Innovations in Science and Technology Education: A Case for Ethnoscience Based Science Classrooms

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Abstract - It was previously believed that useful knowledge was only generated in laboratories or research institutions for subsequent transmission to the ignorant peasants. Available evidence has revealed that these peasants are not actually ignorant but endowed with complex knowledge system that could transform the world if appropriately harnessed, hybridized and incubated in a more organized science classroom. This paper presents appropriate background, rationale and procedures for integration of indigenous knowledge systems into formal science classrooms processes and instructional modules.

Key words - Constructivism, ethnobiology, ethnochemistry, ethnomathematics, ethnomedicine, ethnoscience, and ethnophysics.

Introduction

In October 2008, the ICSU regional office for Africa organized a symposium on Science Technology and Innovation (STI) in Africa. The purpose of the symposium was specifically to discuss the achievements and challenges faced by Africa in the application of Science Engineering and Technology (SET) for development and to map out the way forward. The report emphasized that the symposium would serve as an important step towards strengthening partnership on the continent for the implementation of African Science and Technology consolidated plan of action (STCPA) developed by the African Union (AU) and the new partnership for Africa's development (NEPAD) (ICSU, 2008:7).
Ministers and government representatives generally noted at the symposium that incentives were required to stimulate brain gain in addition to promoting indigenous knowledge systems (IKS) and prioritizing research to target individual nation's needs. This is in congruence with UNESCO's main plan for STI in Africa – the need for greater collaboration for science development with special focus on the identification of the kind of science and technology that African requires so that they can establish their own agenda and adapt their science education to suit their specific needs. Unfortunately they did not articulate how science classrooms could be innovatively used as a template for transcribing indigenous knowledge for sustainable development and hybridization of scientific knowledge.

Ethnoscience is the knowledge that is indigenous to a particular language and culture. It approximates or reflects the natives' own thinking about how their physical world is to be classified. Studies in constructivism opened up an avenue for man to view science not only as a body of systematic knowledge, a method, a process, a product or a way of investigation but also as a way of thinking. Ethnoscience deals with local perception, practices, skills and ideas and their underlying cosmologies in the context of processes of socioeconomic development. The term Ethnoscience therefore becomes an articulation of a particular culture, describing the often unique systems of indigenous knowledge (IK) and Indigenous Technology (IT) characteristics of local population or groups in the third world as well as of the similar groups in the western nations (warren et al 1995). In sum, Abonyi (1999) noted that the fundamental focus of Ethnoscience is the natives' point of view, their relation to life, to realize his vision of the world. Considering the fact that science is the tool with which man learns about his environment, its resources and problems and how to control and utilize them both productively and sustainably and also realizing the fact that Science, generally, is an institution in which a community of people work and are bound together by certain social organizing relations to carry out certain tasks in society, then it must be appreciated that science is one of the most powerful sources of ideas moulding beliefs and attitudes to the universe and society and indeed man's whole pattern of thought, culture and politics.

Current studies on methods of science instruction in Africa have revealed that the existing instructional approaches are highly particularistic, hopelessly biased and guilty, not only of perpetuating a lack of understanding regarding indigenous fields of knowledge and cognition but also wrecking outright harm on them (Ajikobi and Bello, 1991; Atwater, 1993; Selin, 1993; Tindimubona, 1993). The current instructional approaches seem to have contributed to poor concept formation and attitude among beginners to science. This trend in concept formation and attitude is carried along as students' progress in science

(Fafunwa, 1983). Adesoji and Akpan (1991: 70) already noted that science taught in Nigeria and Africa generally make us academic foreigners in our own country". They made reference to the handbook of Science Education Programme for Africa (SEPA) as saying that a tragedy of science education in Africa which children and adult have shared is that it has not always paid attention to the culture of the Africans both in methods and materials.

Fafunwa (1983:20) understood the dilemma quite well when he stated that "the African Society today is in an ambivalent position and so is the child from this environment". He explained that between the ages of 0 and 5, the African children are wholly brought up in a traditional African environment. He further observed that as those children reach the primary school age they enter another educational system quite different and strange to the one they were brought up in and are already accustomed to. That is, they grew up with certain cognitive (learning) style and suddenly found themselves in another environment with an entirely different approach". On the implications of such estrangement, Fafunwa (1983:20) wrote:

> *The fact of the matter, however, is that the child's cognitive equilibrium has been disturbed and this abnormal situation (the deep gulf between traditional non-formal African system of education and the formal, Western oriented system of education) tends to retard the cognitive process in terms of the anticipated outcomes of the Western form of education.*

Any assumption that an African child could be easily adjusted to such a dramatic change without creating a suitable link is bound to fail. For the child to accept and adapt to a new field of knowledge, the gap between him - his culture and the new field of knowledge has to be bridged.

Science starts with preconception, with the culture and with the common sense. The conceptualist view of science treats science as a quality in its own right. Kneller (1990), addressing the conceptualist view of science, stressed that a child should construct the pictures of his environment in the light of his own experience provided that he finally reaches the objective picture of the universe. Kneller further emphasized that human nature and the general perception of the environment is relative to time and place. The prime virtues, then of any educational system, especially of those that must meet the unprecedented rate of change in modern industrial society, are flexibility and willingness to experiment. In his conception of reality, Spinder noted that even modern adults owe less to their direct experience and more to the experience of their culture.

Dimensions of Ethnoscience

Ethnoscience embraces a number of disciplines namely ethnobiology, ethnochemistry, ethnophysics, ethnomathematics, ethnomedicine, and an array of indigenous Agricultural practices and food processing technologies. The fundamental principle in these aspects of indigenous knowledge system is that the basic concepts and practices are enshrined in environmentally dependent and culturally reinforced knowledge, myths, and supernatural (Abonyi, 1999).

Although ethnoscientific concepts do not walk hand in hand with Western conceptual methods, they share common links, which have been utilized creditably in conventional science classrooms to achieve better acquisition of science concepts and sustainable hybridization (Abonyi, 1999). Apart from empirical evidence provided by Abonyi (1999), the full manifestation of indigenous knowledge system is revealed in a number of internationally unified programmes which include:

i. Toman Obat Keluarga (TOGA): the indigenous Indonesian medicine for self reliance
ii. Philippine On-Farm experiments
iii. Kpelle Steelmaking
iv. Igbo black soap technology
v. The CTTA concept and the Niger study etc

Ethnoscience-based science classroom involves designing practical models of integration of indigenous and cosmopolitan knowledge systems with a view of more balanced processes of development and change. As warren et al (1995) noted, the study of Ethnoscience has come to encompass at least five major aspects:

(a).the (pre)historical assessment of a particular community or society in its natural and cultural setting
(b). the culture specific or culture bound references of the term;
(c). the holistic approach towards the inclusion of a range of subsystems of knowledge and technology in sectors such as medicine, agriculture, environments, education etc
(d). the more dynamic assessment of the concepts of culture in terms of a configuration of interacting western and non-western knowledge system;
(e). the comparative – instead of normative, Western and Non-western inspired – orientation towards the development process in certain regions or cultures.

Rationale for Integration of Ethnoscience into formal science classrooms

The Whorf's hypothesis asserts that "all observers are not led by the same physical evidence to the same picture of the universe unless their linguistic and cultural background are similar or can in some ways be calibrated". A concise analysis of Whorf's hypothesis tells us that there are differences across culture in the understanding and categorization of the physical universe, which in turn shapes man's interactions with the universe and sustainable development. Malinowsky (1992: 138) observed that:

> *An intimate connection exists between the world, the myths, and the sacred tales of tribe, on the one hand, and their ritual acts, their moral deeds, their social organisation and even their practical activities on the other. Myth as it exist in a savage community, that is, in its living primitive form is not merely a story but a reality lived…It is a living reality believed to have happened in primeval times, and continuing ever since to influence the world and human destinies.*

Base on the forgoing, it must be appreciated that ethnoscience-based classrooms especially in multicultural settings has implications in bridging the gap between the learners and the world of reality. Proponents of ethnoscience-based science classrooms (Abonyi, 1999, Ajikobi and Bello, 1991) hinge their arguments on the crystallizing evidence that ethnoscience-based classroom offers the following to learners:

(i). *A base for construction of reality*

Because ethnoscience deals with the knowledge indigenous to a culture, it serves as a base for the construction of reality by linking culture to advanced scientific knowledge. It therefore acts as an intermediate station between fantasy and exact knowledge or between drama and technology, by sniffing a quarry in a cave where dogs cannot penetrate so that their baying and pointing may finally call the hunter to the spot. Ethnoscience, like magic, turn men's mind to the external world: it suggests the need of manipulating it, helps create the tool for successfully achieving it and sharpens observation as to the result.

(ii). *A useful means of systemizing certain aspects of anthropological data*

Ethnoscience plays vital role in systemizing certain aspects of anthropological data concerned with problems of worldviews. It serves as a bridge through which children from various cultural backgrounds cross over to modern conventional or western science. As was earlier noted by Fafunwa, as children progress from non-formal to formal education system, they encounter conflicts that arise as a result of sudden exposure to western science which does not reflected their earlier accumulated anthropologically based scientific data and ideals. Bearing in mind that such anthological data are supernaturally reinforced, the learners find it difficult to adjust. It, therefore, becomes indispensable that a classroom that recognizes the child's background data be used to guide him through either a more comprehensive understanding of the path workings of nature or a self directed realization of errors that were previously cemented in him by his culture. Whichever way, the prevalent rote learning will be avoided in learners as children can now compare, contrast and create links in the ethnoscience classrooms

(iii). *Clears false belief about science*

Ethnoscience classroom has the potential to clear the notion that science is that which modern scientist believe in and the methodologies with which they operate. Studies in ethnoscience helps to reflect the different intellectual traditions of various cultures as well as the scientific problems each society wants its scientists to address and the method that yield better results. The issue of scientific method and its applicability in the development of science has been very controversial in the current studies on ethnoscience. The western scientists have constantly played down the validity of ethnoscience based on the assumption that it does not submit totally to their laid down method and procedure of verification even it yields relevant practical results. Adams (1983) noted that nobody has a monopoly of truth. There is no correct way of knowing; there are ways of knowing and western conceptual methodology cannot discover any more basic truth to explain the mysteries of creation than a symbolic intuitive methodology. In fact, the basic tenet of ethoscience-based science classroom is that there is no monopoly of knowledge especially in the emergent multicultural science classrooms.

Recommendation on Procedures for Integration

In order to introduce sustainable innovation in science and technology education through Ethnoscience-based classrooms, appropriate steps should be taken in the following directions:

(a). *Designing a network of concept hybrid with proper integration and linkage across boundaries*

Transfer should be seen as an interlocking set of communication/information/Education processes rather than as the exclusive activity of a few formal structures or entities (Constance et al 1995). School science programs should be designed to ensure hybridization of concepts and processes across cultural boundaries. This involves establishment of linkages with international institutions on indigenous knowledge like the Centre for Indigenous

Knowledge for Agriculture and Rural Development (CIKARD), The Leiden Ethnosystem and Development Programme (LEAD), Centre for International Research and Advisory Network (CIRAN), Nigerian Institute of Social and Economic research (NISER), Regional Programme for the Promotion of Indigenous Knowledge in Asia (REPPIKA) and a host of others. Linkages between school and these bodies will ensure information flow, documentation of indigenous knowledge across culture and encourage research on their hybridization with other advanced scientific knowledge. By so doing science classroom will become technology incubators and pioneer innovations for sustainable development.

(b). *Development of instructional modules of community science education based on indigenous concepts, practices and products.*
Based on the outcome of the global network and linkages between local and international centres on indigenous knowledge a new classroom module will be generated. A more integrated and unified knowledge system will emerge. This will unit and expand group of science learners who tend to be isolated by artificial institutional and sectoral barriers (Guus, Liebenstein, Slikkerveer and Warren, 1995).
(c). *Building science classrooms with specific focus on local entrepreneurship for the purpose of upgrading and internationalization. Innovations in science should gear towards entrepreneurship*.
A number of indigenous technologies were identified by CIKARD, LEAD, REPPIKA and NISER. The question is: how do we build these technologies into our formal science classroom processes so that they can be improved upon and internationalized. This could also be achieved through establishment of indigenous technology incubation centres in schools with the assistance of the various institutions on indigenous knowledge systems.

(d). *Introduction of multilingual science education modules to facilitate access and utilization of IKS across culture and ensure intercontinental partnership*
It has earlier been established in theories of conception that concepts depend upon prior notions of the boundaries of object, events and their relationships, which are ultimately enmeshed in a linguistic fluid. Parmentier (1993) rightfully pointed out that for many practitioners; modern cultural anthropologists came of age with the historical relativization of the Kantian categories – that is, with the recognition that the creative power of human symbolic representation is largely a product of cultural circumstances rather than solely the result of transcendental potentiality of our cognitive hardwiring. Most indigenous knowledge systems and concepts are preserved in folk languages. In often cases outright translation leads to alteration and error, especially in situations where myths and shamanistic processes were used in the preservation of such knowledge and skills. We also are aware of how Linnaeus' biosystematics grew and expanded from the Gimi and Tzetal indigenous linguistic approaches to plant and animal taxonomies. It is pertinent that networking centres on indigenous system work hand in hand with education ministries and schools to ensure that language does not pose a barrier to effective consumption of intercultural knowledge and skills.

Conclusion

In 2003 conference, ICASE recommended that "science education should be made more relevant to the perceived needs and interests of the students, reflecting a balanced vision of the importance and socio-scientific functioning of industry plus relevance for preparation for, and awareness of student careers, and meeting the needs of the society and culture". Unfortunately, new science education programmes failed to realize the importance of culture and end users in the process of technology design and transfer. We have paid enough lip service to the indispensability of indigenous knowledge in the design and transfer of sustainable science and technology programmes. All institutions and agencies involved in indigenous knowledge systems should establish, without further delay, appropriate linkages with schools to ensure synergy between science education programmes and existing indigenous system for proper and effective hybridization, incubation and sustainable development.

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