What Research Says about African Science Education

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> The problem in non-western [African] science education is not to
> make it more scientific, but to make it less culturally western!
>
> W. W. Cobern, 1996

In this paper an attempt is made to highlight research documented on
the processes and practices of science education in Africa in the last
30 years. The paper first discusses the criticisms made on African
science education programs. The second part deals with the case of
Ethiopian science education. In the third part the major
recommendations made by the researchers will be discussed. Finally,
concluding remarks that contain leading questions for future research
on African science education will be forwarded.

Criticisms on African Science Education in General

Science education in Africa has been criticized from several points of
view. It was early recognized that science education in Africa did not
take into account the intellectual and cultural milieu of the children. In
this regard, Dart and Pradham (1967) state that:

> Science education, in any country, is certainly a
> systematic and sustained attempt at communication
> about nature between a scientific and a nonscientific, or
> a partially scientific, community, and as such it should be
> particularly sensitive to the attitudes and presuppositions
> of both the scientist and the student. In fact, however, the
> teaching of science is often singularly insensitive to the
> intellectual environment of the students, particularly so in

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the developing countries, where the science courses
usually offered were developed in a foreign country and
have undergone little if any modification in the process of
export. Why should we suppose that a program of
instruction in botany, say, which is well designed for
British children, familiar with an English countryside and
English ways of thinking and writing, will prove equally
effective for boys and girls in [an African] village? It is not
merely that the plants and their ecology are different in
[African countries]; more important is the fact that the
children and their ecology are also different (p.649).

The successive decades were also targets of similar criticisms. After
assessing the pedagogical impact of Third World investment on junior
and senior secondary school science in West Africa, Urevbu (1987)
argues that science in the curriculum is perceived as a 'true' subject
of facts and reliable information. It is also argued that the teaching of
science has resulted in a view of science as being concerned more
with information (facts) than with thought and that it has also led to an
alienated response to science from the majority of the learners. Other
researchers also pointed out that in Africa: an 'imminently practical'
discipline – science – was taught with too much abstraction (Tan,
1988); the extent of representing science in a non foreign, expert, and
unsystematic way are still at its infancy (Lewin, 1990).

The science courses in Africa also seem more relevant to those
students with science career aspirations and not to the majority, for
whom secondary science is terminal. According to Ajeyalemi (1990),
in most of the surveyed African (sub-Saharan) countries, the current
secondary science curricula are unsuitable for achieving the objective
of producing scientifically literate graduates. Furthermore, Ajeyalemi
(1990) argues, *most of the graduates from the system can only read
and memorize scientific ... information but may not be able to think in,
do, or use science ... as their counterparts in developed countries* (p.
12).

Peacock (1995) addresses the issue of access to primary science learning for children in rural Africa. The research report raises four major obstacles to access to science learning. Perceptions of science learning is the first obstacle. Recognizing the existence of traditional curriculum in Africa that emphasizes learning about planting, hunting, house building, cooking, pottery, etc., Peacock (1995) argues that powerful internal and external pressures have radically modified the view of science in Africa in the last three decades. Even though there existed a tension between the traditional curricular goal and the goal of western science, *this tension was ignored or resolved in favor of a 'process approach'... modeled on US and UK curriculum development programs* (p.150). After completing the compulsory primary science, most African children terminate their schooling. Thus,

> there exist great gaps in perceptions of science: between traditional ideas of skill learning amongst adults and children in rural areas; the national aspirations and curricula of ministries and training institutions, which have adopted largely Anglo-American models; and teachers in the classroom, who through inappropriate higher education are themselves largely marooned in older, pre-independence models of didactic teaching of factual knowledge (Peacock, 1995; p. 151).

Geographical and resource constraints are the second obstacles to access to African science education, particularly at primary school level. Peacock (1995) also identified centralization as the third obstacle. This has been a typical aspect of African education which involves national-control of curriculum, examinations, deployment of teachers and resource allocation. The last obstacle is the question of relevance of the science curricula to the African children. This issue has been addressed by many African states and some changes have been made to promote the notion of 'meeting basic learning needs' at primary school level. However, the process of selection by examination at the end of this primary phase has not changed. *As long as selection for higher phases of education exists, the examination, and hence to a large extent the teaching in the upper*

years of the basic phase will be geared to the needs of the next phase, rather than to the needs of those leaving (Peacock. 153).

Cobern (1996) argues from a constructivist point of view that the past efforts at transferring curricula and teaching materials from the West, and local development projects that result in curricula and teaching materials only marginally different from western curricula, stem from an acultural view of science that also ground science learning in concepts of logical thinking rather than understanding. Cobern (1996) then pointed out that *the problem in non-western science education is not to make it more scientific, but to make it less culturally western* (p. 305).

Criticisms on Ethiopian Science Education

Since the establishment of the first modern school in 1908 in Ethiopia, three attempts were made to reform the educational system by the last three Ethiopian governments. Each of them attempted to criticize the previous educational system and to formulate new policies. The major slogan of these three educational reforms was to make the school curriculum relevant to the learners' cultures (Seyoum, 1996). The published literature on Ethiopian science education is very much limited. In spite of it, the following major works would give us a picture of science education in general and the specific science subjects in particular.

After the Ten Years National Perspective Plan (1984 – 1994), which has set policy statements for education, launched in 1984 by the military government, new science curricula that were intended to reflect the new policy were developed. A case in point was the chemistry curriculum.

> The new chemistry courses for grade 9 and 10 have been prepared in accordance to the policy decision ... [that] was made to resolve the problems of implementing the physical science course. Also due considerations were

made to provide solid foundation in basic sciences of chemistry and physics (Science Panel, 1986: p. i)

As a result of this decision, chemistry and physics became separate subjects starting from grade 9. Biological science was already a separate school subject.

Several criticisms have been forwarded by some science educators after inspecting these post-revolutionary science curricula. The writer of this article is not, in the first place, quite sure that relevance in African science education could be achieved by providing a 'solid foundation' in basic sciences of chemistry and physics to secondary school pupils. The majority are living in rural and semi-rural areas where there is little need for extensive (solid) theoretical science. Most of the school leavers also do not have the chance either to get jobs or to join the limited higher learning institutions.

The Chemistry curriculum and text books were also influenced by a body of facts, lower order cognitive skills, little inquiry activities, little everyday life related topics and little input to the development of certain intellectual skills such as the spatial ability of students (Temechegn, 1991; 1993a; 1993b; 1997a; 1997b; 2000a; Temechegn, et al., 1996).

The teaching of Biology in our senior secondary schools is found to be subject-matter-centered although the Biology curriculum claims to follow the inquiry model. Moreover, the unrealistic nature of the Biology textbooks has aggravated the already existing problems because the textbooks contain a large number of activities that require a great deal of time for completion (Mekuanent, 1992). This research has also emphasized that teachers' unfamiliarity with the inquiry approach is one factor for the prevailing weakness.

By emphasizing the importance of gathering sufficient data from various sources in order to make an objective assessment of the effectiveness of Biology teaching at tertiary level of the Ethiopian

education system, Zemede (1997) recognized insufficient preparation of high school students and an unbalanced coverage of topics in high school Biology as some of the reasons for the weaknesses.

Recognizing the importance of the inquiry method in teaching science, Esayas (1997) argues that much emphasis is given to the end products of science during the teaching of science at least in Addis Ababa schools. There is the assumption, Aklilu (1997) argues, in Ethiopia that science is science everywhere in the world. This assumption has resulted in the learning of science just to pass examinations.

The Transitional Government of Ethiopia (TGE, 1994a) also documented the inadequacy of the education system to prepare the learner for useful participation in the community. Pointing out the fact that the objectives and relevance of education became questionable in the last 30 years, the Education Sector Strategy (TGE) stated that:

> It is generally agreed that the impact of modern education on the day to day life of the society at large has been negligible. ... The science and cultural components are weak and inadequate to prepare the learner for useful participation in the community (pp. 1-3).

The Government thus developed the New Education and Training Policy (NETP) that states, among others, that the education system is *entangled with complex problems of relevance, quality, accessibility and equity* (TGE, 1994b; p. 2). Based on the NETP new science curricula and textbooks are developed for both primary and secondary schools.

In one study (Negussie, 1998), the Teacher Training Institutes' (TTIs') natural science syllabus is assessed in terms of its adequacy in and relevance to preparing teachers in implementing the newly introduced primary 1st cycle Environmental Science Syllabus. The study has shown that the suggested teaching methods in the syllabus are teacher-centered, that the existing natural science syllabus is barely

relevant and adequate to implement the primary school syllabus, that the instructors tend to give more emphasis to non-integrated course areas in order to train teachers of integrated science, etc.

A study is also conducted on student teaching of would-be secondary school science teachers in the Addis Ababa University (Temechegn, 2000b). Among other things, the science student teachers were asked to describe whether they perceived' differences in science teaching between what they acquired theoretically and what they actually saw through their practice. Almost half of the samples recognized that there was a big difference between the theoretical knowledge offered at the University and the reality experienced at the secondary schools. This discrepancy between theory and practice can be ascribed to at least three reasons (Temechegn, 2000b; p. 88):

- As currently practiced, the professional course that directly attacks the problems and strategies in science education lasts only 9 – 10 weeks of the whole four years study time. It is therefore found to be unrealistic to expect this theoretical course to be as effective as possible in addressing issues of science education in such a short period of time.

- There are no courses for orienting student teachers with school-based laboratory experiments. What has been done, instead, is lecturing on such methods as 'laboratory instruction, inquiry/ discovery methods, etc', methods that are tested in the context of developed countries and that have never been experienced in any course even by the instructors themselves – let alone being examined for their relevance and effectiveness in the Ethiopian context. In other words, even the borrowed pedagogy has been presented only theoretically.

- All the other courses are presented to the students in discrete form. The science student teachers themselves are expected to integrate the pedagogical courses and the subject matter courses and become good science teachers.

The study further revealed that the University science educators did not have a clearly illustrated teacher training model. Because of this reason the kind of knowledge and skills expected from the trainees were not clear to the instructors, the student teachers, and the school supervisors (Temechegn, 2000b).

Forwarded Suggestions

The various international and local research work reviewed above forwarded their suggestions to alleviate the problems they investigated. Space would not allow us to review all of these suggestions. However, the following points are worth mentioning.

The Role of Indigenous Knowledge and Native Technology

Lack of relevance of African science education tò the needs and interests of African children has been stressed in many of the research works mentioned above. There is thus a strong belief that students of science should know the practical applications of the science contents and the resulting social implications.

Socially relevant curricula have their own benefits. When students have exposure to socially relevant curricula, they would understand the role of science in their society, apply their science knowledge to real-life situations and develop skills of decision-making and problem solving (George, 1988). Such exposure can be achieved by including indigenous knowledge and native technology into the science curriculum (George, 1988; Ajeyalẹmi, 1990; Swift, 1992; Temechegn, 1996; Ogunniyi, 1996).

Restructuring of the Science Curriculum

Several problems were mentioned with regard to the appropriateness of the science curricula, particularly at primary school levels. Based on the analysis of the factors associated with the problems, Peacock (1995) suggested the restructuring of the primary science curriculum

into a common core or minimum entitlement curriculum, supplemented by a locally adapted science curriculum. While the former was based on a review of common elements in the science curricula of developing countries, the latter was supposed to be adapted to the needs of specific, individual communities and their rural development needs. Peacock also provided an example of a locally adapted science curriculum for the Amemo District in Wollo Province of Ethiopia. Among other advantages, the locally adapted science curriculum was believed to assist in bridging existing gaps between official curricula and local relevance.

The Role of Constructivism in African Science Education

Constructivism is a model of how learning takes place, rather than a theory of how rationality develops (Yager, quoted in Cobern, 1996). Constructivism focuses on the content of thought rather than the formal operations of logic that thought can involve. Cobern (1996) argues that constructivism leads on to expect that students in different cultures will have somewhat different perspectives on science.

This argument is against the idea and practices of transferring curricula from the West to developing curricula for African countries that are marginally different from western curricula - since such practices are based on an acultural view of science. From a constructivist point of view, on the other hand,

> it is easier to see that modern scientists and traditional people are, in one important aspect, engaged in the same activity. Both are attempting to make sense of the world around them. Rather than focussing on their different conclusions, I would focus on their commonality. ... There is ... no guarantee that interest in science, once divorced from culture, can be sustained among students. In constructivism, the science education research and curriculum development communities have both a model of

> learning and a view of knowledge that is authentically
> sensitive to both culture and science (Cobern, 307).

Concluding Remarks

This paper has reviewed the major research work on African science education in general and Ethiopian science education in particular in the last three decades. There is no claim that this paper is exhaustive. Particularly, no attempt was made to discuss the strengths of the programs since it was assumed that there was a relative consensus on that point.

The general tendency is that, although research has been pointing out since the late 60s that African science education programs lack relevance to the African children, the successive decades have shown little improvement. It is therefore necessary that African professionals in the various fields such as basic science, technology, science education, teaching, and even educational policy development and analysis work together to alleviate the problems. At this point, priority areas in the form of questions can be forwarded:

- Which resources are available in the immediate surroundings of our schools?
- To what extent has basic research in science and technology investigated the local (African) resources? How can their uses be maximized?
- Are there efforts on the part of African (Ethiopian) science educators to develop and validate teaching strategies (models

    - whose implementations are primarily based on the use local materials?
    - whose theoretical bases are the investigation of indigen knowledge?
    - which can successfully be applied in large classes limited resources?

- Can we, simply because of our large classes and limited resources, continue with our traditional methods of imparting knowledge (lower order cognitive skills) to students and still be an essential part of the coming century?
- Are there science education policies that guide and encourage the development and implementation of such tasks?
- Are the professionals ready both intellectually and attitudinally to carry out reforms in African science education, or should such programs be still left aside as minor priority areas?
- In what respect and how can we learn from the experiences of the developed nations?

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