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CONTENT:

CHAPTER SEVEN

SCIENCE EDUCATION AND DEVELOPMENT IN NIGERIA

Abdalla Uba Adamu

Introduction:

This chapter provides an over view of the trends and tendencies in the development of science education programmes and strategies across the world; concentrating on the basic themes and their general directions. These trends and tendencies are then placed within the context of "science for development" matrix and the implications for the development of Nigeria to the year 2000 and beyond analysed, which incorporates specific strategies which will provide food for thought for future policy decisions with regards to the role of science education in National Development.

The main thrust of the review is a focus on curriculum reform directed at improving the quality of science education, with a concern on the long-range solutions of science teaching problems. such reform strategies inevitably assume a direct link between improving science teaching and learning strategies and social and political development of any polity. It also focuses attention on the manpower development emphasis given to science curriculum reforms all over the world.

The Notion of Science For Development:

Due to the importance of science and technology in development, there is a high level of commitment in both developed and developing countries to the provision of educational facilities serving as a basis for much more effective training of manpower in science and technology disciplines. This commitment is reflected in the wide ranging science curricular reforms that swept across most parts of the world at the beginning of the 1960s.

A central rationale for the review was fuelled by the belief that students who were introduced to science in the way envisaged by the science education reform rationales are expected to constitute a better class of manpower raw material in science and technology. Such manpower would be in a better position to appreciate, contribute to, and identify with, the modern world of science and technology. Because of this, a prominent feature of the science education reforms in many cases, especially in developing countries, is a reflection of a rationale linked to the labour market in their objectives.

This theme is further reflected in a review of development plans from African, Asian and Latin American countries, which as Lewin (1984) analysed, were concerned with social equity and nation-building considerations. The development plans lay a special stress on scientific and technical education. This is more so since all the plans, according to Lewin, assumed links between educational characteristics of the labour force and productivity, even though such links were often generally stated.

For reasons of clarity, in this discussion a distinction is made between reforms and innovations. As Miles (1964) for instance argued,

> "One thinks of reform as involving a large-scale change often involving structural shift with a strong melioristic overtones. Norms and procedures operating in the system prior to the reform are generally seen as bad undesirable, or morally wrong. If one sticks to the definition offered here, the so-called curriculum reforms group (PSSC and others) ... can be seen more clearly as marketers of innovations - and as themselves innovations on a large scale than as purveyors of reform" (Miles 1964 p.14).

Thus what makes science education so susceptible to review and innovations is the widely held belief that economic prosperity can only come through modernisation, which, in turn, comes as a result of reliance on science and technological training. As the Committee on Science and Technology in Developing Countries (COSTED) observed.

> "The development of human resources, as important as the development of natural resources, will require proper realistic education. Science can help overcome ignorance, superstition and poverty. Above all, without indigenous science and technology, the resources of a nation cannot be organised for industrial expansion. This leads logically to a consideration of the role of science and technology in education. Scientists and technologists required in the economic infrastructure of an industrial society, no matter how unsophisticated it may be" (Radhakrishina 1990 p.38)

This is more so in developing countries where the steps towards a modern culture are being contemplated. A review of science curriculum in a way that places prominence on the interpretation of science in social advancement therefore justifies constant curricular reviews. As Rosier (1987) argued.

> "Science is included in the school curriculum for two reasons. First, it has a role i helping students understand their environment and to develop skills in the

application of scientific methods to the solution of problems. Second, it provides basic training for those students who will subsequently follow careers in science and technology." (Rosier, 1987 p. 106).

Further, students who were introduced to science in the way envisaged by the science education reform rationales (especially those with roots in the 1960s) are expected to constitute a better class of manpower raw materials in science and technology. Such manpower would be in a better position to appreciate, contribute to, and identify with, the modern world of science and technology. Thus a new theme, particularly in developing countries enters the science curriculum reform discussion and that is "science education for relevance and self-reliance. As Bude (1980) observed in explaining the objectives of the Science Education Programme for Africa (SEPA).

> "SEPA chose as a motto "Education for Self-Reliance" which was instigated by critical reflection on the relevance of education systems in Africa". (Bude 1990 p. 34 see also Knamiller, 1984)

Origin Of Science Education Innovations

A review of the origin of the science curricular innovations provides a clue to their fundamental characteristics, and explores their operational demands. The literature suggests although various countries have different social, economic and political systems, few of the science curriculum reforms activities can be said to be endemic. Most were affected one way or other by similar developments in the United State and Britain.

The direct modelling effects of the first generation of science curriculum movements (1960s) spiralling from the United States and UK had dramatic effects on many countries. They triggered off nation-wide reviews of science curricular contents and teaching methodologies. In most cases, attempts were made to adhere faithfully to the curricular ideals outlined by the general trend of the science curricular reforms. And although the choices for many countries were between adoption and adaptation, invariably a combination of both strategies emerged as for instance happened in Australia (Dow 1971).

Even rapidly industrialising nations like Japan, have used the American 1960s developed science education programmes in their reorganisation of the science education curriculum. As Imahori (1980 p.18) stated,

> "Power of innovation in science education in Japan was initiated in the 1960's by

the introduction of some American projects such as PSSC, Harvard Physics, CBA, CHEMS, BSCS and SMSG... The "process of enquiry" which was emphasised in those projects had a strong impact on Japanese science education. Many Japanese educators and scientists were also quite impressed by the text-books of those projects. As a results, innovative power was initiated in the late 1960's and some text books were reformed imitating the PSSC or BSCS text-books."

The imitating process where the science education programmes of other countries are seen to provide a framework around which developmental objective can be rationalised is of course not peculiar to Japan alone; it transcends all cultures. For instance, in Lebanon, the American SCIS (Science Curriculum Improvement Study), provided a model for science curriculum renewal in the country in October 1972. The main rationale for their use was the conviction that

> "Whatever the student got from the SCIS course was bound to be better than what they could have gotten from the unpopular course they were following." (Za'rour and Jirmanus 1977 p. 409)."

However, it is not in all cases of science curricular reforms in the developing countries that American science courses provided the models. Science curricula from the United Kingdom also provided structural frameworks around which many countries developed their science curriculum. In East Africa, a science project grew out of Nuffield Chemistry courses in Tanzania, Kenya and Uganda during 1966-1967. According to Van Praagh,

> "The courses would be based on modern principles of science teaching with more emphasis on pupil activity and less on rote-learning, and would make use of the Nuffield ideals in construction courses suitable for East African Schools. The courses would take account of the children's background, their future careers, the natural resources of the countries, the teachers and the money available. Draft materials were to be written and tried out in a number of schools in each country. The material must be shown to be teachable by existing teachers in their schools and to their pupils" (Van Praagh 1971 p.273).

And further from East Africa, when the Lesotho Introductory Science Improvement Programme (LISIP) was introduced in 1973,

> "The model chosen for this junior secondary integrated science course was the Scottish Integrated Science Course. Although this model was adapted to meet local needs and conditions, the objectives of LISIP, cognitive and affective, were substantially the same as in the parent course" (Towse 1983 p.159).

Similarly, in Malaysia in 1969, the model adopted for the Malaysian Integrated Science course (MIS) was also the Scottish Integrated Science. And although ,

> "Some adaptation took place, the bulk of the course material and recommended teaching strategies remained unchanged. Indeed MIS materials refer teachers to the Scottish Integrated Science publications for further advice and guidance." (Lewin 1980 p.34; see also Jeffrey 1971; but for a more detailed study which look at the issues of trans-cultural curriculum adaptation, see Lewin 1981).

Interestingly, while in Malaysia the junior secondary schools adapted the Scottish Integrated Science curriculum (from Scotland), the upper secondary schools in the country used an adaptation of the Nuffield Foundation Science Teaching Project materials, especially the Biology, Chemistry and Physics Projects developed in England (Tan 1979). And this in a country that fought so hard for colonial independence from Great Britain!

The persistent use of science educational models from developed countries as a basis for the new reorganisation of the role of science in social transformation in developing countries is often justified by the contention that the benefits of science are not culture specific. According to an argument,

> "Modification is not drastic in the subject matter of Chemistry ad Physics programmes for international use as they are largely of international constants. Chemical reactions are the same in North America as in Australia, and the principle of the lever is the same in India as it is in Italy" (in Maddock 1981 p.4).

And while the initiators of the original programmes and courses may feel assured their ideas are taken root in all cultures, the developers of the BSCS (an American Biology curriculum developed in the 1960s), for instance, could not help cautioning that,

> "While some of the BSCS materials are suitable for use outside the United States, the versions of BSCS Biology were prepared with students in the temperate zone of North America in mind, and they are not considered suitable for use in overseas countries without adaptation" (Maddock 1981 p.4).

A similar caution was also voiced where Nuffield Foundation Science Teaching Projects of the United Kingdom were adapted in developing countries. As van Praagh (1971) observed in considering the appropriateness of the Nuffield Chemistry course in developing countries:

"We must remember a number of factors in which differences of varying degree exist. These include the background of the children, their futures after taking the Certificate, the teacher who will teach them, the facilities for science teaching in schools, the amount of money available etc. All these were factors we had to take into account when thinking about and working out the Nuffield material. The general objectives are the same but a certain amount of modification is needed in working a suitable scheme" (van Praagh, 1971 p.270 and 272).

However, as was to become a pattern in cases of either adaptation or adoption (and the distinction in most cases often proves difficult to make), fundamental issues such as appropriateness of the newly acquired science curricula were masked by rhetoric. As UNESCO reported in a case study of the Malaysian science curricular reforms,

"The science curriculum innovations, with their inquiry-based activity-oriented approaches to the teaching/learning science, have given rise to some problems. One is the concern for the effective implementation of this inquiry-based teaching. Other problem areas include lack of apparatus, an important component in this activity mode of teaching/learning science, and the concern for the effectiveness of in-service education" (UNESCO 1984 p. 163).

Further, enthusiasm about the newly adapted science course, tend to override practical considerations, especially those to do with the set of circumstances in the various schooling systems. This is seen, for instance, in the SCIS adoption in Lebanon where,

"As to be expected, many problems were faced in the implementation of a programme roughly half way around the world from its birth place, especially as there was no assistance from project personnel and the school began teaching the courses without all the prepared materials and apparatus" (Za'rour and Jirmanus, 1977 p.410).

Similar problems were encountered in many other places where the developmental ideas suggested by the American and British science educational strategies were used as summarised plans for social transformation in developing countries. As Reay (1977) observed about the introduction of the American Physical Science Study Committee Physics curriculum,

"India introduced the PSSC without ensuring that certain conditions were satisfied (such as motivated and re-oriented teachers) and without considering local circumstances. The advance on earlier teaching was too great and PSSC did not survive as such in India, although some parts of the package are still used, such as the locally manufactured kits of apparatus and the films" (Reay 1977 p. 143).

The used of science curricula from other more developed countries certainly has some advantages. For instance, it provides an instant set of ideas, rationale and materials which some countries cannot produce immediately because of the lack of appropriately trained personnel. This indeed seems to be the case in developing countries just freed from colonial domination. Such transfer also provides models of new course which could be used in the training of future curriculum developers.

The transfer also has some disadvantages, *not the least of which a nation's needs are not always catered for in the transferred curricular.* Further, the cultural mode, ie. the linguistic social and ideological references of transferred curricula did not always match that of the user country. This does tend to create an unusual political situation in developing countries. For instance, having fought hard to regain political freedom from colonial administration, it is interesting to note that many developing countries still relied on former colonial rulers for curricular inspiration in science education. This paradox is reflected in the development of the Science Education Programme for Africa started after independence in many African countries when, according to glowing accounts of the programme,

"Dedicated American and European scientists, curriculum developers and science educators began a gigantic curriculum reform in Africa" (Alabi 1980 p. 140).

Their efforts eventually led to the premier contemporary science curriculum project for Africa in the form of the *African Primary Science Programme* which later became *Science Education Programme* for Africa (SEPA).

However, the consistent primary motive for considering the changes in developing countries is the dissatisfaction with prevailing curricula. In many developing countries, political independence has brought in new priorities which, it was felt could not be met by former colonial curricula. As Alabi (1980) explained,

"With many African countries becoming independent, the Ministers of Education began to call for educational Reform in education generally so as to make education directly related to the newly acquired independent status of African states. They stressed among other things, relevance, quality and large turnover of trained personnel" (p. 140).

A refined illustration of this new ethos is reflected in the rationale of Nigeria's Aiyetoro Basic Science Programme developed in 1962 which states,

> "In the past, science had been taught in an authoritarian, verbalistic manner in Nigerian secondary schools. The objective of this project was to produce materials, centred around the process of science, which would teach pupil to accept the evidence of their own senses rather than to rely on authority in the person of the teacher or the book and to engage in independent, critical thinking. Nigeria was just emerging from its colonial past, and it was felt that a science programme of this sort would contribute much toward producing citizens who could participate in a democracy" (in Lockard 1970, p. 203).

A similar analysis of antecedent schooling conditions was made in other developing countries; and associated with the analysis is a curricular solution borrowing precedent from science curricular reform in either United States or England. For instance, in Thailand, it was observed that;

> "The nation wide chemistry curriculum at the upper secondary school level prior to 1976 ... had been very traditional in comparison to many other countries. Laboratory was not a required part of the course. Some topics were out of date. Teaching strategies emphasising memorisation were based entirely upon a teacher's teaching rather than a student's learning. Teachers were not familiar with investigative inquiry teaching techniques... High level questions were seldom asked. Students were not encouraged to ask questions, think, present ideas, or participate in class discussions." (Sapianchai and Chewpreccha 1984 p. 44)

The attempts to link science curriculum reform with labour market also made appearances in some projects and became associated with a concern aimed at the production of scientifically literature labour force. And at secondary school level in many developing countries, any labour market orientation of the school curricula is more readily identifiable with vocational labour force, rather than highly trained scientific and technological manpower more associated with advanced training in scientific which has its genesis in secondary science curriculum. As King (1984) argued in considering science education in East Africa,

> "The new interest in asking about the impact of science on work and society is likely to be very different question from those asked of vocational students. For one thing, there is interest in the transformational potential of science. Not just whether students have ended up in vocational jobs, but whether they are using their science to apply and to modify their environment" (King 1984 p.12).

The concern therefore about the inadequacy of the existing science curricula to enable students to contribute to social development has given rise to rapid reappraisal of such practices and led to new strategies in developing countries. The most predominant concern (linked with political forces) - emerged in the United States and gave rise to the initial wave of science curricula reforms. This movement rapidly found itself in developing countries, and the initial rationale of such curricular reforms in the US mutated to social forces (to do with development). Suddenly, the same science which has been taught for decades has overnight, become irrelevant and inadequate in solving social problems. Science curricular from more developed countries were adopted, or adapted as providing adequate means of social transformation.

Characteristics of the science Education Programmes

The intentions and likely outcomes of these reforms for African countries were clearly stated in the project brief of the African Primary Science Programme. This was started in Kano, Northern Nigeria in February 1965 by American advisers with major funding from the Ford Foundation. The stated objective of the APSP was:

> "To determine to what extent new ideas and methods for teaching science, particularly the so-called "discovery" method developing in the United Stated, United Kingdom and elsewhere are applicable for Africa. Specifically in Sierra Leone, Liberia, Ghana, Nigeria, Kenya, Tanzania, Uganda, Malawi, Zambia and Lesotho" (in Lockard, 1967, p5)

Five years later, in 1970, representatives from nine Anglophone countries in Africa assembled in Freetown, Sierra Leone and renamed the APSP Science Education Programme for Africa, SEPA. Its motto became "Education for Self Reliance" and it became an umbrella organisation for the development of science education programmes in the continent.

In other situations, the science curriculum reform was approached from the perspective of creating new science learning contexts in the form of high schools which differ radically from the existing conventional schooling process. These schools become a long term investment in ensuring a supply of science graduates from the secondary schools. One of the earlier cases of this was in Turkey, where the Ford foundation substantially financed the development and establishment of a science Lycee in 1964. The Lycee was to cater for high ability children with aptitude for science education. As the Turkish Minister of Education explained in introducing the Lycee in February 1962.

> "As for our country, I find it suitable to found a High School of Science where students with high ability could be boarded without charge... The High School should train the staff for our future scientific programme and the graduates of such a high school should further their education in the fields where they are most gifted (in Maybury 1974 p. 112).

Similarly, one of the Malaysia strategies of long term science curriculum reform involved the government setting up specialist science schools. As a Malaysian government plan explained,

> "One important feature of the upper secondary education was the establishment of fully residential science schools, with a total enrolment capacity of 9,200 to provide expanded educational opportunities for pupils from rural areas. Ten of the schools have been completed, while on is expected t be completed by 1977" (Malaysia 1976 p. 386).

Thus the belief in the potentials of science, through science education, to reduce the magnitude of already existing social and educational problems became formalised through massive science curricular reforms which became a single universal anthem cutting across all racial, social and ideological barriers. The image of science education as powerful agency for social, indeed universalist human transformation - making humanity one big happy family - has never been made more evident.

Some Emergent Lessons:

However, it was not long before a disquietening feeling started to develop among the science education community across the world about the science curricular activities. Rapid changes in social economic and political affairs in virtually all countries from the mid 1960s to mid 1970s brought with them new perspectives on the use of scientific knowledge in human affairs. Questions begun to be asked about what the science curricular reforms actually set out to do and what they ended up doing.

The issues raised by the science curricular reforms reflect a new trend in humanistic perception of the role of science in social affairs, and government accountability. In the United States, the various political and social changes of the 1960s and 1970s - the same forces that led to the initial science curricular reforms at the beginning of the 1960s - created deep feeling of uncertainty about the future of science education. The direct consequence of these changes were in the area of public and significantly Congressional support for science education. As Yager (1981 p.2) explained, "Individuals and organisations (Many of them fundamentalist groups) attacked some of the old (eg. MACOS) and most of the new (science) curriculum efforts as "unAmerican", inappropriate, and even pornographic. These concerns caused a major reassessment of policies, directions and support for science education activities. During the mid 1970's work on curriculum development was curtailed; active projects were scaled down and few new ones were initiated."

The direct consequence of this development is the setting up of many evaluative projects by the National science Foundation. One of them, co-directed by Stake and Easly (1978) has the main objective of collecting information which describes the status of pre-college science education in the US in 1976 to determine its future direction. Another was Project Synthesis whose main purpose was,

"To assemble information that would provide a picture of K-12 science Education. An attempt was to be made to asses the impact of public support for science education during the past twenty years. Where the improved courses and the support for teacher education successful? Had science education kept pace with science, society, knowledge and schooling? (Yager 1981 p.2)

Many aspects of science education where assessed in the light of important educational goals, student capabilities and limitations, and forces at work within educational systems. The assessment by Project Synthesis team,

"Revealed a growth mismatch between the practice of science education and the needs to individual students and our democratic society. The basic problem is that the educational goals reflected by practice in science education appeared to be extremely narrow, and based on the erroneous assumption that most science students will go on to take considerable coursework leading to careers in science. Goals which appear to be largely ignore include preparation for citizen participation in science and technology related - societal issues, preparation to utilise science in everyday life, and preparation for making career choices in science-related fields" (Kahl and Harms 1981 p. 113).

In the meantime, developing countries, especially those in Asia which had adopted or adapted overseas (American or British) curricula were, by 1969,

"Experiencing considerable difficulties in their use, as was reported by delegate after delegate at the joint UNICEF - UNESCO regional workshop on planning for science teaching improvement in Asian schools, held in Bangkok, Thailand in 1969. The delegates consistently stated that the imported materials were proving unsuitable for use in their countries, and some countries at least have subsequently moved away from their use. In the Phillipines, for example, following the implementation of the BSCS Biology after it had undergone a thorough adaptation process, it was found in 1967 that students were producing inadequate performances, were finding concepts in the materials difficult to grasp, and were experiencing considerable problems with language comprehension. As a result, the Phillipines has subsequently developed more appropriate materials of its own" (Maddock 1981 p.5)

Finally, in Africa, it became evident to the philosophical architects of the African Primary Science Programme (APSP), which later became the Science Education Programme for African (SEPA) that the rhetoric of the newly adapted (mainly American) science curriculum differs from the reality of their demands or use. Yoloye and Bajah (1980) in a survey raised this issue with various people connected with the development of the APSP, and queried whether Africa was ready for the educational revolution envisaged by the APSP. They discovered that,

> "In our interviews with the African science educators, we... posed the problems raised above and it was significant to note that the Africans saw these problems as disturbing at first....The teachers on whose hands APSP materials were placed were ill-prepared to teach science, let alone teacher it in this revolutionary way. Although the organisers of APSP held what were described as 'workshops', these were mainly material development and appraisal workshops and not inservice, competency based workshops. The examination system in the education programmes of most African countries were still followed and so the problem with the new approach was apparent" (Yoloye and Bajah 1980 p.179-180).

Out of this global malcontent, a new vision for the science education agenda for the 1990s in all countries emerged; and that is a direct concern with making the child the focus of educational enterprise. The humanism of science education has never been more evident. The emergent propositions about science education reform for the 1990s assumed assumed less ideological and political tones than the first generation of science education reform movements. They lost some of the political hysteria that tinted the earlier American and British originated science curricula. They became more pragmatic and more tuned to sociological realities of the context they will operate.

This is because it became rapidly evident that changing the objectives of *science curriculum to reflect a modern sociological statement* does not yield the desired social transformation expected.

Towards The Future

The review in this chapter highlight the various attempts to carry out changes in science education. In the process, the review reveals the strong emphasis placed on science education as an agency of social transformation in both developed and developed countries.

The most common set of strategies that emerged are attempts at revolutionising the science curriculum to achieve this broad objective, but invariably without a corresponding change in the set of assumptions that govern the teaching and learning of science, especially the developing countries. From the various reviews, it emerges that a strong factor in considering the pattern and direction of change in science education is a consideration for satisfying social needs through radical reform in content and rationale of science programmes.

Moreover, the instances cited, even in countries with limited resources, made allusions to provision of science education for all learners. And yet it was not explored whether failure to achieve reasonable measure of outcomes is connected to this mass orientation of science education.

Also, effective measurement of the overall outcomes of these projects has never been fully carried out. It would be interesting to know, for instance, the extent to which pupils exposed to the newer science curricular developed the presence of mind and analytical insights expected of them as a result of acquiring the values of the newer science curricula.

This is important because it should enable identification of the most important aspect of the science education continuum to pay attention to, if science education can be seen to contribute social development.

Another variable conveniently overlooked by apparently overworked Ministry bureaucrats whose jobs it is to hack out curricular menus and dump them in the classrooms is the powerful influence of examinations on the educational system. Dore's (1976) work on the diploma disease which afflicts educational societies the world over, but more epidemic in developing countries, has raised issued about the relationships between examinations, social pressures and curricular rhetoric. For instance, a study by Adamu (1991) shows that examinations can exert pressures, albeit hidden, on teacher' interpretation of the curriculum in the classrooms, no matter how innovative the curriculum claims to be. This is significant in the implications it suggests for curriculum reformers and policy makers.

For instance if a curriculum based on the process/enquiry approach to science teaching is taught didactically, then whatever the students achieve cannot be attributed to the enquiry approach.

This has far reaching consequences. This is because curriculum development in science education usually has strong social and political bases. Consequently, science education projects especially curricular reforms, are expected to result in more people in society knowing more about science and having a better understanding of the nature of scientific work. Often, curriculum development also is expected to encourage more young people to enter scientific and technological occupations. This chapter has raised possibilities that the expectations that curriculum development can influence broader social and educational matters in Nigeria may be an uphill task.

Thus it is not enough to merely improve the curriculum by hanging its objectives and introducing words with social and developmental dimension. A whole new range of integrated science curriculum development strategies has to be developed for Nigeria. This should see science education not merely as a list of impressive and politically significant objectives which policy makers and curriculum developers hoped to be attained by students, but as a dynamic classroom process which reflects itself both in its statements of intent and in the examination system.

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