# UNESCO AND THE TEACHING OF SCIENCE AND TECHNOLOGY

by DAVID LAYTON

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UNESCO AND THE TEACHING OF SCIENCE AND TECHNOLOGY

by DAVID LAYTON

ABSTRACT

Amongst international agencies, UNESCO is unique as a specialized agency of the United Nations with competence and responsibility in both science and education, together with a special concern for developing countries. The following account focuses on one limited component of UNESCO's work, namely its contributions to pre-university science and technology education as promoted and co-ordinated from Headquarters in Paris.

The early years were understandably dominated by the needs of post-war reconstruction, including the provision of support for science teachers in devastated countries, the re-equipping of laboratories, and the publication of school texts relevant to education in tropical contexts. Surveys of the conditions under which science teaching was taking place, and of the available human and material resources, were also initiated. One significant response was the preparation and publication of The UNESCO Source Book for Science Teaching (1956) which, periodically revised and updated, had been translated into 30 languages and had sold over 750,000 copies by the close of the 1970s. Regional activities, including improved co-operation between national associations of science teachers, were also encouraged.

Emphasis on the peaceful uses of atomic energy, the theme of a UN Conference in Geneva in 1955, and recognition of the extent of the scientific and technological skill resources of the USSR, stimulated efforts to modernize science curricula in the USA and several European countries in the late 1950s and the 1960s. Resulting projects were notable for the deep involvement of leading scientists. The long-standing collaboration between UNESCO and the International Council of Scientific Unions (ICSU), both based in Paris, was strengthened by ICSU's establishment in 1961 of La Commission Interunions de l'Enseignement des Sciences (CIES), the forerunner of its Committee on the Teaching of Science (CTS, 1968-1993). Simultaneously, UNESCO established a Division of Science Teaching, staffed by personnel who had been leaders in science curriculum reforms, with Dr A. V. Baez as its Director. The aim was to strengthen UNESCO's programmes for improving the teaching of science at pre-university level in developing countries. Pilot projects to incorporate modern approaches, methods and materials were started - physics for Latin America, chemistry for Asia, biology for Africa and mathematics for the Arab world.

The focus of effort throughout this period was on 'the teaching of the basic sciences', the theme of a series of influential publications by UNESCO describing new trends on the teaching of biology (five volumes between 1967 and 1987), chemistry (5 volumes between 1967 and 1981) and physics (four volumes between 1968 and 1984). Some volumes comprised selections of significant articles from the science education literature and commissioned papers; later ones recorded the proceedings of international conferences, often organized by ICSU with UNESCO support.

Some strands of UNESCO's science teaching activities continued, more or less unchanged, throughout its first fifty years. Teachers' guides, following the widely popular UNESCO Source Book for
Science Teachers, were developed and published. The UNESCO Handbook for Science Teachers (1980) was intended for teachers in primary and lower secondary schools. Other volumes dealt with the teaching of particular sciences and with the problems and possibilities of teaching science in particular regions (e.g. UNESCO Handbook for Biology Teachers in Latin America was published and distributed in 1982 by the UNESCO Regional Office for Science and Technology, ROSTLAC).

The construction and provision of low-cost laboratory apparatus and equipment for science teaching was another enduring concern, again leading to a series of publications. Similarly, out-of-school science and technology activities for young people, involving science fairs, clubs, camps and Olympiads, remained an important focus for encouragement. Regional and sub-regional training workshops for key personnel were held and regional guidebooks and manuals published. A UNESCO Source Book for Out-of-School Science and Technology Education consolidated experience in this field in 1986, the edition being printed in Arabic and Russian, as well as English.

Regular reviews of the state of science and technology education in order to monitor the nature and extent of changes, to identify trends and to underpin programmes of action in the field constituted a fourth strand of activity. Even without these, however, it was clear by the late 60s that major changes were taking place in the international contexts of science and technology education. Many nations had achieved independence from colonial rule; concerns for national development were strong; with the democratization of education more and more children, not least girls, were going to school; and, increasingly, there was recognition of an urgent need to relate education to real-life situations and the world of work. UNESCO's response to these contextual changes involved the promotion of integrated science teaching and increased support for technology as a component of general education.

The integrated science programme was launched in 1968 and comprised publications, workshops, advisory services and pilot experiments in Member States. A series of international conferences at Varna (1968), Maryland (1973) and Nijmegen (1978) attempted to clarify the concept of integrated science, to consider how best teachers of integrated science might be trained and to review integrated science teaching worldwide, respectively. By 1990, six volumes on New Trends in Integrated Science Teaching had been published, together with regional contributions to the same theme.

Technology did not feature to any great extent in the early educational work of UNESCO, other than in connection with its social and economic implications. Throughout most of the 60s the emphasis remained on the teaching of the basic sciences, not least because technology was seen largely, though mistakenly, as 'simply applied science'. One major contributory influence which led to a revaluation of the place of technology in general education was the radical report of the International Commission on the Development of Education, chaired by Edgar Faure and established by UNESCO in 1971. This argued for a broadening of the concept of general education to incorporate technological knowledge so that we might better control 'everything man does to modify his world'. For Faure and his fellow commissioners, science teaching should aim to underline the interdependence of knowledge and action and the teaching of science should be dovetailed with the teaching of technology.

Parallel changes in the concept of technical and vocational education located its beginning as an integral part of everyone's basic general education in the form of initiation to technology and to the world of work. These were accompanied by a relocation of science teaching activities in the Division of Science, Technical and Vocational Education. New pilot projects were initiated including
ones on science and technology in rural areas, science and technology and productive work; technology in general education; and the teaching of science and technology in an interdisciplinary perspective. A Science and Technology Education Document Series was inaugurated in 1981, forty-seven publications resulting by 1995. In 1984 an International Network for Information in Science and Technology Education (INISTE) was established; its regular Bulletin brought details of projects and other developments to a wide audience. A series of volumes on Innovations in Science and Technology Education was also launched in 1986, volume one including accounts of several of the pilot projects and volume five (1994) being devoted entirely to technology education.

Following the World Conference on Education for All (Jomtien, 1990) and in recognition of a need for 'a world community of scientifically and technologically literate citizens', a major initiative, Project 2000+, was launched by UNESCO in 1992, much of the impetus coming from the International Council of Associations for Science Education (ICASE). An initial surveying and pilot project phase was followed by an International Forum in July 1993 when guidelines for designing, implementing and evaluating projects were developed. It was recommended that by 2001 all countries should have in place appropriate structures and activities to foster scientific literacy and technological literacy for all.

Writing in 1995, it is too early yet to judge the effectiveness of such a uniquely decentralized project. The future of UNESCO's work in the field of science and technology education is to define, taking into account the reduction of the central team of specialists in science and technology education. ICASE, a body with limited resources, is in no position to co-ordinate developments on the scale envisaged. Furthermore, the historic partnership with ICSU was fractured in 1993 when the Committee on the Teaching of Science was replaced by a new Committee on Capacity Building in Science. Its programme to some extent overlaps with, but goes beyond, the science component of Project 2000+. The reported deliberations of the Committee so far make little reference to technology and the extent to which there will be co-ordination of effort, both nationally and locally, remains unaddressed. The challenges to UNESCO's work in the field of science and technology education have never been greater.

INTRODUCTION

For the most part, the brief account which follows is restricted to the teaching of science and technology in schools, rather than in universities and other institutions of higher education. Additionally, UNESCO's significant contributions to non-formal science and technology education are touched upon, although there is no attempt to survey these comprehensively. For present purposes, developments in mathematics education, environmental education, health education and nutrition education, whilst clearly of importance and closely related to the teaching of science and technology, have been deemed to fall outside the scope of the account. Many of UNESCO's initiatives in the teaching of science and technology have originated and taken place at regional and sub-regional level; whilst reference is made to some notable examples of these, any attempt to do justice to their contexts and range would require, and deserves, a separate and more detailed study. The focus here is on science and technology education as promoted from UNESCO Headquarters in Paris.
Science teaching, whether in schools or universities, was some way down the formal agenda of UNESCO’s Department of Education in the Organization’s early years. The Department's first responsibility was seen as the establishment of ‘a clearing house of information on the theory and practice of teaching for the use of Member States’. Thereafter, problems of reconstruction and rehabilitation in war-ravaged countries, the educational needs of war-handicapped children, the combating of adult illiteracy and ignorance, and the development of resources for education in international understanding were dominant concerns.

Against this background, it was the Department of Natural Sciences which took the first initiatives in the field of science teaching. An early step was the publication in 1948 of a slim booklet of 88 pages entitled “Suggestions for Science Teachers in the Devastated Countries”, a work which was later translated into Arabic, Chinese, French, Spanish and Thai and which was the direct precursor of one of UNESCO's best selling publications, the “UNESCO Source Book for Science Teaching” (1956: revised and enlarged edition, 1962).

Another early publication addressed the topic of “War-Devastated Science Laboratories” (1949). To assist countries, “Inventories of Apparatus and Materials for Science Teaching” were compiled, one volume for primary, secondary and vocational schools, a second for universities and a third - issued in several parts - for technological institutions, covering physics and chemistry, veterinary sciences, agricultural sciences, medical sciences, electrical engineering and mining engineering (1950-1956). Accompanying these was a bilingual text, “La Construction d’Appareils de Laboratoire à Usage Scolaire” 1954), a collection of designs of apparatus and materials for schools in countries where industrial production was not yet very advanced and where local artisans and vocational schools could manufacture the items for appreciably less than the international market price. At an earlier stage, fifty large boxes of workshop equipment needed to make apparatus for the teaching of science had been distributed to war-devastated countries such as the Philippines.

An associated development, involving collaboration between the Departments of Education and Natural Sciences began with a contract with Oxford University Press for a series of ten books on the teaching of science specially written for use by teachers in ‘tropical primary and secondary schools’. Plans for these volumes matured slowly. “The Teaching of Science in Tropical Primary Schools” by E. D. Joseph and “The Teaching of Chemistry in Tropical Secondary Schools” by N. F. Newbury were published in 1953, but fourteen years later when “The Teaching of Rural Science in Tropical Primary Schools” (by I. P. Shanks) was published, only seven volumes in the projected series had been completed.

It was recognized early in UNESCO’s life that the extent to which science teaching took place in different countries varied considerably and the conditions under which it had to take place were often little understood. In 1948, his second and final year as Director-General, Julian Huxley invited Member States to provide information about the rôle of science in general education in their


2. “Suggestions” was prepared by J. P. Stephenson, a science teacher on the staff of the City of London School and a regular exhibitor at the members’ exhibition of science teaching apparatus and methods at the Annual Meetings of the Science Masters’ Association in the United Kingdom.

communities and the International Bureau of Education (IBE) was asked to undertake an enquiry into the introduction of natural sciences in the primary school.\(^4\)

The results of a subsequent survey of science teaching in secondary schools, discussed at the IBE's Fifteenth International Conference on Public Education in 1952, exposed serious deficiencies in many countries and led to recommendations for science as a core subject in the education of all children between eleven and fifteen years of age.\(^5\) A parallel survey of science teaching in primary schools was published in UNESCO's "Educational Abstracts" in 1955,\(^6\) by which time concerns in many countries had moved beyond post-war reconstruction to the rôle of science and technology on the supply of scientifically trained personnel, including teachers.

UNESCO's response to this situation took several forms. A revised and enlarged version of the 1948 booklet on "Suggestions for Science Teachers" was published in 1956 as "The UNESCO Source Book for Science Teaching"; updated again in 1962, it had been translated into thirty languages and had sold over 750,000 copies by the close of the 1970s.\(^7\) Support for regional activities increased, an example being the study conference in Bangkok in October 1956 on science teaching, attended by representatives of fifteen Asian and South Pacific countries. Attempts were made to improve cooperation between national associations of science teachers; in 1950 a document, "International Cooperation Between Organizations of Science Teachers" was prepared and distributed, followed by a compilation of "UNESCO Publications Relevant to Science Education", issued in three languages;\(^8\) UNESCO staff members attended annual meetings of science teacher organizations in Member States and, in 1955, a "Science Teaching Newsletter" was commenced and circulated to select lists of science teachers.\(^9\) By the end of 1954 an internal document had been prepared with suggestions for a long-range UNESCO programme in the field of science teaching. The resources for science teaching available to UNESCO were, at the same time, brought to the attention of all National Commissions.\(^10\)

Efforts were also increasingly directed to the non-formal sector. Here the aim was "to enable the general public to understand the practical applications of science to modern life"\(^11\) and from its earliest years UNESCO had placed importance on the popularization and social implications of science. As a result of co-operation between the Departments of Natural Sciences and Mass Communications, monographs were published on aspects of the popularization of science and scientific exhibitions were held, one on 'Our Senses and the Knowledge of the World' opening in France in 1952 and touring Thailand, Indonesia, Vietnam, Cambodia and Hong Kong later that year, followed by the Philippines, Japan and India in 1953.\(^12\) The Kalinga Prize, awarded annually for an

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outstanding contribution to the popularization of science by a science writer, was made possible by a generous gift from an Indian industrialist, Mr B. Patnaik, in 1950. The establishment of science clubs and science fairs was also encouraged as means by which young people might be brought into contact with science and its applications. In this connection, an illustrated “Handbook for Science Clubs”, written by Mrs K. Sen Gupta, Principal of a girls' secondary school in New Delhi, and designed to stimulate the organization of amateur science clubs in India and Asia, was published by UNESCO in 1953.  

NUCLEAR ENERGY, THE COLD WAR AND THE CURRICULUM REFORM MOVEMENT

In 1956 an event occurred which changed the pace, if not the direction, of UNESCO's efforts to improve the teaching of science. The UNESCO Institute for Education at Hamburg organized an international meeting of 'experts' to consider the content of 'the physical and natural science curricula' in primary and secondary schools. Those attending came from European countries, the USA and the USSR. The meeting was held in the shadow of a vast new programme undertaken by the United Nations in the field of atomic energy, involving the establishment of CERN (Conseil Européen pour la Recherche Nucléaire, later the European Organization for Nuclear Research) and a UN Conference at Geneva in 1955 on the Peaceful Uses of Atomic Energy, attended by some 1200 delegates. Like the UN, its parent body, UNESCO was under pressure to assist expansion of the peaceful uses of atomic energy in order to lift 'the burden of hunger, poverty and disease'. It also had a unique responsibility among UN specialized agencies to encourage 'the diffusion of scientific knowledge in the field of atomic energy'. In this connection Dr Gerald Wendt, then Chief of the Division for the Teaching and Dissemination of Science in the Department of Natural Sciences, had written a pamphlet for the general reader, “Nuclear Energy and its Uses in Peace” (UNESCO, 1955).

Delegates from every country at the Hamburg conference were emphatic that a critical examination of the science curriculum was vital to the welfare of modern communities and that all pupils should know something of the production, nature, uses and possibilities of atomic energy. The problems associated with this, not least the dearth of suitable apparatus for experimental work and the lack of knowledge about atomic energy on the part of many teachers, were acknowledged, but the consensus was that some understanding of the subject by the rising generation was essential. In this connection, the products of German firms manufacturing science teaching apparatus, the efforts in the USSR to help young people to understand the structure and working principles of the first atomic power station and comic strip techniques in the USA such as 'Dagwood splits the atom' were noted approvingly.

The Hamburg meeting catalysed efforts to modernize science curricula in several European countries, the Nuffield Foundation's Science Teaching Project in the UK being one major development which followed. Simultaneously in the USA, where comparative studies of US and USSR scientific and technological skill resources and the symbolic launch of the first orbiting satellite in 1957 were providing grounds for concern, a battery of major science curriculum projects was funded to underpin future economic and military competitiveness. Of course, the science curriculum reforms of the early 1960s were driven by forces other than Cold War fears and the quest for technological


14. This account of the Hamburg meeting is based on: C.R.E. Gillett (editor) “Science in Schools. Report on an international meeting of experts held at the UNESCO Institute of Education, Hamburg, 22-27 October, 1956”, Hamburg, UNESCO Institute of Education, 1957; and the private papers of Dr Henry Boulind, one of four UK participants in the meeting.
innovations to energize the economy. Scientific knowledge was advancing at a staggering pace and the influence of science and technology on all aspects of life was profound; yet many of those leaving secondary schools appeared to be foreigners in their own culture.

The science curriculum projects were notable in many ways, with one distinguishing feature, at least of the first wave, being the deep involvement of leading scientists. UNESCO’s activities in the field of science and science teaching, similarly and from the earliest days, had also been closely associated with professional scientists. The reason for this, according to Jaime Torres Bodet, the second Director-General, was that

In the field of Natural Science, UNESCO found that there were already active and firmly established international organizations, more particularly in pure science which ... had an International Council of Scientific Unions (ICSU) grouping a number of organizations for individual sciences. This was a system ready made for UNESCO.15

Over the years, ICSU had been a beneficiary of substantial UNESCO annual subventions and in 1961, no doubt responding to the wave of curriculum reforms, established La Commission Interunions de l’Enseignement des Sciences (CIES), the forerunner of its Committee on the Teaching of Science (CTS, 1968 to 1993). Around the same time, individual scientific unions appointed education commissions for their particular subjects, e.g. IUPAP’s International Commission on Physics Education. In the same year, 1961, UNESCO established a Division of Science Teaching staffed by personnel who had been leaders in science curriculum reforms, with a former Physical Science Study Committee (PSSC) member, Professor A. V. Baez, as Director. The aim was to strengthen its programmes for improving the teaching of science at pre-university level in developing countries and build on the UNESCO/United Nations Development Programme (UNDP) support for the establishment to teacher training colleges in Africa and elsewhere.

Accordingly, a series of pilot projects was started to help incorporate modern approaches, methods and materials in science teaching programmes in developing countries; in Brazil, 1963, physics for Latin America; in Bangkok, 1965, chemistry for Asia; in Cape Coast and other centres, 1967, biology for Africa; and in several Arab countries, 1969, mathematics for the Arab world. Although international teams of experts contributed to the leadership of these regional projects, they did so in close partnership with local scientists and educators, with practising teachers involved in the creation of the new materials.16

The focus on individual sciences was continued in a major series of publications on which UNESCO embarked before the close of the 1960s. Under the theme of “The Teaching of Basic Sciences”, volumes appeared describing new trends in the teaching of biology and chemistry (both 1967) and physics (1968). Five volumes in the chemistry series had been published by 1981, five in biology by 1987 and four in physics by 1984. Some volumes comprised selections of significant articles from the science education literature, others drew on specially commissioned contributions,


whilst others again recorded the proceedings of international conferences, often organized under the ICSU umbrella with UNESCO support.

**CHANGING CONTEXTS**

Some strands of UNESCO’s science teaching activities continued, re-interpreted for their times, more or less unchanged throughout its first fifty years. The widely popular “UNESCO Source Book for Science” Teaching (1962), already mentioned, was updated and supplemented to provide a broader coverage of the science material likely to be included in introductory courses, appearing as “New UNESCO Source Book for Science Teaching” in 1973. A companion volume, written by authors from various countries, “UNESCO Handbook for Science Teachers” (1980), was intended mainly for those working at the primary and lower secondary level. Related volumes dealt with the teaching of particular sciences (e.g. “Teaching School Physics. A UNESCO Source Book” edited by John Lewis and containing contributions from twenty six countries, 1971) and with the problems and possibilities of particular regions (e.g. “UNESCO Handbook for Biology Teachers in Latin America”, 1982, with parallel volumes in 1986 for biology teachers in Asia and Africa, the Latin American and Asian volumes being published and distributed by the respective UNESCO Regional Offices for Science and Technology).

The construction and provision of laboratory apparatus and other equipment for science teaching was another enduring concern, especially with respect to cost. A volume in the New Trends series on “The Utilization of Educational Technology for Science Education” was published in 1974, based on papers delivered at a meeting previously convened by ICSU/CTS and UNESCO. A subsequent volume addressed “New Trends in School Science Equipment” (1983) with further volumes on “Low-Cost Equipment for Science and Technology Education” following (volume 1 in 1985 and volume 2 in 1986). Examples of low-cost science and technology materials for kindergarten, primary school and senior middle school levels, from national institutions of the Democratic People’s Republic of Korea, People’s Republic of China and Brasilia, were made available in microfiche form in 1990.

A third continuing strand of endeavour concerned out-of-school activities. In 1967 an International Co-ordinating Committee for the Presentation of Science and the Development of Out-of-School Scientific Activities (ICC) was established, with sponsorship from UNESCO and the Council of Europe. It progressively expanded its work of encouraging, and disseminating information about, all forms of out-of-school scientific activities, especially in developing countries, including science fairs, camps, clubs and Olympiads; the range was extensive, from Pioneer Centres in the USSR to Junior Engineers, Technicians, Scientists (JETS) in Zambia and other African countries. A volume, “Out-of-School Science Activities for Young People”, was published by UNESCO in 1969, around which time a series of regional and sub-regional training workshops for key personnel was held. Particular accounts based on local practice followed. UNESCO’s Regional Office for Science and Technology in Latin America and the Caribbean (ROSTLAC) produced a “Guidebook for Out-of-School Activities” in 1971, the companion Regional Office for Education (OREALC) issuing a “Manual for the Promotion of Scientific and Technological Activities for Young People” in 1984. Two years previously the whole of a special issue of the substantial Bulletin of the UNESCO Regional Office for Education in Asia and the Pacific (ROEAP) was devoted to accounts of “Out-of-School Activities in Asia and the Pacific. A UNESCO Source Book for Out-of-School Science and Technology Education” consolidated experience in this field in 1986, the edition being printed in Arabic and Russian, as well as English.
Regular reviews of the state of science and technology education in order to monitor the nature and extent of changes, to identify trends and to underpin programmes of action in this field constituted a fourth enduring strand of activity. Surveys of science teaching in secondary and primary schools (1952 and 1955) have already been noted. A comprehensive survey of the status of science teaching was planned in 1954 as part of a study of the world-wide shortage of science teachers and trained science personnel. This was followed by an issue of UNESCO's “Education Abstracts” devoted entirely to “Training of Science Teachers for Secondary Schools”, with details of provisions and resources in twenty-five Member States. In 1978 a worldwide review of developments in integrated science teaching was undertaken by Sheila Haggis, Chief of the Science Education Section in UNESCO's Division of Science, Technical and Environmental Education, in collaboration with Philip Adey. A few years later, in response to recommendations from the International Congress on Science and Technology Education and National Development (1981) an international inquiry was undertaken 'on the pace occupied by science and technology in school timetables and curricula'. A questionnaire was sent to all UNESCO's 161 Member States in 1984 and an analysis of their replies was published, “The Place of Science and Technology in School Curricula: a Global Survey” (1986), followed by case studies in five countries (People's Republic of China, Uganda, German Democratic Republic, India and Pakistan).

Although such important strands of activity as these continued, major changes were taking place in the international contexts of science and technology education. Many nations had achieved independence from colonial rule; concerns for national development were heightened; with the democratization of education more and more children and young people, not least girls, were going to school; and increasingly, there was recognition of an urgent need to relate education to real-life situations, the solving of practical problems and the world of work. Two pivotal thrusts in UNESCO's response to these contextual changes involved the promotion of integrated science teaching and increased support for technology as a component of general education.

At its General Conference in 1968, UNESCO launched a programme of integrated science teaching comprising publications, workshops, the stimulation of pilot experiments in Member States and advisory services. In part the case for integrated science was built on concerns that school science courses should not be conceived primarily as laying a foundation for more specialized studies of science at a higher level. More positively, unproductive duplication of the teaching of certain topics appearing in more than one of the familiar biology, chemistry and physics courses might be avoided. In developing countries, especially, where for many children primary schooling was still the only level experienced, it was important that scientific attitudes and some knowledge of science should be fostered early. Provided suitable materials were available, the teaching of integrated science might not only match teacher resources, specialists in biology, chemistry and physics courses might be an unrealistic proposition in primary schools, but also the 'logic of children' for whom the world was not seen and experienced in terms of the separate scientific disciplines.

These and other arguments underpinned the movement for 'integrated science', a term whose precise meaning proved tantalisingly elusive even in the limited contexts of primary and lower secondary education. At the first international congress on 'the integration of science teaching',

19. Sheila Haggis and Philip Adey. A review of integrated science education worldwide. Studies in Science Education, vol. 6, 1979, pp. 68-89. (The results of the review were reported to an international conference on integrated science education held at Nijmegen, The Netherlands in 1978.)
organized, with assistance from UNESCO, by ICSU's Inter-Union Commission on Science Teaching (CIES) at Varna (Bulgaria) in 1968, diverse interpretations of integrated science were offered by participants. Even so, it appeared that such an approach could have merits in certain situations, the crucial determinant of its effectiveness being the preparedness of the teacher. The training of teachers for integrated science was recommended as a worthwhile topic for a further conference. In the event, this was not held until five years later, in 1973, at the University of Maryland, again organized by ICSU, now through its Committee on the Teaching of Science (CTS), in collaboration with UNESCO. By this time UNESCO had already published two volumes on “New Trends in Integrated Science Teaching”. The first, in 1971, was a collection of previously published articles contributing to the definition and exemplification of integrated science. The second, in 1973, comprised commissioned articles and examples of integrated science curriculum projects. A third volume in 1974, again in the New Trends series, was based on the proceedings of the Maryland conference. Volume 4 (1977) on evaluation of integrated science courses, volume 5 (1979) based on the proceedings of the Nijmegen Conference on Integrated Science Education Worldwide, and volume 6 (1990) followed, with regional variations on the same theme (e.g. “Integrated Science Teaching in Africa”, 1989), constituting a steady flow of publications recording and stimulating developments over two decades.

UNESCO’s interest in technology, if not its advocacy of technology education, is long-standing. From its inception, the Department of Natural Sciences was active in the popularization of science and its social implications; UNESCO’s journal, “Impact of Science on Society” (1950 on), edited from the Department, carried frequent articles and abstracts on technology and society.20 The emphasis on the teaching of the basic sciences in the Division of Science Teaching throughout the 1950s and 1960s, however, precluded any significant developments in the teaching of technology, other than in the context of technical and vocational education. Possibly this was no more than a reflection of a then widely held opinion that technology was essentially applied science and that, in the context of general education, a sound foundation of basic science was the prime requirement. It was symptomatic of the times that the West’s educational response to Sputnik in 1957, a spectacular feat of engineering, was in terms of ‘pure science’ curriculum reforms. Ten years later, at the end of his term as Director of UNESCO’s Division of Science Teaching, Dr A. V. Baez’s recommendations for improving the teaching of science with particular reference to developing countries, prepared for the UN Advisory Committee on the Application of Science and Technology for Development, were entirely related to the basic sciences.21

One major contributory influence which led to a revaluation of the place of technology in general education was the report of the International Commission on the Development of Education, established by UNESCO in 1971. Under the chairmanship of Edgar Faure, a former Prime Minister, and Minister of Education, of France, the Commission produced a radical and challenging set of recommendations. In dealing with schools, it was argued that ‘rigid distinctions between different types of teaching - general, scientific, technical and professional - must be dropped, and education, as from primary and secondary levels, must become theoretical, technological, practical and manual at the same time’. The concept of general education needed to be broadened to include socio-economic, technical and practical knowledge, in addition to traditional subjects. It must incorporate


21. “Improving the teaching of science with particular reference to developing countries”. Prepared by Dr A. V. Baez for the Advisory Committee on the Application of Science and Technology to Development of UNO (October 1967).
'above all - technological knowledge: as technology affects more and more people, compelling them to understand and master the technical world, so education in theoretical and practical technology becomes necessary to everyone'. It followed that 'One of the basic objectives of science teaching should be to underline the interdependence of knowledge and action. This concern should lead to dovetailing science teaching and the teaching of technology.' In spring 1974 an issue of “Prospects”, UNESCO’s quarterly review of education, explored these issues further in a dossier of eight articles on technology and general education.

Parallel to these changes in the concept of general education, revised recommendations concerning technical and vocational education were adopted at the General Conference of UNESCO in 1974. It was stated that technical and vocational education should begin as 'an integral part of everyone's basic general education in the form of initiation to technology and to the world of work.' An understanding 'of the technological facet of modern culture in both its positive and negative attributes, and an appreciation of work requiring practical skills' should be 'a required element in the curriculum, beginning in primary education and continuing through the early years of secondary education'.

This impressive convergence on the educational potential of technology had major implications for the work of the Division of Science, Technical and Vocational Education, in which, by the end of the 1970s, science teaching activities had been relocated. In UNESCO’s programme for the biennium 1979-80 reference was made to a review of ways of adapting science and technology education to a changing society and to the diversity of needs of Member States. To explore the issues in greater detail an international congress on Science and Technology Education and National Development was convened by UNESCO in 1981 and attended by some 200 participants from over 80 Member States. The results of this and of associated meetings on specific topics were published in 1983. By that date four new pilot projects had been initiated - science and technology in rural areas; new methods for the pre-service and in-service training of personnel; science and technology education and productive work; and technology in general education. Each of these involved the co-operation of several institutions in different Member States, in the case of technology in general education the participating countries being Australia, China, India, the Philippines and Sri Lanka. Consultation meetings between the working groups were held and, in November 1985, an International Symposium on the teaching of technology in the context of general education met in Paris. In the biennium 1986-87 the projects were extended to other geographical areas, with a focus on additional themes including the teaching of science and technology in an interdisciplinary perspective and, later, technology teaching linked to science education.

24. An interesting review of UNESCO's activities in the fields of science and technology education at the end of the 1970s is:
26. Descriptions of several of these and other projects are given in:
The experiences and outcomes from these innovations were disseminated in several ways. An International Network for Information in Science and Technology Education (INISTE) was established in 1984 and its “Information Note” later “Bulletin”, published regularly, brought details of the projects and other developments to a wide audience. A “Science and Technology Education Document Series” (STEDS) was inaugurated in 1981, number 4 in 1983 being a report on a survey conducted in thirty seven countries, of technology education as part of general education. By 1995, forty seven publications had been issued in the series, all free of charge, with several being in, or translated into, languages other than English. A series of volumes on “Innovations in Science and Technology Education” was also launched in 1986, volume one including accounts of several of the pilot projects listed above and volume five (1994) being devoted in its entirety to technology education.

In a brief account such as this it is not possible to do justice to the full range of science and technology education activities which took place within this period. Two other important developments deserve recording, however. UNESCO’s support for science in the primary school curriculum continued, a particular focus being a project involving a workshop approach to teacher education. Also, there was a growing concern for the education of girls and women in science and technology, including ways of improving access by them to these fields.

**SCIENTIFIC AND TECHNOLOGICAL LITERACY FOR ALL: 2000+**

The World Conference on Education for All, at Jomtien, Thailand in March 1990, was convened by the executive heads of UNESCO, UNICEF, UNDP and the World Bank in response to the stagnation or deterioration of education in many countries during the 1980s. Economic recession, mounting debt burdens and rapid population growth had made it impossible for developing countries to maintain the pace of educational expansion of previous decades.

The Conference addressed the problem of meeting basic learning needs. Its Declaration, proclaimed at the end of the meeting, recognized

> 'that sound basic education is fundamental to the strengthening of higher levels of education and of scientific and technological literacy and capacity and thus to self-reliant development'.

In relation to the supportive policy context necessary for the success of basic education programmes it further declared that

> 'Societies should ... insure a strong intellectual and scientific environment for basic education. This implies improving higher education and developing scientific research. Close contacts with contemporary technological and scientific knowledge should be possible at every level of education.'

The implied need for 'a world community of scientifically and technologically literate citizens' was the starting point for a major initiative, Project 2000+, announced by UNESCO in 1992. This joint venture was based on a partnership between a group of major intergovernmental organizations and


agencies, and non-governmental organizations with special concerns and responsibilities in the field of science and technology education and research. It was planned in three phases. The first, up to July 1993, entailed the collection, analysis and collation of information, completion of surveys and pilot projects. The second, in July 1993, involved an International Forum to discuss issues and develop guidelines for designing, implementing and evaluating projects in Phase 3. This extended until 2001, by which date it was recommended that there should be in place appropriate structures and activities to foster scientific literacy and technological literacy for all, in all countries.29

Much of the impetus for Project 2000+ came from the International Council of Associations for Science Education (ICASE). This non-governmental body had been established in 1973 at the University of Maryland, USA, at a meeting of representatives from twenty seven science teachers' associations immediately following the International Conference on the Education of Teachers of Integrated Science. The idea of such an association had been explored initially by participants at a UNESCO Regional Workshop on Integrated Science Teaching held in the Philippines in 1970 and at a meeting of leaders of teacher associations two years later in Singapore. Prior to the Maryland meeting a Directory of Science Teachers’ Associations was prepared by the Association for Science Education, UK, under contract from UNESCO, and this was periodically revised as the membership of ICASE increased. In addition to publishing a journal, “Science Education International”, ICASE - in association with UNESCO and ICSU - arranged regional activities and otherwise promoted improvements in science teaching.30

Project 2000+ is an extraordinarily ambitious undertaking and unlike any previous UNESCO intervention in the field of science and technology education. There is no central control over developments and no global funding to support these. The “INISTE Information Bulletin” has been remodelled to serve as a means of disseminating news of regional and country developments, including the establishment of national co-ordinating task forces and the involvement of non-governmental organizations.31 Also, volume 6 in the Innovations in Science and Technology Education series, as yet unpublished, has been devoted to the theme of 'Scientific and Technological Literacy: Meanings and Rationales' and is intended as an aid to those contributing to and implementing the project. Nevertheless, the task of interpreting a slogan such as 'Scientific and Technological Literacy for All' and converting it into practicable and effective operations on the ground is formidable. No less daunting is the scope of the enterprise which embraces both formal education and non-formal activities, teacher education and leadership challenges, deeply embedded gender considerations, the setting of development priorities and technical problems of assessment and evaluation. At regional and local levels there are difficult battles to be fought for resources and sensitive negotiations to be conducted in order to forge partnerships and construct alliances. It is too early yet to judge the effectiveness of such a decentralized project which relies for success on


commitment to an overall goal of undisputed importance and on a sense of ownership of initiatives and endeavours at the local level.

**FACING THE FUTURE**

Amongst international agencies (to borrow the words of a former Director of UNESCO's Division of Science Teaching),

UNESCO is in a class by itself because it is the Specialized Agency of the United Nations with competence and responsibility in both science and education and because it has always had a special concern for the developing countries.32

Administrative evolution of 'science and technology teaching' during the first half century of UNESCO's life raised some issues over its place in the organization's scheme of things. Until 1972, the teaching of science (there was scant reference to the teaching of technology) was under the jurisdiction of 'Science', initially the Department of Natural Sciences and, later, the Department for the Advancement of Science. In 1972, as part of an internal reorganization, it was moved under the administrative and budgetary control of 'Education', initially as a Division of Pre-University Science and Technology Education, then as a Section of the Division of Science, Technical and Vocational Education, later the Division of Science, Technical and Environmental Education. By 1991, there was a Section for Science and Technology Education within the Division for the Development of Education; by October 1992, a Unit for Science and Technology Education (with a separate Environmental Education Unit) in the Section for Science and Environmental Education within the Division for the Renovation of Educational Curricula and Structures. These structural relocations raised some questions about the most effective deployment of UNESCO's resources and staff.

Past activities provide rich evidence of interventions, sponsorships, brokerages and disseminations which have yielded significant outcomes, probably achievable in no other way. Furthermore, there are lessons to be learnt about the structures and relationships which have been facilitatory. A case in point is the frequent co-operation between UNESCO and other international, but non-governmental, agencies working for the improvement of science education, particularly ICSU and ICASE. This partnership was made both easier to realize and more effective in execution by interchanges in the personnel involved. Dr A. V. Baez, Director of UNESCO's Division of Science Teaching from 1961 to 1967, became Vice-Chairman of ICSU's Committee on the Teaching of Science from 1969 to 1974 and Chairman from 1974 to 1977. Dennis Chisman, Secretary of ICSU/CTS from 1969 to 1977 became Executive Secretary and Treasurer of ICASE when it was established in 1973, continuing to serve on ICSU/CTS after 1977 as ICASE representative. Members of UNESCO's science education staff also served on the education commissions of the individual science unions, for example, Dr N. Joel on the education commission of the International Union of Pure and Applied Physics and Dr F. Vohra on the Commission for Biological Education of the International Union of Biological Sciences. Such collaboration was facilitated by the geographical proximity of ICSU's headquarters to that of UNESCO in Paris. The triangular relationship was further strengthened by the presence on ICASE's Executive Committee of representatives from both UNESCO and ICSU. This degree of cross-membership not only guaranteed the efficient exchange of relevant information, but also facilitated an economical division of labour and contributed to that invaluable resource, a long-term collective memory of developments, personnel and contexts world-wide.

The present situation is that, in 1993, the International Council of Scientific Unions disbanded its Committee on the Teaching of Science and established a new Committee on Capacity Building in Science (CCBS) under the chairmanship of a Nobel Laureate and Director Emeritus of the Fermi National Acceleration Laboratory in the USA, Professor Leon M. Lederman. \(^{33}\) The seeds of this development can be seen in the deliberation of ICSU's Vienna meeting in 1991 on 'An Agenda of Science for Environment and Development in the 21st century' (ASCEND 21), convened to prepare a consolidated contribution to the forthcoming UN Conference on Environment and Development (UNCED). The concept of capacity building assumed central importance at the Rio 'Earth Summit' in 1992, especially in its action programme, Agenda 21, under recommendations about means of implementing change.

A guiding conviction of the CCBS is that 'the scientific illiteracy of the peoples of the world presents a universal crisis which transcends North-South, developing and developed, rich and poor'. Superimposed on this problem is 'the wide discrepancy in science and technology prowess that maintains the North-South gap'. The Committee is recommending that ICSU should launch a major Programme in Capacity Building in Science, to start in January 1997 for an initial five year period and following a year of planning and fund-raising. The type of activities which are proposed include:

1. establishing a network for capacity building in science, a key to which is telecommunications technology applied to a clearing house rôle;
2. strengthening primary school education by establishment of agreed standards of scientific understanding at the end of specified periods of schooling: by identifying core concepts, skills, attitudes, materials and consumer tools: by enhancing the status of teachers: and by other measures;
3. overcoming the isolation of scientists in developing countries;
4. promoting public understanding of science; and
5. presenting the case for science. \(^{34}\)

It will be clear from even this abbreviated outline of what the CCBS is proposing that, in its educational aspects, there is a risk of considerable overlap with UNESCO's project 2000+. It will be important to ensure that there is effective co-ordination overall, but especially at national and local levels, so that efforts are supportive and synergistic rather than conflicting and debilitating. It seems necessary that ICSU's programme should proceed with close alliance with UNESCO and also with ICASE whose network at the level of practising teachers of science is unique among international agencies and enables influence and developments to reach parts of the system that other organizations cannot reach directly. National and regional centres for science and mathematics education, in the creation of several of which UNESCO participated, have also a role to play. What does seem clear, however, is that professional science, acting through ICSU and stimulated by global concerns about environmental quality, population pressures, dwindling natural resources, hunger, poverty and disease, has reasserted its strong commitment to the improvement of science education, in both its formal and non-formal aspects, especially in the developing world. What makes this endeavour different from previous science-driven reforms, especially those of the 1960s, is the extent to which science education research over the past thirty years has advanced our understanding of the


\(^{34}\) Recommendations of the ICSU Committee on Capacity Building in Science (CCBS) for a Programme on Capacity Building in Science, J-une 1995, pp. 3-6.
teaching and learning of science and of the complex process of science curriculum change. Even so, Jerrold Zacharias’s judgement, from the 1960s PSSC project, that it was easier to put a man on the moon than change the high school science curriculum, still deserves to be heeded.

There remains the question of technology as a component of general education. There is no international organisation, with a remit comparable to that of ICSU, for engineering and the technologies. The World Council of Associations for Technology Education (WOCATE), modelled on ICASE, is of very recent origin, as are many of its member teacher associations and, as yet, its networks are partial and undeveloped. Although the CCBS asserts that ‘science and science-based technologies are the driving engines for change in modern society’ and ICSU’s scientific associates include organizations with an important applied orientation, there is little reference to technology and technology education in the reported deliberations of the committee so far. It would be unfortunate if UNESCO’s work in supporting this now widespread movement to empower young people in the realms of practical capability should be allowed to run into the sand. Carefully judged interventions in the made world lie close to the heart of solutions to environmental and development problems. To equip the next generation for dealing with these, science education and technology education should be advancing in concert within a moral frame and there remains important work for UNESCO to do in this regard. Its opportunity to use science and technology education to promote collaboration between nations and to encourage mutual understandings of each other’s situations has never been greater. As for means, the concept of a large headquarters’ team is probably no longer feasible or effective, but a central core of expertise working with contracted, finite life, well-focused task forces, constituted and reconstituted as demand required, would have much to recommend it.
BIOGRAPHY OF THE AUTHOR

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After graduating in Natural Sciences at Cambridge University, David Layton worked in an industrial research laboratory and, for thirteen years, as a secondary school teacher of chemistry. He moved to Leeds University in 1960 as a lecturer in chemical education, becoming the first Director of the Centre for Studies in Science Education, 1970-82, and Professor of Science Education, 1973-89. He was awarded the OBE for services to science education in 1988 and is an elected Honorary Member of the Association for Science Education and of the Standing Conference for Schools’ Science and Technology.

His activities have included:
Director, National assessment of pupils’ performance in science (Leeds APU project) 1977-82
Director, St. Williams Foundation Technology Education Project, 1985-88
Co-Director, National Evaluation of the TVEI Curriculum, 1985-88
Chairman, Steering Committee, SCSST project on Practical Problem Solving 5-13, 1987-88
Co-opted member, Secretary of State’s National Curriculum Working Group on Design and Technology, 1988-89
Consultant to OECD project on innovations in science, mathematics and technology education in OECD countries, 1989-94
Member, Consultative Committee, Nuffield Foundation Design and Technology Project, 1991-94

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