-economic empowerment" (National Planning Commission, 2004, p.35).

The issue of scientific literacy is global and requires the best science teaching which aims towards transforming the society through the contributions of scientific literacy to the formation of quality citizens and the making of people that can think critically, act ethically to build a formidable and stable national economy. Such circumstances are responsibly provided by quality and professional science teachers with positive experiences of professional development characteristics geared to learning new pedagogical practices and devoted to deepened science subject matter knowledge. The discourse on transformative science teacher professionalism in this research is about creating a collective vision for and improving science teachers' ongoing professional development. This study further provide insight into how science teachers' professional learning would make them become creative and innovative pedagogues for the benefit of the society and for dispersing 'best practices' in science teaching profession to overcome the global economic crisis.

Transformative science teachers are expected to collaborate at deep levels with colleagues, students and other stakeholders and aimed at achieving a totally scientific literate Nigeria nation. A transformative science teaching profession cannot emerge without sustained and comprehensive support from educational leaders, within schools, systems, universities and governments. Such professional development endeavour is not only desirable to nation building in the period economic recession and global economic crisis but also essential for re-establishing social responsibility as a guiding social principle, national re-orientation and re-birth, and for reclaiming our national pride through scientific literacy with the development of transformative science teaching profession.

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