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ABSTRACT

The deliberations of the Co-ordinating Meeting for the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Program in Integrated Science Teaching held in May, 1971 are contained in this report. The report first reviews the recent developments and trends in integrated science teaching at the national, regional and international levels. Particular emphasis is placed on developments which have taken place during the last two years. UNESCO's current program in integrated science is described. This consists of these four areas of UNESCO activities: (1) a series of publications in integrated science teaching; (2) workshops on a regional, sub-regional and national basis to exchange information, to examine particular aspects of integrated science teaching and to study particular programs; (3) pilot experiments on a national basis for the development of new methods and materials for integrated science teaching at the primary and lower secondary levels, and for the training of science teachers; and (4) technical services to Member States through UNESCO field experts concerned with integrated science teaching. Major trends and problems in integrated science teaching and suggestions for UNESCO's future program in integrated science teaching are reviewed in the report. (Author/PR)

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UNITED NATIONS EDUCATIONAL,
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CO-ORDINATING MEETING FOR UNESCO'S PROGRAMME IN INTEGRATED SCIENCE TEACHING

Unesco, Paris, 10-12 May 1971

FINAL REPORT

SUMMARY

The Report contains the deliberations of the Co-ordinating Meeting for Unesco's Programme in Integrated Science Teaching. The meeting was held at Unesco Headquarters from 10 to 12 May 1971, and was attended by some 12 scientists and educators involved in various ways in Unesco's programme in this field. It was also attended by representatives of organizations which have programmes in this field in Africa and Asia.

The major purpose of the meeting was to review Unesco's current programme in integrated science teaching, to consider Unesco's evolving rôle in the promotion of integrated science teaching throughout the world, and to make specific suggestions concerning its future programme in this field. The meeting also served the purpose of bringing together individuals who had been working on various aspects of Unesco's integrated science teaching programme but who had not previously had the opportunity of interchanging views and information concerning their respective rôles.

The meeting first made a review of recent developments and trends in integrated science teaching at the national, regional and international levels. Particular emphasis was placed on developments which have taken place during the last two years. This review is summarized in Section II of the Report.

Unesco's current programme in integrated science teaching as provided for under programme resolution 2.21 adopted by the General Conference at its sixteenth session, was then considered by the meeting. This programme is described in Section III of the report. It consists of:

1. A series of publications in integrated science teaching.

2. Workshops on a regional, sub-regional and national basis to exchange information, to examine particular aspects of integrated science teaching and to study particular programmes.

3. Pilot experiments on a national basis for the development of new methods and materials for integrated science teaching at the primary and lower secondary levels, and for the training of science teachers.

4. Technical services tc Member States through Unesco field experts concerned with integrated science teaching.

In its review of major trends and problems in integrated science teaching the meeting gave particular attention to three issues which it considered of particular importance. These are:

1. The concept of integrated science teaching.

2. The learning process and the teaching of integrated science.

3. Teacher education for integrated science.

The conclusions of the meeting on these topics are contained in Section IV of the report.

Suggestions for Unesco's future programme in integrated science teaching are contained in Section V of the report. This section also contains an appraisal by the meeting of Unesco's evolving rôle in this field.

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I. INTRODUCTION

1. Unesco's programme in integrated science teaching was launched at the Unesco General Conference in 1968. The term "integrated science teaching" covers the approaches in which the concepts and principles of science are presented so as to express the fundamental unity of the scientific thought and to avoid premature or undue stress on the distinctions between the various scientific fields. This concept was affirmed at the Congress on the Integration of Science Teaching organized by the "Inter-Union Commission on Science Teaching" of the International Council of Scientific Unions held in September 1968 with Unesco support. In its initial stages, this programme is aimed at the first 8 or 9 grades of schooling. It is focused on key-personnel in science education improvement such as curriculum planners, tutors in training colleges and science supervisors. It is also concerned with methods and materials for the teaching of integrated science and for the preparation of teachers (both pre- and in-service).

2. The major purpose of the Co-ordinating Meeting was to review Unesco's current programme in integrated science teaching, to consider Unesco's evolving rôle in the promotion of integrated science teaching throughout the world, and to make specific suggestions concerning its future programme in this field. As a means to this end the meeting considered within a global perspective:

(a) Current developments in integrated science teaching (national, regional and international).

(b) Major trends and problems in integrated science teaching.

(c) The programme of co-operative efforts that is needed to solve these problems.

Recommendations concerning Unesco's rôle, its network of relations and its future programme were made, as far as possible, within this global perspective.

3. The meeting also served the purpose of bringing together individuals who had been working on various aspects of Unesco's integrated science teaching programme but who had not previously had the opportunity of interchanging views and information concerning their respective rôles. The participants at the meeting included:

(a) representatives from major integrated science teaching projects and programmes which are used as resources in Unesco's programmes;

(b) leaders of Unesco-supported projects in integrated science teaching in developing countries;

(c) representatives of international and regional organizations concerned with integrated science teaching;

(d) staff of Unesco Regional Offices concerned with Unesco's integrated science teaching programme;

(e) individuals making a major contribution to Unesco's integrated science teaching programme, particularly in the field of publications.

(For list of participants, see Annex I).

4. The meeting was opened on 10 May by Mr. S.O. Awokoya, Director of the Department of Science Teaching and Technological Education and Research, who welcomed the delegates to the meeting. Mr. Awokoya outlined the development of Unesco's integrated science teaching programme from a set of theoretical guidelines evolved at the planning meeting for the programme in March 1969 to an evolving set of activities taking place all over the world. Mr. Awokoya indicated how, in a brief two-year span the concept of integrated science teaching has developed, and how on a world-wide basis this approach is now making an impact on pupils in schools. He considered that integrated science teaching provided for the educational nurture of the embryo scientist. By initiating him into the skills, processes and major concepts of science it could provide the basic foundation for his future specialized training in pure or applied science. At the same time integrated science teaching, by drawing on the phenomena of the child's environment as its subject matter and by initiating him into the applications of science in his everyday life can make a major contribution to his general education, whether he will pursue his scientific studies to a higher level or not.

5. Dr. H. Foecke, Director of the Division of Science Teaching, outlined Unesco's preliminary thinking concerning its programme and budget in science education for the 1973-1974 biennium, and its general plans for the six-year span beginning in 1973. Dr. Foecke indicated that a Unesco science education programme is developing which is an entity. Within this programme there will be activities aimed at all educational levels. The integrated science programme will be one part of an overall programme which has several different components. These include the teaching of the basic sciences, physics, chemistry, biology and mathematics, as well as in new fields which are increasingly appearing in school curricula such as the environmental sciences. They also include cross-disciplinary areas such as school science equipment, educational technology in science education and teacher training for science education. There will also be regional programmes in science education in Africa, Asia, Latin America and the Arab States.

6. The meeting then elected the following officers:

Chairman: Prof. M. Matyas, Chairman ICSU Committee for the Teaching of Science

Rapporteur: Mr. P. Richmond, Editor "New Trends in Integrated Science Teaching".

The Agenda was adopted (see Annex II). The following presentations were made, and conclusions and recommendations were agreed upon.

II. REVIEW OF CURRENT DEVELOPMENTS WORLD-WIDE IN INTEGRATED SCIENCE TEACHING

A review was made of recent developments and trends in integrated science teaching at the national, regional and international levels. Particular emphasis was placed on developments which have taken place during the last two years. During this review, frequent references were made to the Unesco publication "New Trends in Integrated Science Teaching" which describes many of the projects and ideas referred to below in greater detail than is given in this report. (References to "New Trends in Integrated Science Teaching" will be given, where appropriate).

(a) National activities

Activities in the various countries represented at the meeting were described, as follows:

United States of America. Dr. Lockard gave brief descriptions of some seventeen projects in integrated science teaching at the primary and secondary levels which are at the experimental or implementation stages in the United States of America. He drew attention to the many ways in which integration is effected in these programmes: from the American Association for the Advancement of Science - "Science, a Process Approach", where the skills and processes of science provide the integrating theme for an elementary school course, through the Biological Sciences Curriculum Study, where aspects of physics and chemistry are brought in as appropriate to a biological study for high school pupils to the Earth Science Curriculum Project where aspects of many sciences including physics, chemistry, biology, geology, meteorology and oceanography are brought together in a study of the earth suitable for high school pupils. Other projects of particular note were the Intermediate Science Curriculum Study, which is a self-pacing junior high school programme, the Engineering Concepts Curriculum Project which brings together aspects of engineering science and physical science, the Physical Science for Non-science Students course which is a college course for future elementary school teachers of science, and the Portland Project which is a senior high school course in Physics, Chemistry and Biology. The Quantitative Physical Science project, the Educational Research Council project and the Minnemast project attempt to integrate the teaching of mathematics and science. Reference was made to "New Trends in Integrated Science Teaching", page 370, where all seventeen projects are described in more detail and to the Appendix 1 to this volume, which lists major integrated science teaching projects world wide. Dr. Lockard also referred to the "Federation of Unified Science Education" - FUSE - which works with school systems and with individual teachers, helping them to select programmes and materials, from the wealth of what is available, suited to their own situation and needs. Particular emphasis is placed by this organization on the in-service training of teachers.

Australia. Professor Fensham outlined three Australian projects:

(i) The New South Wales Science Textbook Project which carried out pioneering work in integrated science teaching in Australia. The

rapidity with which this programme was put into operation revealed the need to prepare teachers adequately to teach an integrated science course.

(ii) The Junior Secondary Science Project (JSSP) which has produced teaching material for grades 7 and 8 in physics, chemistry, biology, geology and astronomy for the State of Victoria. This project is the direct precursor of:

(iii) The Australian Science Education Project (ASEP) which is the first federal science education project in Australia. It is funded jointly by the Australian Federal Government and all six States of Australia. Being a "third generation project", it is able to utilize the experience gained by its predecessors. ASEP is not just a development project producing self-contained materials. It caters for six different States with different types of requirements - two States have comprehensive schools, with pupils differentiated into streams, whereas the other States have all pupils going together up to Grade 10. The Project is producing modules of material, designed to suit both types of educational pattern. There is at present an extensive trial and evaluation of these materials in the various States, and an extensive in-service teacher education programme.

Professor Fensham also mentioned that some schools are using materials developed overseas, such as the Intermediate Science Curriculum Study and Harvard Project Physics materials (U.S.A.) and Nuffield materials (United Kingdom) to see how these materials may best be drawn upon as resources in Australia.

The United Kingdom. Professor Keohane gave a brief outline of the transition from "general science" to "integrated science" which is currently taking place. He indicated that the "general science movement" proved unsatisfactory because of inadequate teacher preparation. He referred to the Science Teacher Education Project (STEP) which is producing modules of material to assist teachers in teaching modern integrated science programmes. There are now several integrated science projects at the secondary level. These are:

(i) Nuffield Combined Science, a two-year introductory science programme which has produced modules of teaching material for pupils aged 11-13 years.

(ii) Nuffield Secondary Science, a programme for pupils aged 13-16 years. This programme consists of eight themes across the whole range of physical and biological sciences. Each teacher follows his own route through the teaching material.

(iii) The Schools Council Integrated Science Programme (SCISP)
This is also a programme for 13-16 year old pupils.
It has three major themes:
Building Blocks (atoms, cells, populations, etc.)
Interaction
Energy

This programme attempts to introduce the sociological implications of science and to modify attitudes as well as introducing concepts and skills.

Professor Keohane also referred to the integrated science teaching project "Science 5/13" which is producing integrated science teaching materials for the elementary school level and which is a follow-on to "Nuffield Primary Science". There is also a project "Nuffield Physical Science" - a combined course of physics and chemistry for upper secondary level.

Mr. Chisman described the "Scottish Integrated Science Project" which is producing materials for secondary school level. These materials integrate physics, chemistry and biology. They have come to be the basis of several overseas schemes, including Malaysia, the Caribbean and Malta.

Malaysia. Mr. Chang Kwai presented a paper on the secondary science scheme in Malaysia and explained that the Scottish worksheets are being used without much adaptation so far. This will come later in the light of experience. Books and other material may be produced, but money is not yet available for a thorough evaluation of the needs of secondary science teaching. Mr. Chang Kwai indicated that plans were also afoot for introducing integrated science into the primary schools. Materials have already been developed for this purpose, but teacher training and retraining is a major problem.
(see also "New Trends in Integrated Science Teaching", page 252).

Ghana. Mr. Adu Ampoma stressed the part that the Ghana Association of Science Teachers has played in reorganizing science teaching. He also emphasized that an approach to science teaching closely related to local problems is essential. Ghana is now trying to produce a scheme which is original and appropriate for West African conditions. Two workshops have been held recently, at which attitudes, skills and applications of science appropriate to the Ghanaian situation have been identified. It is intended to produce an original programme, but none-the-less, curriculum developers are making use of much resource material including that of the Africa Primary Science Programme. The Ghana scheme covers primary, secondary and teacher-training levels. One difficulty is the dissemination of reports and ideas generated at workshops.

Nigeria. Mrs. Haggis outlined how the Science Teachers Association of Nigeria (STAN) and others working in the field had reviewed in detail aims and objectives of the first two years of secondary education. There was considerable local enthusiasm, but teacher-training colleges did not always produce teachers qualified to teach integrated science. (See also page 218 of "New Trends in Integrated Science Teaching"). At the primary school level, a Nigerian Primary School Project has been established, which is linked with the Science Education Programme for Africa (see Regional activities).

Israel. Mr. Blum outlined work in Israel which is closely related to the cultural and technological needs of the country. At the primary level, there is a project covering grades K-6, based at the Tel-Aviv University. For grades 7-9 there are courses in integrated physical sciences, and in biology, and also a project using agriculture as environmental science. These projects are based at the Ministry of Education Curriculum Centre, Jerusalem. Although the Israel Science Teaching Centre tries to co-ordinate the different projects, at different levels, many difficulties have to be overcome. He raised many significant questions including the social and psychological considerations which must be considered by curriculum developers, the relative ease of integrating physics and chemistry and the agricultural significance of biology. He suggested that science teaching is complicated by language problems and children must be valued who can act scientifically without necessarily being able to write a formal report. He described a "scientific story" approach, used to increase verbal skills.

Brazil. Professor Raw described how conservation is an integrating theme in a Brazilian science course. He noted nine aspects which can be considered of particular importance; two were the small apparatus kits which can either be used in school or bought in shop for use at home. Parents can thus supplement (and perhaps influence) work done at school.

Throughout discussions on these national projects, emphasis was constantly placed on the part teacher education has to play. The lack of involvement of mathematicians was also noted. It was hoped that a Unesco conference dealing with mathematics and science might be arranged.

(b) Regional activities

Africa Primary Science Programme. Dr. Chaytor explained that this programme is not a syllabus, that attitudes and knowledge are important. To date some fifty units have been produced. Some countries find the project materials difficult to handle because of their unstructured approach and the fear that teachers might lose control and thus security. It is hoped that the regional project can lead to local ones.
(See also "New Trends in Integrated Science Teaching", page 136).

The West Indies Science Curriculum Improvement Project (WISCIP).
Mr. Chisman recorded the growth of WISCIP (A) from its beginnings in Trinidad in 1968-1969 to its current trial WISCIP (B) in many islands of the Caribbean. A substantial volume of trial materials has been written.

The Science Education Programme for Africa (SEPA) which came into existence during 1970, seeks to co-ordinate activities in science education in Africa, particularly at the primary level and in the related teacher training. It has a programme for in-service training of teachers, of workshops for producing materials for teacher education and of exchange of information.

It was noted that the Regional Centre for Education in Science and Mathematics in South East Asia (RECSAM) at Penang, Malaysia, which serves the countries Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet-Nam is running training courses in integrated science teaching at the primary level. It is proposed that, in the future, training courses also be organized for integrated science teaching at the secondary level.

(c) International activities

Mr. Chisman presented the report of the ICSU Committee on Science Teaching. This committee was reconstituted in 1969, and replaced the original Inter-Union Commission on the Teaching of Science. The terms of reference of this Committee are:

(i) to further the teaching of science at all levels;

(ii) to co-operate with other organizations concerned with science teaching;

(iii) to facilitate co-operation among the teaching commissions of the individual scientific unions.

Liaison with Unesco has been established particularly with reference to Unesco's programme of integrated science teaching. The Committee has acted in an advisory rôle in connexion with Unesco's publications programme, and will continue to do so, if requested by Unesco, in the future. Other interdisciplinary activities in Unesco's programme will be studied by the Committee and, if requested, advice will be offered.

The Committee is planning a major international Conference on Science Education devoted to a study of the problems of the education and training of science teachers with particular reference to integrated science teaching. It is likely that the Conference will take place at the University of Maryland in April 1973. The objectives of the Conference are as follows:

to assess the nature of integrated science and interdisciplinary science courses,

to review the education and retraining of science teachers with particular reference to integrated science, including a study of the rôle of the universities in this process,

to draw conclusions and make recommendations concerning the future action that needs to take place in this field.

It is envisaged that 25-30 key participants will be invited to contribute major papers to this Conference and that about 100-150 other participants will take part. A Conference time-table has been drawn up by the Conference Sub-Committee. A local organizing committee has been established, under the joint chairmanship of Dr. D. Lockard and Dr. M. Gardner of the University of Maryland.

Other concerns and activities of the Committee are as follows:

(i) It is proposed to organize, during 1972, a small seminar or symposium on educational technology in science education.

(ii) One of the main interests of the Committee is liaison with science teachers associations throughout the world. It is hoped to work closely with Unesco in establishing a confederation of science teachers associations with a view to exchanging information on the work of such organizations and assisting in the dissemination of information from one country to another. Such a federation would eventually qualify as a non-governmental organization affiliated to Unesco.

III. UNESCO'S CURRENT PROGRAMME IN INTEGRATED SCIENCE TEACHING

At its General Conference in 1968, Unesco launched its programme in integrated science teaching. The objectives and scope of this programme were outlined at the Planning Meeting for Unesco's Programme in Integrated Science Teaching. The Final Report(1) of this meeting contains proposals for a general strategy in this field, and detailed suggestions for a four-point programme comprising (a) publications, (b) workshops on a regional, sub-regional and national basis, (c) stimulation of pilot experiments on curriculum development and teacher training in Member States, (d) advisory services. This programme was conceived as a collaborative one between Unesco and other international and bilateral aid agencies and non-governmental organizations.

Unesco's integrated science teaching programme difiers in several respects from the discipline-oriented pilot projects which were run by the Division of Science Teaching in previous biennia, and has the following general characteristics:

1. It is not confined to one particular region of the world. Activities started in Asia and Africa. They are being extended in the course of the current biennium to the South Pacific and Latin America, and will subsequently be extended to the rest of the world.

2. It is not identified with any one particular approach to science teaching. Rather, it seeks to identify various approaches and curriculum "models", and to encourage the establishment of working groups which will develop and subsequently implement the model or models most appropriate to their own particular needs.

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(1) Reference document SC/MD/13 "Final Report of the Planning Meeting for Unesco's Programme in Integrated Science Teaching".

3. It is an on-going programme which, employing a diversity of modes of operation (see previous paragraph), aims to assist all stages of the development of integrated science teaching programmes - not just the pilot stage.

(a) Publications. The publications programme aims to make information available about existing projects, the situations to which they cater, their aims and objectives, their approaches, the materials they have produced and how far they have been successful in achieving their goals.

(i) New trends on integrated science teaching. This forms part of the Unesco series of publications: "The teaching of basic sciences". It contains information on integrated science teaching, mainly at the primary and junior secondary level, from all over the world, and the needs of developing countries have been particularly borne in mind. Volume I has just been published (May 1971) and pre-publication copies were available for review by the meeting. Mr. Richmond (Editor of this volume) presented the publication to the meeting. He indicated that this volume is intended for the use of teacher educators, curriculum developers and also interested teachers, to provide information concerning what is currently taking place in integrated science teaching throughout the world. He circulated a short questionnaire inviting comments on Volume I of "New Trends in Integrated Science Teaching" and suggestions for the contents of Volume II of this publication.

(ii) A revised edition of the Unesco Source-book for Science Teaching has been produced, incorporating much modern material and removing material which is outdated and impracticable. It will be published early in 1972 under the title "The New Unesco Source-book for Science Teaching". Dr. Lockard, Co-ordinator of the Committee which has carried out the revision circulated sample sections of this publication for inspection.

(iii) An annotated bibliography of integrated science teaching projects will be produced during the current biennium under contract with the ICSU Committee on Science Teaching.

(b) Conferences and workshops. Workshops on a regional or national scale are being organized to exchange information, to examine particular aspects of integrated science teaching and to study particular programmes. The first such meeting was held in Israel in August 1969, within the framework of the Rehovot Conference on Science and Education in Developing States(1). A national workshop was also held in Ghana in April 1970.

(1) Reference document "The Junior Science Conference - Final Report", Israel Science Teaching Centre.

The first Regional Workshop was held in the Philippines in August 1970, and included participants from 12 Asian countries. At this workshop, a plan of action was drawn up for the promotion of integrated science teaching in the Asian Region. In 1971-1972 four such regional workshops are planned: in Africa, Asia, Latin America and the South Pacific region.

Dr. Berlin and Dr. Saint-Rossy gave an account of the two regional workshops for English-speaking African countries which will be held in July and September 1971, in Nairobi (Kenya) and Ibadan (Nigeria) respectively. These workshops involve collaboration between Unicef and Unesco, both in their planning and execution and also in their financing. The Nairobi Workshop to be held at the Unesco Field Science Office, will be attended by those concerned with the formulation of education policy in all 17 English-speaking African countries. It will have a duration of one week and will be particularly concerned with education for rural development at the primary school level. Particular attention will be given to science teaching and related aspects of agriculture, health and nutrition. The workshop will evolve guidelines on which future national programmes can be based.

The Ibadan workshop, to be held at the Conference Centre, University of Ibadan, by invitation of the Government of Nigeria, will be concerned with the planning of specific teaching programmes in integrated science for African countries. It will review existing programmes in English-speaking African countries and make suggestions concerning ways in which these programmes may be extended and implemented on a wider basis. It will also produce specimen teaching materials.

(c) Pilot experiments on the development of new methods and materials for integrated science teaching. With a view to stimulating experiments in the development of different approaches to integrated science teaching, Unesco assistance is being given to several national working groups to develop methods and materials adapted to local needs. It is anticipated that these experiments will result in comparative data on the different approaches which, in due course, can be made widely available as resources to other groups working in this field. Examples of such national activities are as follows:

In Israel, teaching units in primary school science are being developed in a project at Tel Aviv University, which is linked with the Israel National Science Teaching Centre. Several major primary science projects, notably the Science Curriculum Improvement Study (U.S.A.) are providing resources for this project, but the materials being developed are essentially indigenous in nature.

In Ghana, an integrated science project has been established under the joint auspices of the Ministry of Education and the Ghana Association of Science Teachers(1). This project is concerned with both primary and secondary levels, and with the related teacher-training programmes.

In the Philippines work on the production of an integrated junior high school course has started at the Science Education Center at the University of the Philippines, in collaboration with the Ministry of Education. The teaching materials of the Intermediate Science Curriculum Study (Florida State University, U.S.A.) have been used as resources for this particular project.

Unesco's assistance to recognized working groups is made available in three principal ways:

(i) Teaching materials are supplied, which can be used as resources in the local development projects;

(ii) The services of short-term consultants are provided, many of whom are themselves involved in major science curriculum projects;

(iii) Contracts are entered into with the various working groups, which can make available the results of their work to Unesco for wider dissemination.

As Unesco's Regular programme funds for this project are very limited, countries are encouraged to seek additional assistance from other sources. To date, assistance from the following sources has been requested and provided:

(i) Where the project is associated with a science teachers association or similar body, a request for assistance may be made under Unesco's Participation programme.

(ii) Assistance with expert services and equipment can be provided by the United Nations Development Programme.

(iii) Assistance for equipment and for running in-service training courses may be provided by Unicef.

(d) Technical services. At Unesco Headquarters, a briefing room is maintained at which integrated science teaching materials, embodying modern approaches are displayed. Unesco science teaching experts and others visiting Unesco are briefed on these materials and approaches on their way to field assignments. They may be provided with additional information when they are established in the field. Supporting services are

(1) See reference document "Report on the Workshop on Science Education sponsored by the Ghana Association of Science Teachers in collaboration with Unesco and the Ghana Ministry of Education".

also being provided in cross-disciplinary areas such as science teaching equipment and science teacher training. These services, while being concerned with a broader area of science teaching than integrated science alone have particular application to the integrated science teaching programme, as it is at the earlier levels of science education that problems such as supply of appropriate equipment and of adequately trained teachers are particularly acute.

IV. MAJOR TRENDS AND PROBLEMS IN INTEGRATED SCIENCE TEACHING

A review was undertaken of some of the major trends and problems in integrated science teaching. Three issues were selected for special consideration. There were:

(a) The concept of integrated science teaching

(b) The learning process and the teaching of integrated science

(c) Teacher education for integrated science.

(a) The concept of integrated science teaching has developed progressively. It appears to be universally agreed that at the primary school level it is natural and desirable. It was felt that the adjective "undifferentiated" applied to science teaching at this stage is particularly appropriate. Whether a course is "process" or "concept" oriented, whether the teaching material is organized on a modular basis or as a sequentially structured curriculum, in practice subject matter is drawn, as appropriate, from many areas of the scientific field, and the young child is not burdened with considerations of whether he is learning "biology" or "chemistry" at any particular moment. Indeed, in many scientific studies of a "project" nature he may be utilizing ideas drawn from several sciences during one particular topic or study. It should also be noted that there is a strong trend in several countries towards a totally integrated primary school curriculum.

At the secondary school level, there is much less unanimity as to the level at which the teaching of science could be split up into the separate disciplines. There seems to be a trend in many countries, however, towards as much integration and co-ordination in the teaching of science as is feasible, and a growing awareness that compartmentalization in the teaching of science is undesirable, particularly at the lower secondary level.

Different curricula use different integrating factors and it is difficult to state categorically whether a particular science curriculum is "totally integrated" or only "partially integrated", the extent to which integration is achieved in practice often depending on the individual science teacher. It was felt that it might be more valuable to refer to an "integrating principle" in science teaching, rather than to speak of "integrated science" as such. It was suggested by Mr.Blum that, as an aid to classifying any particular programme with regard to the extent

to which it was integrated, one could establish an "integration matrix", with "scope" and "intensity" of integration as its two dimensions. The purpose of this matrix would be to show where a particular programme stands as to integration. It could not give information about other facets of the curriculum, although there are quite a number of facets, which should be defined, when a curriculum is described.

The intensity dimension could be considered as a continuance or could be split up into three degrees of intensity: "co-ordination", "combination" and "amalgamation". Co-ordination would usually apply to independent programmes taught simultaneously, which were influenced to a varying degree by a common agency e.g. an educational authority or a planning committee. A combined science programme would have chapters or other major units organized round headings taken from the different disciplines, whereas in a truly amalgamated programme on interdisciplinary topic or issue would form the unifying principle at the chapter level. (see Fig. 1).

Many integrated science programmes emphasize their constituent content fields differently. For example both Harvard Project Physics and the Physical Sciences Study Committee materials integrate some elements from chemistry, but without treating it systematically. This aspect could be demonstrated in the Integration Matrix by using a thick line for the main content fields and a thinner line for the units from outside this field, which were integrated, and which are different in these two projects (fig. 2).

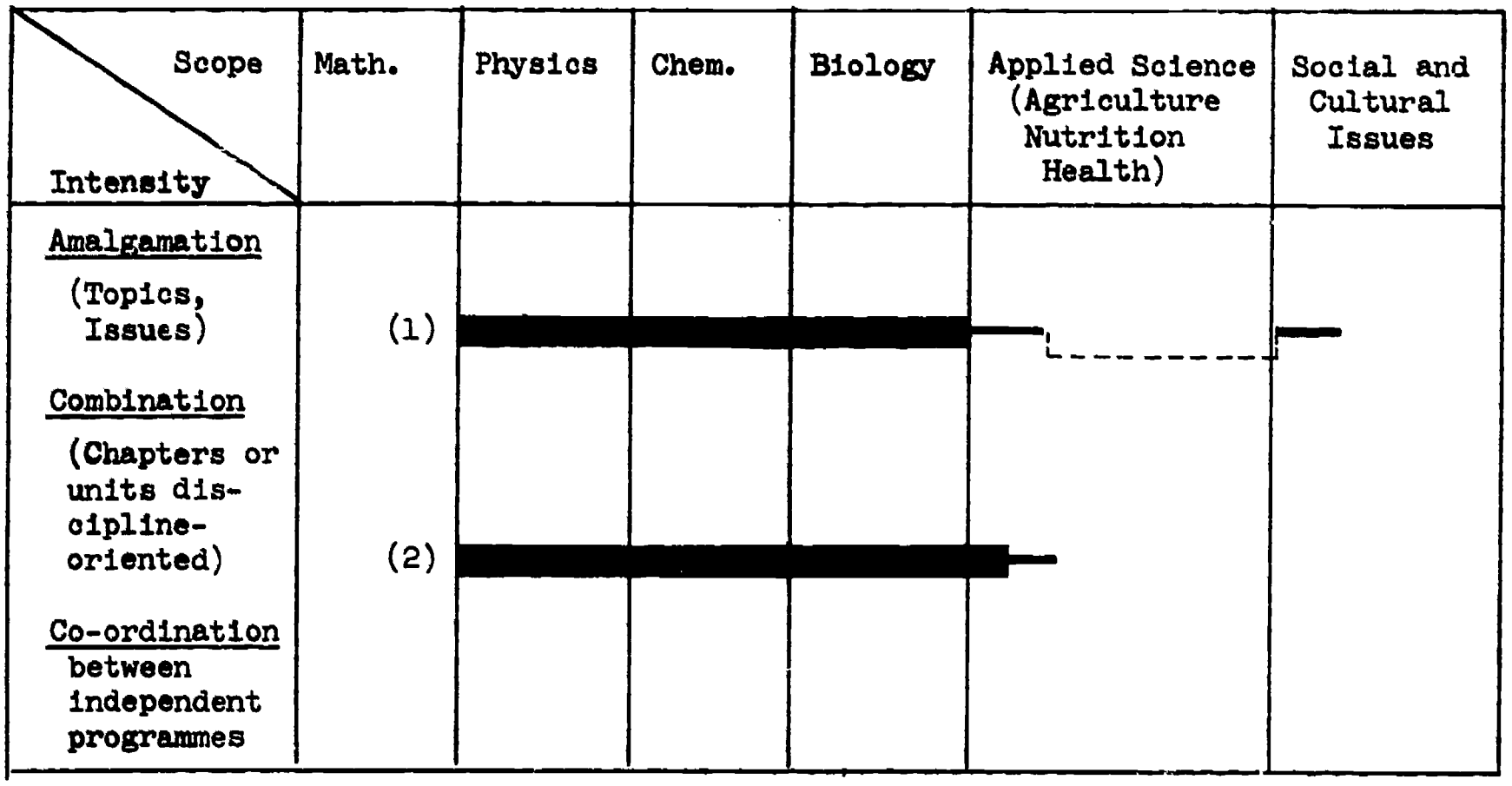
The scope dimension would cover the range of the scientific disciplines, passing from the natural sciences to the applied sciences and the social sciences. In most cases teaching programmes in science integrate adjacent disciplines, but quite often the integration would also be between elements which do not belong to adjoining content areas. This kind of integration could be shown, in the matrix, by a thin connexion line, as in the case of Harvard Project Physics (Fig.2).

It would be difficult to show the "integrating factor(s)" of a particular programme on such a matrix, because these factors do not form a continuity of any sort. Some of them belong to the intensity dimension (topic, issue) and are intrinsically linked with integration. Others, such as "process" can also be used as the organizing principle in discipline-centred curricula. It would also be difficult to show the facet of "flexibility" on the matrix. Two programmes with identical content and identical focus on the matrix could differ very much as to their flexibility. One of them might be highly structured, such as most current Israeli programmes, the other highly flexible, such as the British "Science, 5-13", or the "Schools Council Integrated Science Project". The Australian approach of structured modules would fall somewhere in between.

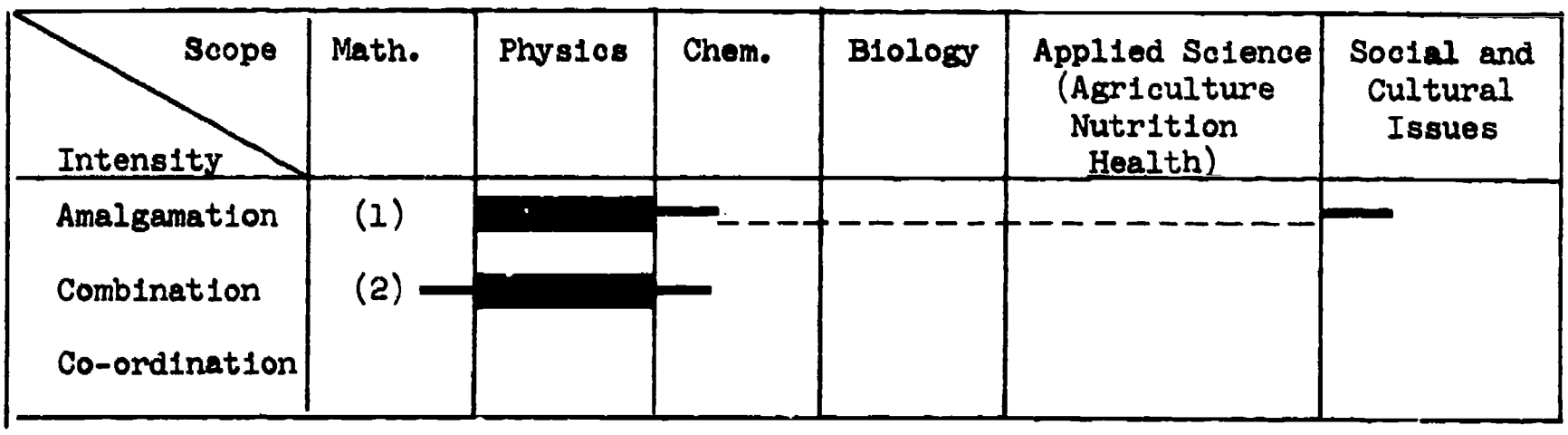
With regard to teaching approaches, which also cannot be shown on the matrix, many "labels" for integrated curricula are currently in vogue, such as "process", "concept", "environment", "inquiry", "relevance" etc. In practice, as science is both a process and a body of knowledge, most current programmes contain something of all these approaches, but the extent to which a particular approach is emphasized varies from one programme to another. Clarification of

Figures

Projects: (1) Schools Council Integrated Science Project, U.K. Fig.1
(2) Tel Aviv Elem. Science Teaching Project, Israel



Projects: (1) Project Physics, U.S.A. Fig.2
(2) Physical Sciences Study Committee, U.S.A.



the "teaching approach" description of any particular programme is needed. Questions need to be asked such as "how much of a particular approach (e.g. process) is used in a specific curriculum?" "How much weight is given to concept formation?" etc. This clarification is needed by those agencies, such as Unesco, which act as disseminators and stimulators of integrated science programmes. It is also needed by those who study curricular approaches for possible adaptation.

(b) The learning process and the teaching of integrated science. The importance of the need to understand more fully the learning process in connexion with science teaching was stressed at the Planning Meeting for Unesco's Programme in Integrated Science Teaching(1). Of particular importance is a paper on science education "The Learning Process and the Teaching of Science and Mathematics" prepared for the United Nations Advisory Committee on the Application of Science and Technology to Development at its eighth session in November 1967. The second report of the United Nations Advisory Committee emphasized the importance of research in the learning of science and indicated the need for a major programme in this field. The need for such a programme was endorsed by the meeting. It was felt that, as a start, information should be collected concerning studies on the learning process which have been carried out and which have a bearing on science teaching, particularly in developing countries. This information could be disseminated both through publications and through meetings of research workers in the field. It was noted that several examples of such studies are included in Part III of New Trends in Integrated Science Teaching, Vol. I. A bar to learning science in many countries is associated with language questions, particularly where there are no words in a particular vernacular language for certain key scientific concepts. This is an important area for research.

(c) Teacher education for integrated science. Throughout the meeting teacher education, both pre-service and in-service, was seen as the key to implementation of integrated science teaching. Unless effective teacher education programmes are put into operation, science teaching that is integrated is unlikely to take place in the schools.

In preparing primary school teachers, the major problem is the introduction of suitable science courses into the training colleges. Training college science courses are often modelled on those of secondary schools and may be too academic in approach to meet the needs of prospective primary school teachers. They may also be organized along "disciplinary" lines. There may be little relation between the teaching methodology practised in the science courses and that advocated in the "educational methodology" courses. Many primary school teachers are required to teach science when they, themselves, have never studied the subject or its teaching methodology. Experience in several countries represented at the meeting - notably Ghana, Malaysia, the United Kingdom and the United States has shown that even for such teachers, in-service courses can be effective if the teachers are well-motivated.

(1) See reference document SC/MD/13 page 7

Teachers at the secondary level may have followed science courses in colleges or universities which have been discipline-oriented, or they may be specialists in one scientific discipline only, and not feel themselves competent to teach courses which cover a broader range of the sciences. It was agreed that greater interdisciplinarity is needed in the university and college training of secondary school teachers.

The meeting welcomed the proposed conference on the training of teachers for integrated science (see Section IIIc) and hoped that these questions would be considered in depth at this meeting.

V. PROPOSALS FOR UNESCO's FUTURE PROGRAMME

(a) General lines of action

Unesco's rôle was seen as that of an "internationalizer" and "catalyst" as far as integrated science teaching is concerned. Unesco should encourage those involved in integrated science teaching, in both developed and developing countries to be aware of the existence of an international information network in this field, and should work actively to strengthen and extend this network. The participants at the meeting, all of whom are involved in Unesco's programme, are aware of the existence of this communications network. However, many project leaders are still working in semi-isolation. Projects leaders should, from the start of a project, be made aware that there is much in the way of resources that can be drawn upon, and that their project ideas and materials are likely to be of interest and relevance much more widely than their initial terms of reference may envisage. Unesco should, in collaboration with other international agencies and regional organizations working in the field, and, where appropriate, with bilateral aid organizations, help in developing this awareness, through a programme of publications, meetings, visits and advisory services. Unesco should also help to promote promising activities in developing countries, through direct assistance of various types (financial, personnel etc.) provided through Regular programme or extra-budgetary sources, at the request of the country concerned.

(b) Modes of operation

In order to be more effective in this rôle, Unesco's capability should be increased to operate in the following ways:

(i) Communication. Experience has shown that education authorities in most countries are ill-informed about the nature of integrated science teaching and its educational possibilities. They are also lacking in information concerning what programmes and resources are available and which, among the various alternatives, are likely to be best suited to their own particular situation and needs. Unesco needs to be in a position to communicate effectively on such matters as:

the concept of integrated science teaching;

the characteristics of particular programmes - their aims and objectives, philosophical and psychological basis;

the distinctions between the various programmes - their similarities and differences;

which programmes are likely to provide the most useful resources for particular local needs.
(see also Part IV (a))

Such information should be communicated in collaboration with others working in the field, for example, the International Clearing-House on Science and Mathematics Curricula of the University of Maryland, the ICSU Committee on Science Teaching and, at the regional level, the Science Education Programme for Africa.

It was suggested that countries also need examples of teaching materials embodying particular approaches, as well as descriptions of them. Trial materials may also have an on-going commentary which may be extremely useful. While it would be difficult for Unesco to organize the exchange of actual materials to any great extent on a world-wide basis, regional activities could be extremely useful, especially if associated meetings on a regional basis were also arranged. To implement this suggestion, at least one Unesco-supported clearing-house for integrated science teaching would be necessary in each geographical region - Africa, Asia, Latin America and the Arab States.

Other suggestions that were made were:

Organizing an international workshop to examine the problems of adapting materials designed for use in a particular environment to other situations.

Supporting, through fellowships and study tours, the visits of project leaders from one country to projects in other countries. It was noted that visits from one developing country to another are particularly worthwhile. In practice such visits tend to be from "developing" to "developed" countries.

(ii) Advisory. Unesco's capability must be increased to advise countries on all aspects of the development of integrated science teaching programmes. Such advice must be provided in the light of experience gained through the field programme and as a result of the analysis of such experience. Advisory services must be available:

Through Headquarters services,
Through the services of regional offices and centres,
Through the services of national centres, resident advisers and short-term consultants,
Through periodic reviews on an international or regional basis, at which guidelines for future action in this field are developed.

(iii) Operational. Unesco's experience in the discipline oriented projects, and in the integrated science teaching programme, to date, has been largely in the operation of projects which were of a pilot nature only. Unesco's capability needs to be increased to assist countries at all stages of operations, from producing initial materials, through their trial and testing, to eventual implementation in the schools. Unesco also needs to be able to assist with the operation of complementary programmes in areas such as science teacher training and science equipment production. The links between the teaching of integrated science and related areas, such as technology teaching, health education and environmental education also need to be strengthened.

Much of this operational programme will be carried out through extra budgetary sources, and in close collaboration between several departments or divisions of Unesco and with regional offices. Unesco's Regular programme activities such as publications and workshops must be planned in relation to the needs of the operational field programme and with a view to strengthening Unesco's operational capability.

(c) Specific activities

As indicated in section (a) above, the meeting endorsed the on-going programme of publications, conferences and workshops, visits and advisory services and assistance to pilot experiments on a national basis. It considered that this programme should be extended in scope and in geographical coverage. The meeting suggested that the following specific items should be included in Unesco's future programme.

(i) Publications

1. Volume II of "New Trends in Integrated Science Teaching", to be published in 1973. Preparations for this volume should start immediately, so that the delay between the appearance of Volume I of the publication and Volume II should not be too great. An editorial board for the preparation of this volume would be convened by the ICSU Committee on Science Teaching, under contract with Unesco. The meeting endorsed, in general, the idea that this volume should follow the new pattern of the series "The teaching of basic sciences" and should consist of a series of articles surveying the "state of the art" in major areas in integrated science teaching. However, it was recognized that some difficulties might be encountered in an immediate change to the new pattern. Volume II of "New Trends in Integrated Science Teaching" would, therefore, to some extent, be "transitional" in character, representing the change from the old pattern to the new.

2. "Teachers Handbook for Integrated Science Teaching", to be published in 1973. Preparations for this volume would also start immediately. The handbook, which would be written for the use of practising teachers as a complement to the "New Unesco Source-book for Science Teaching", should include among its contents a clear statement of the concept of integrated science teaching, an analysis of the various approaches to integrated science teaching in operation, and guidance for the teacher on how to teach integrated science.

3. "The Education of Teachers for Integrated Science", to be published in 1974. This publication would follow the "Conference on the Education of Teachers for Integrated Science" to be held at the University of Maryland in April 1973 under the auspices of the ICSU Committee on the Teaching of Science. It would embody the main ideas presented at the Conference, and would include a selection of the conference papers.

4. A series of monographs on different approaches to integrated science teaching. The publication of such a series, drawing on the experience of the various Unesco-assisted working groups in integrated science teaching, should be foreseen in Unesco's long-range programme. (see also Section (iii) below). Each monograph should contain an analysis of the project itself (how it was set up, how its materials were developed, etc.). It should also provide examples of teaching materials developed by the particular project, together with a clear description of the teaching approach intended to the material.

5. Collections of articles on integrated science teaching. It was considered that, once the 4-year cycle of "New Trends in Integrated Science Teaching" in its new format had been launched, it might be desirable to compile collections of articles on integrated science teaching reprinted from science teaching journals at yearly or two-yearly intervals.

(ii) Conferences and workshops

1. At the international level, Unesco support for the "Conference on the Education of Teachers for Integrated Science" (see section (i) 3 above) was welcomed. It was envisaged that Unesco assistance would take the form of providing travel grants for participants from Africa, Asia, Latin America and the Arab States, as well as direct participation in the Conference itself, and in its preparation.

2. The suggestion of holding a meeting for the purpose of forming an "International Federation of Science Teachers Associations", which would ultimately qualify for the status of a non-governmental organization with Unesco, was welcomed. It was noted that this meeting was likely to follow immediately the "Conference on the Education of Teachers for Integrated Science", and also to be held at the University of Maryland. Although such an activity does not fall directly within Unesco's integrated science teaching programme, it was noted that, in practice, many science teachers associations are active in promoting integrated science teaching and that, in several African countries, the sponsorship of the national project for integrated science teaching is carried out by the Science Teachers Association. The meeting also noted that, in preparation for this activity two small consultations of Science Teachers Associations would be held during 1972, one in Africa and one in Asia.

3. Future regional workshops should be held to extend the geographical coverage of the programme. It was noted that a regional workshop will be held in Latin America in 1972, and it was suggested that regional workshops should be held in the Arab States and Africa (for French-speaking countries) during

1973-1974. Such workshops should be concerned with reviewing current developments in integrated science teaching in the particular region, and with drawing up suggestions for the promotion and implementation of programmes of integrated science teaching in countries of the region, as far as possible, on a collaborative basis among these countries. It was recommended that the reports of such workshops should be given as wide publicity as possible, and that follow-up programmes should be encouraged through Unesco and Unicef Regional Offices and by Unesco experts serving in the participating countries. Collaboration with regional programmes, such as the Science Education Programme for Africa, should be fostered in the organization of the workshops themselves and in the follow-up programmes. It was also felt desirable that working on a collaborative basis with other units in Unesco and with other interested agencies, related programmes should be developed on a regional basis which emphasize the science teaching aspects of:

pre-school education,

agricultural education,

health and family life education,

education to rural development.

4. Sub-regional workshops should also be held for neighbouring groups of countries, such as countries in South East Asia and the Caribbean. Such workshops should be focused on specific problems and topics such as testing and evaluation in integrated science teaching, or on the production of prototype materials which could be adapted in appropriate ways for use in each participating country. These workshops should also be conducted in close collaboration with other bodies and institutions with similar concerns, such as the Regional Centre for Education in Science and Mathematics of the South East Asia Ministers of Education Secretariat (RECSAM).

(iii) Support to pilot experiments on a national basis for the design and testing of new methods and materials for integrated science teaching should continue. Particular attention should be given to the preparation of materials for teacher education. Assistance should be extended to countries in Latin America and the Arab States as well as to on-going projects in Africa and Asia. The results of such projects should, in due course, form the basis of a series of Unesco-published monographs (see section (1) 4). Close collaboration should be maintained with Unicef, with other international agencies, and with bilateral agencies such as CEDO, the British Council, USAID etc. in carrying out these activities.

ANNEX I/ANNEXE I

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Mrs. S.M. Haggis	Division of Science Teaching, (Secretary-General of the Meeting)
Miss C. Fonsale	Division of Science Teaching, Secretary

ANNEX II

A G E N D A

1. Opening of the Meeting

2. Review of current developments world-wide in integrated science teaching

   (a) National activities:
   - U.S.A. projects
   - Australian projects
   - U.K. projects
   - Malaysian project
   - Ghana project
   - Nigeria project
   - Israel projects

   (b) Regional activities:
   - African primary science project
   - Caribbean project

   (c) International activities:
   - Report of the ICSU Committee on Science Teaching

3. Review of Unesco's current programme in integrated science teaching

   (a) Publications:
   - New trends in integrated science teaching
   - Unesco source-book for science teaching

   (b) Conferences and workshops

   (c) National activities

   (d) Advisory services

4. Major trends and problems in integrated science teaching

   (a) The concept of integrated science teaching

   (b) The learning process and the teaching of integrated science

   (c) Teacher education for integrated science

5. Proposals for Unesco's future programme

   (a) General lines of action

(b) Modes of operation:
Communication
Advisory
Operational

(c) Specific activities

(d) Links with other organizations.

6. Conclusions and recommendations.

ANNEX III

Documents presented at the meeting

1. Co-ordinating Meeting for Unesco's Programme in Integrated Science Teaching, Working Paper.

2. Report of the ICSU Committee on Science Teaching.

3. New trends in integrated science teaching; editor's report.

4. Revision of the Unesco Source Book for Science Teaching, Chairman of Revision Committee's Report.

5. Report of Planning Meeting for Integrated Science Education Workshops in Africa.

Background information documents

1. Final Report of Planning Meeting for Unesco's Programme in Integrated Science Teaching, Paris, March 1969.

2. Report of the Junior Science Conference, Israel 1969.

3. Report of the Workshop on Science Education, Takoradi, Ghana, 1970.

4. New trends in integrated science teaching.

5. Suggested outline of a Unesco assisted experimental integrated science education project at the junior secondary school level, by A.W. Torrie, Unesco, India.

6. Where is education heading? by J. Piaget.