SCIENCE EDUCATION IN COMMONWEALTH AFRICA

Some countries represented at the seminar provided papers on the progress they have made in science education and its present state of development. The main points emerging from these papers are summarized below.

Primary Cycle

Objectives

African countries in the Commonwealth share a science education approach attributable to historical factors. Prior to independence and for some years thereafter, the objectives of science education in the primary school were not stated explicitly. In terms of practice, however, they seem to have included identification of plants and animals, a knowledge of basic rules of hygiene, and an ability to recall facts. Science appeared in the primary school timetable under the labels of Nature Study and Hygiene.

In 1960, Commonwealth African countries participated at a conference in Lagos on "Science in the Advancement of Newly Independent African States". The meeting resolved that science should be taught in primary schools in Africa not merely to serve purely intellectual purposes. It should also aim to equip young persons with a functional and rational understanding of their world to a level that would create feelings of liberation and of mastery of the environment. Science education would thus adopt a generalized approach suitable for all children. Also, at the 1961 Addis Ababa Conference of African Ministers of Education it was noted that African primary education as a whole was at variance with the postulates of independence and with the demands of rapid technological advancement. But it was not until a similar conference in 1968 that African Ministers of Education spelled out the objectives of science education in the context of national development and stressed the development of attitudes in the learning of science.

Earlier in 1965, at a conference held in Kano, Nigeria, and attended almost entirely by African members of the Commonwealth, a definitive overall objective of primary science had been suggested: the focus would be the development of children - intellectually, physically, culturally and socially - to understand and make rational decisions about their total environment. Science would serve as a useful medium for that development. Science was deemed useful for this purpose because of its nature, methodology, and wide applicability. To nurture and refine this objective at the regional level, the Science Education Programme for Africa (SEPA) was formed.

Each African country in the Commonwealth has made some effort to develop the idea of using science as a vehicle for human growth in consonance with its total aspirations. The Arusha Declaration of 1967, for example, provided an appropriate framework for Tanzania; the New Primary Approach served in Kenya; while a 1970 White Paper, the recent National Policy Paper, and the 1970 Takoradi Conference enshrined the objective in Sierra Leone, Nigeria, and Ghana respectively.

Content and Methodology

In the days of Nature Study and Hygiene, subject content was limited to a few plants and animals and to a study of a few rules of personal hygiene. Children had to identify from drawings, and to remember names of specific plants and animals found in the local environment. The "chalk-and-talk" method of teaching was used. The teacher would make diagrams and write notes on the chalkboard for children to copy. Very often pupils copied diagrams from books, and occasionally the teacher would dictate notes. Very few or no visual aids were used. An important characteristic of the methodology was the memorization and recitation of facts by pupils.

During the last ten to 15 years, because of the shift in the major objective of primary science, the content has changed dramatically; it has been enriched by the development of primary science curricula in all Commonwealth African countries. The primary science syllabuses now being prepared in each country organize content in terms of different attributes to be developed - intellectual processes and concepts; inquisitiveness, interests, and attitudes; and physical and manipulatory skills. Nevertheless, the use of the inquiry-based practical approach at the classroom level remains largely a hope than a reality.

Pre-service Teacher Education

As in the primary schools, science as such was not, until recently, taught in institutions training teachers for the first cycle of education. The content of Nature Study and Hygiene was slightly broader than that of the primary school; the teaching methodology was the same.

Science was introduced in teacher training colleges following its appearance in the primary school curriculum. Consequently, the science background of teacher trainees was either non-existent or very poor. This often led to an academic orientation of content and to the exclusion of the methodology of science teaching since this was the responsibility of the methods tutor! Though content and methodology are now integrated, many teacher training colleges still devote the better part of their science education periods to the improvement of the students' background in science.

One of the fundamental problems of science education in the teacher training colleges was that science tutors themselves had an academic orientation to science, and their methodology was largely that of the transfer of scientific information to the students. Even as equipment and laboratories became available, science teaching remained theoretical. Country papers, notably from Nigeria, Zambia, Tanzania, Sierra Leone, and Botswana indicated that this situation is changing gradually.

Further, with the re-orientation of science in primary schools towards integrated environmental science approaches and with the stress on practical science, a practical problem-solving approach to science teaching is now emerging. This is evident for example in the regional tutor-training programme at the Njala campus of the University of Sierra Leone which receives Commonwealth Secretariat support (through the CFTC) by way of fellowships to students from Commonwealth Africa.

In-service Teacher Education

All the African members of the Commonwealth run refresher and re-orientation courses for serving teachers, many of whom have a poor knowledge of science and very little training in practical science and its use

as a medium for education.

In-service training courses range from short briefing sessions to workshops lasting several weeks. Although briefing courses tend to be theoretical, in-service workshops adopt activity approaches so as to develop practical skills in making and selecting materials and equipment that will make science teaching practical and meaningful at the classroom level. It is noteworthy that some countries, such as Zambia, have special colleges for the extended retraining of serving teachers.

Facilities for teaching science

In the last decade, Commonwealth African countries have established science curriculum development centres to spearhead the improvement of science teaching in schools and teachers' colleges. Where such centres do not exist, Institutes of Education have served the purpose. Centres and Institutes have been engaged in the development of science curriculum and syllabus guides containing suggestions for content, built-in methodology, materials, and locally available simple equipment and tools. Science curriculum development centres and their sub-centres also serve as training points for teachers during formal courses and allow individual teachers to avail themselves of their facilities.

Science laboratories are a regular feature in teacher training colleges but not in primary schools. In most colleges the laboratories are equipped for tutor demonstration only, but in others the situation allows for student experimentation as well. Usually teacher training colleges also have wood and metal workshops where students get opportunities to design and construct science teaching aids. At the primary school level, an "outdoor" approach to science learning, and the use of technology artifacts found in the local community, are preferred. Notwithstanding, at some centres (e.g. at Abraka in Nigeria) pilot schemes are under way on the production of science teaching kits for primary schools. The paucity of reliable information relating to actual classroom practice in primary schools and teacher training colleges, and to the costs and effects of a practical science teaching approach on schools, suggests a deficiency in monitoring and feedback services which requires urgent attention.

Secondary Science Education

Historical Introduction

Concurrently with the drive for the expansion of education to meet the targets assigned by the Addis Ababa Conference of 1961, there has existed in Africa a trend towards the improvement of general scientific and technical education. One of the recommendations of the 1961 conference was directed towards the reform of the content of education in order to meet the demands of technological progress and economic development, especially industrialization in Africa. In August 1964, an international conference held in Lagos recommended a plan for scientific research and training with a view to "study conservation and utilization of natural resources in Africa". The Lagos plan envisaged the training of scientific personnel at three related levels: the highest level would be that of experienced scientists with full postgraduate training, the middle level would group together those scientists with a university degree, and the third level would deal with training given at the post-secondary school level. On the subject of science teaching, the conference recommended that new approaches be introduced "including the teaching of science at early stages in schools, making use of more realistic methods of practical and experimental work, and of producing

new text-books suited to local conditions".

Development

In the past most Commonwealth countries in Africa taught science as Physics-with-Chemistry, Physics, Chemistry, Biology, General Science, and Health Science. The teaching was based on the Cambridge Examination syllabuses. In general the syllabuses were examination-oriented, not teaching syllabuses, and teachers tended to teach for the examination rather than educate the students. Rote learning was the order of the day; students learned and reproduced at examinations results of experiments they had not performed in class.

In the 1960s, new science curricula such as Integrated Science, Agricultural Science, and Home Economics were gradually introduced and were supported with materials in the form of teachers' guide-books, student manuals and science equipment. In many countries this school science project material was at first provided from other countries with very little or no modification. For instance, the Scottish Integrated Science Project, and the Malaysia Integrated Science Scheme, were introduced into Botswana and the Seychelles respectively.

The innovation in science curriculum was aimed principally at the junior secondary school, and in most countries only pilot schools were involved. It was soon evident that although the projects led to improvement in science teaching they left a number of problems unsolved, particularly the increasing cost of equipment which had to be imported from the sponsoring country.

Attempts to improve science syllabuses and to write student manuals and teachers' guides followed next. In some countries, the designing of syllabuses has been a function of institutes of education which are either outside the university systems (as in Tanzania, Kenya, Mauritius and Sierra Leone) or within the university set-up (as in Nigeria and Ghana). Apart from, or in addition to, these institutes, curriculum development centres have been established in countries such as The Gambia, Zambia, Seychelles, Malawi, Ghana, and Nigeria as separate units of the Ministry of Education, and their science panels are responsible for planning, revision, and reform of the curriculum.

Science Teachers' Associations have played and continue to play prominent roles in science curriculum reform especially in Zambia, Nigeria and Ghana. For instance, the Science Teachers' Association of Nigeria (STAN) pioneered the Integrated Science Education Project for Nigeria, and the Ghana Association of Science Teachers (GAST) has been responsible for the Project for Science Integration whose syllabuses, student manuals and teachers' guides are currently being used in the first two years of secondary school in Ghana. Both STAN and GAST are noted for their professional input to the syllabuses and examinations organized by the West African Examinations Council.

It must be mentioned that successful science curriculum development necessitates the collaboration of many educational institutions. Curriculum units on centres, teacher training institutes, and university education facilities must join forces with teachers in the field to produce material that was relevant both to national educational goals and to the teacher working in the classroom.

Although this has been the general trend, progress on the road of

science education reform is slow. One of the main reasons for this is the large number of primary school leavers gaining admission to secondary schools. They put more strain on science teaching facilities than most secondary schools can cope with. The demand for places will increase with the trend towards universal primary education which is on the way to being fully implemented in such countries as Mauritius, Nigeria and Tanzania. To promote national development and productive employment, secondary school syllabuses are being diversified to include agricultural training, and technical and pre-vocational education. In countries like the Gambia and Tanzania for instance, attempts are being made to do this by setting up secondary technical schools which aim to provide technically oriented and vocationally oriented courses. It is hoped that these applied courses will enable graduates to be directly absorbed into the manpower pool of technicians.

Other factors mentioned as militating against the teaching and learning of science include shortage of qualified staff, non-availability, inadequacy and ineffective utilization of teaching aids and equipment.

All the countries represented suffer from a lack of qualified science teachers. Thus, for a long time to come, they may be forced to rely on expatriate teachers who are employed on contract basis for a duration of three years or so.

The qualifications normally required for teaching as a trained teacher is a university degree together with a certificate or diploma in education. Nearly all the countries now have national universities able to train students for science education degrees. But generally it is found that education diploma courses are not popular with science students. They prefer to be employed in industry. Many schemes have been put forward to attract to the teaching profession and keep them there. For example, the Federal Government of Nigeria offers, as an incentive to graduate science teachers entering teaching initially, additional salary increments above that of their Arts counterparts. Kenya, Tanzania, Sierra Leone and Ghana have similar schemes. Other steps taken to improve the conditions of service of qualified science teachers are easier University admission requirements, quality upgrading of serving teachers through in-service education, and the creation of more Colleges of Education which train science teachers only (Tanzania and Kenya).

School Science Laboratories and Equipment

No matter how much the curriculum is improved or how imaginative and well trained the teachers are, every school needs a minimum of science equipment and laboratory space to make science teaching effective. However, except in a few cases, most science laboratories are ill-equipped, ill-maintained, poorly staffed and not spacious enough. Surveys of secondary schools in some countries have shown not only that equipment is lacking in most secondary schools but that damaged equipment is often left unattended and unrepaired.

It is very rare to have laboratory technicians in schools. Most laboratory attendants or assistants have at the most a junior secondary certificate, and normally they are trained on the job by class teachers who are themselves lacking in technical skills. There is therefore a great lack of expertise in the techniques of maintenance and repair of science equipment in schools.

Wherever a sound programme of science teacher education exists,

experience in improvisation of science equipment also exists. It is usually expected that science teachers should learn how to construct some science apparatus during the course of their training. Although this activity should be encouraged as one effective mechanism for the renewal of ideas and the introduction of new designs in science equipment, efforts to supply equipment have to go beyond improvisation. There should be local production which implies a sophistication over and above improvisation, and which results in supplying apparatus for the needs of the whole school system rather than for the needs of an individual school.

Almost all the countries report activities aimed at producing equipment for science teaching particularly for primary and lower secondary schools. Detailed descriptions submitted by participants will be used in updating the Secretariat's publication, The Production of School Science Equipment. For this reason only a few examples are given briefly here. The most advanced efforts have so far been made in Kenya where the School Equipment Production Unit (SEPU), set up in 1969, has produced students' kits for Physics, Chemistry and Biology. The set of three kits cost only about US $150. Most of the items in the kits have been developed locally. SEPU's programme of activities includes pre-service and in-service training for teachers. The Science Curriculum Development Centre in Njala University College in Sierra Leone, has constructed simple items principally for primary teaching. The Scientific Instrumentation Centre in Accra, recently set up as a joint project by UNDP and the Government of Ghana, has started production in glassware equipment. The Centre for School Science Equipment in Yaba, Nigeria, is currently focusing its attention on the repair and maintenance of equipment in schools through the operation of Mobile Service Units, though there are plans for production of equipment in the near future. JETS (Junior Engineers, Technicians and Scientists) - the official organization responsible for school science clubs in Zambia - organizes activities at which various items of equipment are produced. In Botswana, a Teaching Aid Production Unit has been set up in Francistown. In Lesotho, plans are underway to staff and equip the production unit at the Science/Maths Centre. The Tanzania Elimu Supplies, a para-statal organization is concerned mainly with distribution of equipment, but under the Small Industries Development Organization there are plans for some small industries to produce science teaching equipment. And, in Swaziland the Science Centre at William Pitcher Teachers' College produces a limited range of equipment.