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ABSTRACT

The major purposes of this workshop were to develop teaching and learning materials on certain selected key biology concepts relevant to environmental, genetic, and agricultural aspects, and to develop exemplary training materials on certain teacher competencies relating to laboratory and field techniques. Chapter One reports on the status and problems of biology education in India, Malaysia, Nepal, Pakistan, Sri Lanka, and Thailand. Topic areas considered are biology in the school curriculum (including biology content and curriculum development efforts), instructional and curriculum materials, teacher competencies, and teacher education. Chapter two considers new trends in biology education, such as a shift from teaching botany and zoology as separate subjects toward a unified course of life sciences. The contributions that biology can make toward environmental education programs and the design of instructional materials for students and for teachers are also considered in light of the trends identified. Chapter three provides short descriptions of three teaching and training units. Topic areas of these materials include practical/laboratory techniques for teaching environmental factors, freshwater ecosystem and water pollution, the cell cycle, environmental biology utilizing field studies, types of variations, and the possibility of gamete formation in a dihybrid cross. (JN)

Asian Programme of Educational Innovation for Development **APEID**

DEVELOPING MATERIALS FOR BIOLOGY TEACHING

Report of a Sub-regional Workshop

Bangkok, 3-12 August 1981

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INTRODUCTION

Background

In pursuance of Resolution No. 1/01 of the General Conference of Unesco adopted at its twenty-first session, the Unesco Regional Office for Education in Asia and the Pacific (ROEAP), through its Asian Centre of Educational Innovation for Development (ACEID), organized the Sub-regional Workshop on Biology Education at ROEAP, Bangkok, from 3 to 12 August 1981.

During 1980 Unesco had organized a Regional Workshop to Review Biology Education in Asia which was held at the Science Education Centre, University of the Philippines, Quezon City. The Regional Workshop had reviewed biology education in Asia at the secondary level focusing on three main aspects, namely, environmental, genetic and application of biology to health, nutrition and agriculture. In addition, it also identified teaching competencies for biology teachers to handle the new topics increasingly finding place in biology curricula of various participating countries.

The Regional Workshop identified the various concepts, principles, topics, practical experiences, teaching/learning strategies, values and skills which could find place in a secondary school biology programme in respect of the three aspects which were the concerns of the Workshop, and suggested the need for developing teaching/learning and training materials for these topics.

Purpose of the Workshop

The Sub-regional Workshop which was a follow-up of the Regional Workshop to Review Biology Education in Asia, had the following main purposes:

i) To develop teaching/learning materials on certain selected key biology concepts relevant to environmental, genetic and agricultural aspects; and

ii) To develop exemplar training materials on certain teacher competencies relating to laboratory and field techniques.

Participation

Seven participants, one each from India, Malaysia, Nepal, Pakistan, Sri Lanka and two from Thailand, participated in the Workshop. In addition, the Regional Adviser on Environmental Education, ROEAP, and the Science Education Specialist from ACEID, also participated in the Workshop. Some sessions of the Workshop were also attended by observers from the Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok. The list of participants is in Annex I.

Opening of the Workshop

Mr. Raja Roy Singh, Assistant Director-General, Unesco ROEAP, welcomed the participants and [illegible]d them and their governments for accepting Unesco's invita[illegible]e indicated that though in the developed countries a variet[illegible] are being used to get science to the people, in the countr[illegible]is region it is mainly the formal education systems th[illegible] deal with this problem. For this reason the science teach[illegible]mmes in our countries have to focus on two main tasks, fir[illegible]get science permeate into the daily life of the people by d[illegible]ing scientific attitudes and outlook in our societies through h[illegible]g children understand what science means, what it can do, and wh[illegible] it cannot do. Secondly, to get the new thrusts in science into our teaching with emphasis on the elements of 'uncertainties' and 'creativity'. He further pointed out that the science that we are teaching is not of today, or even of yesterday. We are mostly preoc[illegible]ied with transmitting the established knowledge. What we have [illegible] look for is the creative edge to science teaching and for this, biology lends itself very well as in biology we are dealing with science of tomorrow. He wished the participants all success in their co-operative endeavour in developing instructional materials which will support the development of competence and creativity in science.

Dr. M.C. Pant, Science Education Specialist, ACEID, explained to the Workshop its procedure and schedule of work and what various past activities under APEID had achieved in the area of instructional materials development.

Officers of the Workshop

The Workshop elected Dr. M. Arslan (Pakistan) as Chairman and Dr.(Mrs.) S. Bhattacharya (India) as Rapporteur of the Workshop. Dr. M.C. Pant (ACEID) assisted the Workshop as its Secretary.

Method of work

After election of the officers, the Workshop considered its agenda and schedule of work and approved these with modifications.

During the next two plenary sessions, the Workshop decided to discuss the position of biology teaching in the participating countries and various problems and issues encountered in developing new biology teaching/learning programmes with particular reference to the nature of instructional materials that are being used and the innovations that are beign attempted in this regard.

During the next four plenary sessions, each participant presented his draft teaching/training unit and general comments were made by other participants for making improvements in the units. The Workshop then assigned each unit to one of the participants (other than the author) for making a detailed critique and propose changes in the draft to improve its effectiveness. This exercise was followed by work in small groups for further improvements over the ones made by individual critics. The revised drafts were then considered in two plenary sessions for finalization.

The Workshop decided that as the teaching/training units would be printed separately after further editing, an abstract of these units should be given in the report to enable the readers to know what these units contain and how they can be used in biology teaching.

In the concluding session, the Workshop considered its draft report and adopted it with certain modifications which have been incorporated in this final report.

Chapter One

POSITION OF BIOLOGY TEACHING AND RELATED INSTRUCTIONAL MATERIALS

India

Biology in the school curriculum

In India, the 10+2 system of school education has been adopted by the central government. A few States, however, still have the 11-year school system. According to the 10+2 system, the first ten years are general education, with science as a compulsory subject in the curriculum. The +2 stage is divided into science, commerce, or humanities streams.

In the science curricula developed by the National Council of Educational Research and Training (NCERT), biology forms a part of 'Environmental Studies' at the primary level (classes I-V), 'Integrated Science' in the middle schools (classes VI-VIII), and 'General Science' at the secondary level (classes IX-X). At the +2 stage, biology is taught as a separate subject. The biology component of the curricula at all stages is highly environment based, and has strong components of health, nutrition and agriculture. Furthermore, genetics and cell biology are important components at the higher secondary stage (+2 stage).

The most important change in the teaching of biology has been that instead of treating botany and zoology as separate subjects, the content is presented as 'Life Sciences' at the secondary and as 'Biology' at the higher secondary stage, thus stressing unity rather than diversity amongst living organisms. Another aspect which deserves mention is the introduction of investigatory experiments or projects at the higher secondary level. This was introduced with an idea to expose students to the methodology of tackling problems scientifically and to develop creativity.

Instructional materials

The NCERT has developed syllabi and textbooks for all stages of school education. The textbooks produced by NCERT are well illustrated and in two languages, English and Hindi. The States which use the NCERT books are permitted to translate them into the regional languages. The language, especially the technical terms in regional languages, often poses difficulties. To overcome this, the Hindi version of the NCERT textbooks gives the English equivalent in parenthesis.

Besides the textbooks, NCERT has also produced teacher's guides and test items for each class. The teacher's guide clarifies for teachers the concepts given in the textbook; gives details of activities which can be used for improved teaching/learning of the concept; highlights the points to be emphasized; and gives a list of additional reference material for teachers, including books and audio-visual aids. The test items, based on objective methods of evaluation, include a variety of questions on each chapter which test knowledge, understanding and skills, and enables the teacher to construct proper tests with minimum effort. Currently, efforts are being made to produce activity-oriented workbooks for the various classes. Kits for demonstration are also developed and manufactured by NCERT, especially for the lower grades.

NCERT has also produced a number of low-cost supplementary readers related to various topics included in the biology course which are of use both to the teachers and students. Furthermore, NCERT has also produced charts, films, filmstrips and tape-slide sequences, both for teacher training as well as for classroom use.

Teacher competencies

The introduction of the new trends in biology education, with stress on values and social relevance, has put the teacher and the teacher education system under stress. The teacher at all levels are products of the conventional education system, and face great difficulties in trying to comprehend these modern trends. A teacher, for instance, at the higher secondary level is almost always a conventional M.Sc. in either zoology or botany, with a Bachelors degree in Education. The latter courses include mostly pedagogic aspects with very little science content. With such a training, he finds it difficult to deal with the whole spectrum of biology topics as prescribed for the higher secondary level, which includes genetics, cell biology, agriculture, health, ecology, and industrial microbiology. Also, the specialization in one subject, either zoology or botany, prevents him from having practical skills in the other areas, and one often finds that inexperienced teachers who are Botany M.Sc.'s are unable to cope with dissection and other zoological techniques confidently, or vice-versa.

The fault does not lie with the teachers, but the education system in the colleges and the universities. While the curricula in the schools have been updated, colleges still have the old-fashioned curriculum, with botany and zoology as separate subjects, and areas such as health and nutrition, and agriculture not forming a part of the subjects. The solution therefore lies in the improvement of the teacher training programmes, both pre-service and in-service. This is by no means an easy task when one considers the vast number of teachers in the country.

The NCERT, in an effort to update the teachers, has started a series of enrichment courses in new biology for teacher educators and key persons from the States, with the hope that this will have a multiplier effect in updating teachers. About 15 teacher

educators are trained in a two-week course on the new trends. The course content is the same as for teaching secondary and higher secondary biology. The stress is mainly on the practical experiences and use of the environment for teaching biological concepts, especially ecology. Other areas covered include teaching strategies like use of newspaper cuttings for teaching about environmental problems, discussions on social relevance, value education. It is hoped that within a short time, it will be possible to have trained key persons in each State who, in their turn, could update the biology teachers of secondary schools in their State.

Furthermore, the Regional Colleges of Education (RCE) under NCERT also have correspondence-cum-contact courses for pre-service training of teachers, for which distance teaching materials have been developed. The RCE at Bhubaneswar also offers a M.Sc. Education degree, wherein the course includes the biology content at the M.Sc. level plus the pedagogic aspects of education. These efforts, however, are only a beginning for solving the problem of updating the vast number of teachers, and producing better oriented teachers in the future.

Malaysia

Biology education in the school curriculum

Malaysia has six years of primary education, followed by three years of lower secondary and two years of upper secondary education. The post-secondary or pre-university education is of two years' duration.

At the primary level, the environment is utilized as a medium for instruction, where pupils are encouraged to study science from the environment. Various biological concepts are included in the scientific concepts studied from the environment. At the lower secondary level, biology is part of the integrated science syllabus, which is a three-year course. Basically, these nine years are geared towards providing a science education in the context of a general education.

At the upper secondary level, biology is taught as part of general science for the arts stream pupils, and as a separate discipline for the science stream pupils. The science curricula at this level are structured in such a way as to provide a continuity with the lower secondary science programme.

At all these levels, the teaching-learning strategies emphasize inquiry-oriented and activity-based approaches. Besides content, the new science curricula focus on processes of science and their application to everyday life. The investigatory mode of teaching-learning leads to conceptual understanding and the ability on the part of pupils to relate the science learnt in the classrooms to real-life situations.

In the context of social relevance of the biology curriculum, the content includes, among others, elements of environment, health, nutrition and genetics. Due emphasis is given in the biology curriculum to concepts in ecology and microbiology.

Curricular materials

The science curricular materials include those for pupils and teachers. Pupil materials include worksheets, textbooks and reference materials. The worksheets for the lower secondary level and the textbooks at the upper secondary level include, among others, sufficient activities which generally were not the feature of the old textual materials, and probing questions, a feature not present in classical textbooks, to encourage inquiry-oriented teaching-learning. Teacher materials include teacher's guides and a comprehensive apparatus list for each curriculum. In addition, there are three issues per year of the science newsletter for teachers. These are sent free to all schools. Teachers are encouraged to contribute articles to this newsletter, and thus share their ideas with other teachers.

Teacher education

In-service education has been and is being provided for science teachers to expose them to the curricular innovations. Such in-service courses enable the teachers to familiarize themselves with the teaching-learning strategies of these science curricular innovations. Such in-service courses were run at the national level to begin with, and later, conducted at the State level. The pre-service education of teachers at the teachers' training colleges and the faculties of education in the universities have also taken into consideration these innovations in the science curricula.

Since 1977, in-service courses have been conducted for key science teachers to enable them to update themselves professionally in various aspects such as classroom testing techniques, curriculum evaluation, and laboratory management, to name a few. These key teachers in turn would be involved at the state level for the professional development of teachers there. This mode of in-service education for teachers would help gear it to the specific needs of teachers.

Nepal

Biology in the school curriculum

School education in Nepal is divided into three stages: Grades I to III primary, Grades IV to VII lower secondary and Grades VIII to X secondary. Science is taught as a compulsory subject from Grades IV to X. The science course is offered as a course of 'general science' where biology is one of the elements. The other elements being physics and chemistry.

Biology is further organized under two main parts: botany and zoology. In zoology portion, the focus is on animals with or without backbones as well as the cell and its structure. In botany, the texonomical classification of plants occupies the major course content. The Government has however recently decided to reorganize the school structure with a five-year primary stage, two-year middle stage and three-year secondary stage. Science would be compulsory

only in Grades IV to VIII and will be optional in Grades IX and X. The major change in general science for Grades IV to VIII will be the integration of health education elements with general science.

Content of biology

In Grades IV and V at the primary stage, biology concepts are introduced as 'nature study'. Plants and animals are studied as the living things; different kinds of plants and animals and how they grow and reproduce; distinction between plants and animals; flowering and non-flowering plants.

At the middle school stage, the study of plants and animals continues with focus on interdependence of living things and the environment. Structures are studied in some detail and study of micro-organisms is also introduced.

At the secondary level, the structure of cell and its functions, difference between plants and animal cells, tissues and organs, life cycle of certain animals and plants and life processes is taken up. In addition, the useful plants and animals of Nepal are emphasized to make biology more meaningful for real-life situations of the country.

In the revised curricula, some modern topics such as mitosis; life processes such as movement, nutrition, respiration, reproduction; eco-systems; growth of population; and conservation of environment; are being introduced.

Instructional materials

The development of curriculum and instructional materials is the responsibility of the Curriculum, Textbook and Supervision Development Centre of the Ministry of Education. Curriculum is designed and developed by subject specialists of the Centre and reviewed by subject committees and approved by a co-ordinating committee. The textbooks are developed by individual authors who are invited by the Janak Education Materials Centre to prepare the manuscripts based on the curriculum developed by the centre. The Centre is responsible for the review of the manuscripts. Constant attempts are being made to improve the textbooks both in terms of their content as well as presentation and get up.

Shortage of science equipment has continued to be a major problem and to overcome this, as well as to make science teaching more activity-based, extensive programmes of developing low-cost teaching materials have been organized and teachers trained for the purpose. Recently a handbook to help the teachers has been prepared.

Teacher training

Pre-service training is provided at various campuses of the Institute of Education, which also undertake in-service training as and when necessary. Shortage of qualified and trained teachers has been an acute problem in Nepal and it was due to this reason that recently a policy decision was taken to make science optional in Grades IX to X till such time as qualified and trained science teachers are available to staff, particularly, the rural high schools.

Pakistan

Biology curriculum

Biology is a component of the integrated science course from Classes I to VIII. Students entering the secondary level (classes IX and X) are required to make a choice between the humanities and science group of courses.

Students taking up humanities at the secondary level have to study general science for two years which includes topics of biology.

Science group students study biology in addition to physics and chemistry, as a separate subject. Science students completing two years at the secondary level may continue to study biology at the higher secondary level (classes XI and XII). This prepares the student to enter university education or professional education mainly in medical, biomedical, veterinary or agricultural fields.

The curriculum is designed by the Federal Ministry of Education (Curriculum Wing) whereas the textbooks are developed by the Provincial Textbook Boards. In addition, there are Provincial Curriculum Bureaus, which in collaboration with the Textbook Boards, are responsible for the production of teacher's guides. The provincial agencies are supposed to relate the concepts contained in the curriculum to local environment, when developing a textbook.

In the recent years, steps have been taken to introduce and modernise biology curricula at the elementary and secondary levels.

Biology education at the secondary level

The curriculum: The biology curriculum for secondary science education gives an idea of the topics and the concepts to be introduced at this level. There has been a tendency to include in the curriculum maximum number of topics, most of which are descriptive in nature, dealing with diversity in animals and plants. It is felt that more emphasis should have been given to those concepts which are desirable to be introduced at this stage. Some of the topics/concepts requiring more attention would include cell structure and elementary cell physiology, cell cycle, heredity material, genetics, transfer of genetic information, modes of reproduction and growth, developmental biology and environmental biology. It is desirable that morphological aspects be dealt with in relation to functions.

In the present syllabus, consideration has been given to the study of interrelationships of 'organisms and their environment' and to 'biology and human welfare'. However, attempts to relate biology to everyday life have so far failed to make a visible impact.

Instructional materials: Since the development and writing of textbooks is the responsibility of an independent agency, the concepts contained in the curriculum may not be translated adequately in textbooks and the very objective of the curriculum designing may thus be frustrated.

The current textbooks for the secondary level are deficient and defective in many respects. The descriptive part at many places has been made unnecessarily complicated and involved. The same facts can be started in a more simple and lucid style. The text contains numerous mistakes and errors, both factual and typographical. The enquiry approach has not yet been adopted and the questions given at the end of each chapter are mostly of recall type and not probing leading the students to just memorise the facts given in the text.

A balanced treatment of the subject matter is lacking. There is a tendency to overburden the students with unnecessary details of description and terminology. Special consideration must be given to the quantum of knowledge and the kind of concepts to be passed on to the students at a particular level. While writing, the authors need to bear in mind that overloading the students with diverse facts and information, will be at the expense of perhaps more important and basic material which need be assimilated and conceptualized at this stage, by the student. Moreover, with regard to the teaching of a specific topic, one must know how much of content to give, what details should be omitted and where to stop, keeping in view the subject background and comprehension level of the student. One should also realise that the same topic will be dealt with in greater detail at a higher level.

The printing and get-up of the textbooks available to students are far from satisfactory. Most of the pictures and diagrams do not relate to the text and are poorly labelled and described.

Physical facilities for biology laboratories

The biology laboratory and practical work in schools is extremely poor. Although a number of practicals and activities are listed in the curriculum, yet in most of the schools, biology is taught without practically any laboratory work. This state of affairs is mainly due to:

1. Lack of equipment, chemicals and glassware in schools;
2. Lack of training of the teachers in conducting specific experiments. This means a lack of technical skills on the part of the instructors; and
3. Inadequate laboratory space. In many schools, the laboratory periods are not even shown in the regular timetable.

Some suggestions:

1. The agency responsible for curriculum development should actively involve itself in the production of model textbooks, teaching units and teachers guides which may then be adapted by provincial curriculum bureaus in accordance with their own needs and conditions.

2. Competent and motivated subject specialists from universities, colleges and schools be identified and given the task of developing and writing textbooks. Critical evaluation of the textbooks before they are put in print, should be made by the experts responsible for designing the curriculum.

3. The printing and illustration of the textbooks should be improved so that they appear attractive and appealing to the reader. The diagrams should help in elucidating the text and should be adequately and clearly labelled and described.

4. Laboratory and field work should be emphasized at all levels. It should be a regular scheduled activity.

5. Measures should be taken not only to provide core equipment to all schools but also ensure its maximal use and proper maintenance and care.

Teacher training

Teachers imparting instruction in biology at the secondary level are supposed to have a Bachelor's degree in Science (Botany/Zoology/Chemistry). However, many of the teachers teaching biology at the lower levels, do not have a formal training in biology at all. Because of the rapid changes made in biology curricula at school level and with the introduction of new topics like molecular biology and environmental biology, it is becoming essential that in-service teacher training programmes be intensified. Real effort and investment must be made in this direction if science education at schools has to be made meaningful and useful. In addition to the teacher training centres, the universities of the country can play an important role in this regard. It is in these institutions that the teachers involved with secondary and higher secondary education can update their knowledge of the growing discipline of biology and thus come across new information. Many of the technical skills can also be learnt and acquired through this relationship.

Role of teachers

It is strongly felt that one important reason for the falling standards of school education in the country, despite revision and modernization of curricula, has been that the teacher is grossly neglected. He is deprived of what is due to him. As a result, a school teacher lacks motivation with regard to teaching as well as learning. Devotion and commitment have no rewards. Except for a very small percentage employed by 'high class' schools catering to the children from affluent families, the teachers are paid extremely low salaries and have few chances of promotion. The teachers also do not enjoy, at present, the social status and respect which were accorded to them in the past.

Sri Lanka

The system of formal education in Sri Lanka provides for six years of primary education (KG + grades 1-5), five years of junior secondary (grades 6-10) and two years of senior secondary (grades 11-12), after which a minor percentage is selected for tertiary (higher) education.

Biology in the school curriculum

At the primary level, pupils learn science quite informally as study of the nature where the curriculum includes some aspects of basic science. The philosophy here is one of understanding through activity, and the approach is process-oriented. It gives opportunities for the child to study at his own pace his environment - to experiment, to learn through manipulation of objects, to make observations and report on them, to make judgement, etc. The junior secondary grades (6-10) have a common curriculum consisting of nine subjects, including an 'Integrated Science' course designed to give a basic knowledge of science including biology to all pupils. At this level, practical and field work oriented activities are mostly included. At the senior secondary level, biology is taught as two separate branches, botany and zoology.

During the last few years, science syllabi were revised particularly that of chemistry and zoology, where the latest additions such as animal diversity, industrial aspects, technological aspects and ecology were included. Due to the fact that practical papers were abolished from the General Certificate of Education (Advanced level) Examination held at the end of the senior secondary level, students do not take sufficient interest in carrying out practical work. An innovation tried out is the teaching of biology making use of environment as a resource - where both the teachers and students are exposed to the problems of environment and their practical investigation.

Curriculum reforms in biology

In designing the new General Certificate of Education (Advanced Level) curriculum, a deliberate attempt was made to make science learnt in school relevant to the everyday needs of children. With this end in view, a number of non-traditional areas giving information regarding the resources of Sri Lanka were introduced into the curriculum. This is a Curriculum Development Centre project, where field supervisors, research personnel and other experts were brought together with curriculum developers to produce the background information materials for these topics. These have taken the form of teacher resource materials for the senior secondary teachers, who have for long been following a curriculum based on the requirements of a very minor percentage of university entrants of the G.C.E. Advanced Level. The background material produced gives fundamental knowledge and insight into some of the modern industrial and technological methods. Some of the biological topics selected are: (i) information regarding pests and pest control; (ii) information regarding fisheries, etc.

The major innovation in the field of biology teaching was the initiation of the 'Field Study Centre' programme in 1979. Under this programme, a new technique of teaching-learning is tried out, making use of environmental resources. This method has been found to create the required motivation to study biology in a meaningful way by utilizing the real-life situations.

The essential components of a field study centre are an environmental resource of interest, such as a forest reserve, a lagoon, or a river bank, and an organizational centre in the form of a well-equipped school with senior secondary science facilities. It has provided opportunities for pupils, teachers, curriculum developers, field personnel, engineers and scientists to come together to discuss environmental problems and identify study programmes.

One of the most important aspect of the field study centre programme is the development of tools required to perceive environmental problems and study them as they are. Here the participants get an opportunity to investigate a variety of problems. They are helped to select a particular problem which they then proceed to investigate. What is more important than the findings are the processes involved in this type of study, e.g. the selection of the problem, method of observation, gathering information, making use of data, and discussions and interactions with other members and specialists.

There are five field study centres at present and the number will increase to seven by the end of 1981. By the end of 1983, it is proposed to cover the whole country by expanding the network to 12 centres.

Instructional materials

The syllabi, teacher's guides for the primary, junior and senior secondary stages are designed and prepared by the curriculum developers. Textbooks are supplied to all pupils free of charge. In addition to the rapid increase in the number of schools, the new approaches of teaching science also require an increased use of equipment. The provision of science equipment to nearly 6,000 junior secondary schools and nearly 450 senior secondary schools has therefore become a problem for the Ministry of Education. In this context, a new project for improvisation of low-cost equipment has been established.

Teacher education

This is entirely a state subject with the Ministry of Education being responsible for training of primary and junior secondary teachers and the Ministry of Higher Education for post-graduate teacher education.

The training courses for the primary and junior secondary teachers have three components - professional education, academic education and general education.

Since there is no pre-service training requirement for recruitment to the teaching profession, a large number of untrained teachers is present in the teacher cadre at any time. Curricular changes such as the introduction of science in the junior school curriculum has required the recruitment of large numbers of untrained persons as teachers. The realisation that the vast number of untrained teachers cannot be covered through institutionalised training has made it necessary to explore the possibilities offered by distance education methods.

In addition to the above methods of teacher training and in order to help the teachers develop new competencies, especially to cope with somewhat radical curriculum changes, a comprehensive in-service education programme has been organised. This in-service education programme is supervised by the Curriculum Development Centre which has now been amalgamated with the Teacher Education Branch.

The junior secondary level in-service education is organised by the Curriculum Development Centre for the 'master-teachers' to cater for the junior secondary teachers on a decentralized basis.

The post-graduate teacher training programme is limited mainly to the one-year Diploma in Education course offered by the universities. The number of teachers receiving masters and doctorate level education is still very small.

Senior secondary teachers too, most of whom are graduates with a basic degree in science, do follow regular in-service sessions on a decentralized regional basis organized by the Curriculum Development Centre.

Educational research

Since the impact of research activities done mainly in the post-graduate colleges of the universities on the school system has been minimal, a research branch to undertake research activities - mainly to improve the school system - was set up at the Ministry of Education in 1980.

This branch is undertaking research activities mainly to improve the school system. Research for the rationalisation of senior secondary science facilities, grouping of schools in order to share the common resources, etc., are some of the operational research activities carried out by this branch.

Thailand

Biology in the school curriculum

Thailand has recently switched on to a new school structure with six years of primary, three years of middle, and three years of senior high school in place of the old 7+3+2 structure. During the first six years of schooling, science is taught as an integral part of a course on 'life experiences' and under this, biology topics deal with the natural environment of the child. At the middle school stage, science experiences are provided to the children

under the subject 'general science' which deals with major aspects of plant and animal life linking them closely with the real-life situations of the learner and his environment. At the high school stage, biology is taught as a separate subject along with physics, chemistry and mathematics to those students who offer the science stream, whereas for the others it is included as a part of a 'combined physical and biological science course' which is modular in nature, and students can select a certain number of modules dealing with biological and physical phenomena which have direct links with daily life problems.

Efforts in developing high school biology curricula
(The IPST Programme)

The first active biology curriculum development in Thailand started in April 1971. Biology teachers from the higher secondary schools, universities and college instructors, and biologists from various research institutes in the country assembled to exchange views and collect data for subsequent high school biology curriculum development. Following this, the Institute for the Promotion of Teaching Science and Technology (IPST) formed a committee which included officials from high schools, colleges of education and universities, to develop a new biology curriculum for the upper secondary school level. A Biology Design Team (BDT) was established to study biology curricula of various countries and drafted a biology syllabus for the M.S.4 and 5 (Grades XI and XII) in accordance with the various suggestions received. The content of the biology course consisted of a universal portion and a local portion in the proportion of approximately 70:30. The universal portion contained topics such as photosynthesis, digestion and respiration. These topics find place in almost all school biology courses elsewhere also. The local portion contained the biological topics that were suitable for the Thai region, for example, the topics of ecosystems and populations. It was agreed among members of the BDT that the universal topics could be borrowed, translated or adapted from other standard works, but the local topics were to be written in a manner that would suit the needs of the country.

A group of high school biology teachers was established as the Biology Writing Team and the BDT provided the outline of the course content and served as the editorial staff. Specialists were occasionally invited as consultants for review and improvement of materials. Mini-trials were held to make sure the chapters and topics were suitable for practical use. Data and information obtained from the mini-trials served as the basis for rewriting those topics which needed modifications so that they would suit the Thai high school setting.

The IPST biology programme attempted to develop three main characteristics of biology as a science, i.e. the gathering of scientific knowledge, the practice of scientific processes, and the development of scientific attitudes. It adopted an activity based approach. The learner performance was, therefore, the most important aspect. The inquiry method was used as a basis for teaching

strategies so that it would enable and encourage the students to examine the biology of their immediate environment. This was reflected in the development of the instructional materials also.

The experimental editions were tried out and revised during the period 1972-75 and the commercial editions were brought out in 1975-76. All of these materials became available for use in the upper secondary schools all over the country in June 1976. The use of the commercial edition was followed up in the schools for evaluation and further revision. The revised edition is now in use in grade X from 1981.

Instructional materials

The IPST biology materials are new in content, concepts and approaches. The new content represents a view of biology as biologists themselves see it; it is more than a mere addition of new materials to the traditional content of biology textbooks. It represents a re-organization of the subject matter through which run unifying concepts. Its methodology moves away from memorization and routine laboratory exercises and, instead, moves toward scientific inquiry, the processes of science and science as history.

The materials developed include students' textbooks, teachers' guides, equipment for practical work, examples of test items and audio-visual aids such as transparencies, slide sets.

(i) Textbooks

Contrary to some countries where the textbooks developed in U.S.A., U.K. or Europe were adopted or translated, the IPST developed de novo the biology textbooks on its own, particularly the content for local topics such as ecosystem, conservation of natural resources. For the universal topics, ideas and strategies developed from various places were adopted with, in many instances, substantial modifications. The important thing was that Thai data and information was utilized, whenever appropriate, to illustrate the various biological concepts. This took the form of pictures, diagrams, data and results obtained from research studies carried out by local scientists. A pertinent point herein which seems to be unique is the adoption of a combination of the historical approach as well as the experimental approach in biology teaching in order to help students appreciate and understand the history of the development of biological concepts.

(ii) Equipment and materials for practical work

In IPST the development of equipment has been conceived as an integral part of the total process of designing and developing a new curriculum for any subject, and it was for this that an equipment design team was established to assist in this aspect of the work of the various subject design teams.

The IPST equipment design team has its own workshops where prototypes of equipment for both laboratory and field activities are developed. Joint efforts are made between the technicians of the equipment design team and the academic staff members of the

Biology Design Team in the preparation of the prototypes. The prototypes are tried out in the same manner as the textbooks and revisions are made before the prototypes are sent to the manufacturer to mass-produce the item for commercial purpose. Maximum use of locally available materials and technology is emphasized, keeping the design of the equipment as simple as possible.

Materials for practical work in biology such as slides for microscopes have also been developed. A recent innovation is that the IPST Biology Design Team has started bulk culturing of some common living organisms useful for school laboratory activities such as hydra, planaria, paramecium, and distributing them to nearby schools. It is planned to extend this activity to the recently developed Science Teachers' Servicing Centres (STSCs) which are being established in all the Teacher Training Colleges so that all secondary schools in the country could receive authentic biology specimens required for implementing the new curriculum.

(iii) Teacher's guide

Similar to those developed in other countries, the teacher's guides contain detailed information and guidelines helpful for effective teaching such as techniques and procedures in carrying out classroom activities, lists of materials to be prepared, estimated time allowed for particular chapter. Some additional knowledge for teachers has also been included for certain topics which, it is felt, average teachers may not be familiar with.

(iv) Source book of test items

Very little work seems to have been done on 'evaluation' of pupil performance, though it is one of the most crucial parts of curriculum development and implementation activity. However, the IPST has organized workshops on test item writing to provide teachers the necessary knowledge and skills. Although the number of participants have been limited, a considerable amount of accepted items have been developed and compiled to serve as a source material useful for other teachers as well. Samples of these test items were distributed to teachers both in the form of a separate source book and, in some instances, as parts of the teachers' guide.

(v) Audio-visual aids

A considerable number of audio-visual aids useful for biology teaching were also developed by the IPST. At the beginning, only two types of audio-visual aids were developed, the black and white transparencies and slide sets. In doing this, some efforts were also made to adapt some sets of the inquiry slides developed by the BSCS to be used in Thai schools.

Teacher training programme

The IPST biology curriculum development programme did not end with the production of the printed materials. The teacher training component was included as an integral part of the effort as envisaged in the original objectives of the programme. Both in-service and pre-service training for biology teachers were carried out during the period of the development of materials.

In-service training for biology teachers has taken several forms. This included workshops of various durations ranging from two to three weeks; Saturday meetings; and one-week workshops for writing test items. This training was organized for the teachers who participated in the trial programme of the biology curriculum materials. Resource persons who conducted these workshops included members of the BDT, guest specialists from other institutes, and Unesco consultants. The philosophy and rationale of the biology curriculum development were included in all these teacher training programmes. The trial teachers were also expected to serve as master teachers for the in-service training programmes to be conducted later.

The first active pre-service teacher training programme of the IPST began in November 1975 by developing guidelines for carrying out the pre-service training programme for science and mathematics teachers to aid in the implementation of the new curriculum materials all over the country.

Professional support services

Besides the in-service and pre-service programmes, the BDT is developing a variety of other programmes to assist the classroom teachers in continuously improving his teaching of biology. Recently, the BDT has started publishing a newsletter which is sent to biology teaching schools all over the country to inform them of the new activities and movements in biology education and provide useful suggestions for teaching of this subject. In addition, a number of articles and research papers from various journals related to biology education and on biology topics to be taught have been compiled and were made available to the biology teachers as supplementary reading materials. Hopefully, this would be a continuing effort.

Another project currently under implementation is the 'Biomaterials project'. This project was originated in 1979 as it was found that one serious problem concerning the implementation of the new biology curriculum is the lack of teacher's knowledge about sources of useful materials available in the region for the teaching of biology. This problem arises from the differences of flora and fauna in the different regions of the country. Teachers in each part of the country need specific guidelines that are most appropriate for the area. Thus the IPST established a project to search for local materials suited for teaching biology in particular parts of the country. In doing this, four local teachers, training colleges as well as two regional universities were invited to participate in the project. A workplan was designed to gather both specimens and information concerning appropriate local materials to be used in teaching the IPST biology programme. The field work part of the project has been completed and its products are expected to be published and ready to be distributed at the end of 1981.

Another attempt to provide continuing professional support services for biology and other science teachers is the establishment of the Science Teachers Servicing Centres (STSCs) in selected Teacher Training Colleges.

Chapter Two

NEW TRENDS IN BIOLOGY EDUCATION: SYNTHESIS OF EXPERIENCES

General

The reports on the status and problems of biology education in the participating countries (Chapter I) and the discussions of the participants indicates that biology education in this region is passing through a crucial period of change. The new trends in biology education include: (i) a shift from teaching biology as separate subjects of botany and zoology towards a unified course of life sciences, thus stressing unity rather than diversity of living organisms; (ii) introduction of current areas of interest - genetics, cell biology, ecology, etc.; (iii) introduction of applied areas of biology such as agriculture, health and nutrition; (iv) stress on environmental education, social relevance and value education; and (v) development of decision-making abilities in the child. The extent to which these trends have been included in the curricula varies from country to country, and in the case of some countries, even within the country.

New instructional materials have been and are being developed for the new curricula. However, in many cases the curriculum developers were not the authors, and thus the philosophy with which the curriculum developers framed the syllabi did not find expression in the textual materials. Another aspect which seems to be lacking in many of the textual materials is the activity-based inquiry approach to teaching. Indeed most books lack any suggestions for practical and laboratory experiences. Once again this is because: (a) the authors are of the old school and are not familiar with the inquiry-approach style of writing; and (b) they are not familiar with the classroom situations and the type of activities that could be done. However, with the growing stress on the use of environment and of local resources, this problem of lack of activities not only for skills but also for value education is being slowly overcome by inclusion of more practical experiences.

Biology and environmental education

In view of the growing concern for the environment, it would be appropriate at this juncture to consider the contribution that biology can make towards environmental education programmes. If environmental education is about relationships between man and the environment, then it is fundamentally biological. The main issues

with which biologists should be concerned fall into three overlapping fields - ecological, physiological and behavioural. Of these, ecology has received the greatest attention in the discussion of environmental problems. The role of physiology has however been underestimated in any definition of environmental education, yet its contributions to the understanding of sensory perception, metabolic needs, the sources of motivation and related matters are vital. Finally, the importance of behavioural studies for understanding man-environment interactions is yet another aspect which needs emphasis. Equally important are the agricultural and health aspects.

Practical ecology lessons in secondary schools are centred round particular ecosystems, but our efforts as biologists have rather been directed towards problems falling within the boundaries of our own academic discipline. As a result, we have failed to grapple with the natural, social and aesthetic processes that cut across and with value judgements that extend beyond the boundaries of the discipline.

The development of skills in identifying and analysing an ecological problem (e.g. pollution of a waterway) should therefore be seen as an important pre-requisite for integrated, investigatory project-type activities or environmental encounters involving a class, classes or groups of students working together with teachers and local experts. The basic idea behind environmental encounters should be to focus the traditional elements of biology curriculum on a particular issue and to explore what additional knowledge, skills, and attitudes may be involved in solving the environmental issue under consideration.

Ecology has also taught us how complex and subtle are the interrelationships between organisms and their environments. Rather than being concerned with theoretical knowledge provided from parent academic disciplines, environmental education should be about identifying and observing more accurately the many components of our enviornments; about understanding the inter-relationships and interdependence between the components and outselves; about evaluating the aims and environmental consequences of human activities, past, present or proposed; and about action, direct and indirect which will ensure a harmonious relationship between man and the world of which he is a part.

Evaluation

This brings us to a much neglected aspect of environmental education - that of evaluation. Two major dependent variable and subvariable categories for evaluation can be identified as: (a) ecological value system; and (b) ability to act on an ecological value system.

These two basic components would also equally hold good for other areas of modern biology - for instance in the concepts of genetics relating to race, sex discrimination and genetic engineering where not only the value system has to be developed, but also the decision-making abilities

For the first variable namely the value system, separate cognitive and affective or combination (cognitive-affective) test instruments need to be developed. For the second variable - the decision-making ability, the evaluation has to be conducted 'on site', that is while the activity is in progress. This essentially means that the role of the teacher in this aspect has to be taken into consideration, and teacher training programmes should cater to the training of teachers for making 'on site' evaluation. In addition, a couple of unobtrusive behaviour measures, again based on objectives, can be introduced into the evaluative component of the programme.

Instructional materials and their designing

The various aspects outlined above highlight the need for developing new and suitable instructional materials to cater for these new demands on biology education.

Textbooks will continue to remain the main type of instructional materials for the formal system of education. In designing textbooks, it is very necessary to identify the objectives of the material first. The content must be selected to suit the objectives to be fulfilled. The level of the content must be suited to the mental maturity of the child, and should not have aspects which lead to confusion rather than comprehension. The proper sequencing of topics for better understanding also deserves attention.

Illustrations play a very important role, particularly in the instructional materials developed for teaching/learning of biology. These should, therefore, be very clear, properly labelled and proportionate. Wherever possible, the magnification should be indicated. Photographs should be included only if a proper reproduction can be assured. Textbooks should not only be well illustrated, but a definite attempt should be made to depict the content and activities through a series of clearly labelled diagrams, so that the minimum of language problems are encountered.

In view of the lack of adequate in-service training facilities and increasing costs involved in arranging training programmes at a central place, there is an urgent need to develop self-instructional and resource materials for teachers which could be mass produced and widely distributed.

A spectrum of people should be associated with the development and revision of textbooks and teacher training materials. This should include university teachers/content experts, practising teachers, and experts in pedagogic aspects, especially those dealing with evaluation.

Apart from the textbooks, three main types of modular instructional materials need to be designed to meet the demands created by the introduction of new concepts/topics and trends:

(a) For students: These should cover the new as well as difficult concepts. The content matter should be presented in a simple language, with only the minimum needed technical terms. A short glossary of the terms may form a part of the instructional material.

The theoretical content should be supported by a large number of activities, which should stress both development of practical skills as well as intellectual skills (analysis of data, decision making, etc.). The content matter should be preceded by the aims and objectives (including behavioural objectives) of the unit; entry behaviour; and pre-test to ensure that the children have enough background knowledge to follow the unit. The unit should also have a post-test to evaluate the learning outcome both in terms of cognitive and affective domains.

(b) For teachers: There is need for development of two types of basic materials for teacher training: The first one are units which are basically the same as student units, but developed as teacher resource material with the content treated at a slightly higher level; supplementary reading materials as necessary; the strategies for using the material; list of materials required for activities; alternate activities; fabrication of simple equipment; method for student evaluation; and above all, a conceptual scheme which shows the linkage between the concepts in the unit, and concepts related to the unit. If developed as a teacher training module, the format will be similar to that of a student module at a higher level and would include all resource materials as well.

The second type of instructional materials that are required for the teacher are those covering the interface between biology on the one hand and mathematics, statistics, physics and chemistry on the other. These could be developed as resource materials for teachers - especially in areas such as biopolymers and their chemical characteristics, p^H and its measurement, redox-reactions and electron transport chains, use of statistical methods such as sampling, t-test, for analysis of biological data. These would be meant for updating teachers who have had no exposure to these areas during their training period.

Once the textbooks/modules/resource materials are developed, the first step is to evaluate their usefulness in the field. Opinions should be sought from teachers, students, and content experts. The actual use of material should be evaluated 'on site' with the help of trial schools/institutions. An experimental edition can be printed for these try-outs. Following this, a thorough revision has to be undertaken. The revised editions should be commercially printed and widely disseminated.

A network must be set up for dissemination of the materials. If necessary the materials should be translated into national/regional languages. Care should however be taken to have the appropriate technical terminology.

Chapter Three

ABOUT THE TEACHING/TRAINING UNITS

In this Chapter are given short descriptions of the teaching/training units which the participants had prepared and brought to the Workshop and which were co-operatively reviewed and improved upon.

Title of the Unit: PRACTICAL/LABORATORY TECHNIQUES FOR THE TEACHING OF SOME ENVIRONMENTAL FACTORS (A teacher training manual)

Prepared by Dr.(Mrs.) Shakuntala Bhattacharya, Reader, Biology and Extra Curricular Science, Department of Education in Science and Mathematics, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi-110016, India.

About the Unit: In a country like India with its vast number of teachers, and limited resources, the problem of in-service training poses many problems. While introducing the new biology curriculum at the secondary level, it was felt that experiments which could be based on environment and local resources, if incorporated into a handbook for teachers, would go a long way in solving the problems, especially of performing of suitable activities which could help the teacher to improve the teaching-learning strategies.

The aim of this training unit is to provide broad guidelines for practical experiences related to the teaching of environmental factors which can be used by the teacher for strengthening the teaching-learning strategies. The present Unit is meant for use in teacher training programmes and comprises the following sections: (1) Introduction; (2) Aims and objectives; (3) Background knowledge (entry behaviour), including a pre-test; (4) Practical experiences; (5) Reagents and culture techniques; (6) Strategies for use of practical experiences; (7) Post-test; (8) Keys to pre-test and post-test; and (9) References.

The major part of the Unit consists of about 100 practical experiences which cover aspects such as: (i) planning a field trip; (ii) diversity in the living world (collection and preservation techniques, and population studies); (iii) case studies in interaction between species; (iv) composition of air; (v) soil; (vi) water; (vii) effect of salinity on living organisma; (viii) measurement of factors affecting thermal comfort.

A comprehensive list of reagents, and how to make them, is included in Section V.

The post-test has been designed to test whether the experiments have been carried out by the trainees; if they know how to use these experiences and interpret data; and finally if application and inquiry processes in learning of particular concepts have been gained.

Title of the Unit: FRESH WATER ECOSYSTEM AND WATER POLLUTION (Teacher resource material suggesting an approach for teaching one topic in environmental education)

Prepared by Miss Indra Devi Somasundaram, Secondary Science Unit, Curriculum Development Centre, Ministry of Education, Kuala Lumpur, Malaysia

About the Unit: The following are the contents of this Unit: (i) introduction; (ii) objectives; (iii) ecosystem; (iv) water pollution; (v) value education; (vi) teaching-learning strategies; and (vii) evaluation.

The challenge to science education in the midst of environment crisis confronting societies today is the establishment of curricula with relevant ecological content. If environmental education is to meet the challenge of environmental problems, it must be ecological and experiential. Environmental education can be a vital part of the school science curricula. The study of fresh water ecosystem and water pollution would make a useful contribution towards an ecological approach to environmental education. It is hoped that through the use of these materials, the teacher will be stimulated to improve instructional procedures so as to provide experiences for students which will create an interest and concern for their future interaction with their environment. Further, these materials could provide the basis for the development of other topics in environmental education.

Valuing is a process that needs to be fostered in environmental education. Through value education, the student is able to engage in critical decision-making. Value issues are so much a part of the teaching of science. Almost no topic in any science curriculum can be taught without some opportunity to consider the value implication of the content. Topics can be taught on three levels, namely, the knowledge level, the concept level and the values level. The values level of instruction places emphasis on students' opinions and judgement.

The curriculum materials here, which include among others, teaching-learning strategies, give ideas and suggestions for implementing environmental education as an integral part of the science curriculum, in particular the biology curriculum, as exemplified by this topic. The activities are designed for students in grades 10 and 11 in secondary schools. This is a resource for teachers, and it suggests an approach for teaching one topic in Environmental

Biology, namely, fresh water ecosystem and water pollution. It is important to note that the materials are intended to serve only as a guide in selecting appropriate activities, and should not be considered as a fixed structure.

The Unit gives a brief introduction highlighting the need to inculcate environmental literacy among the school population. It emphasizes the need to infuse elements of environmental education in science education at all levels of the education system. The three dimensions of a good education, namely, content, concepts and values should be considered in such curriculum development.

The general objectives of the topic are listed. The concept of the ecosystem is then discussed to provide information for the teachers so as to assist them in the planning of the teaching-learning strategies of this topic. The pond is considered as an example of a fresh water ecosystem for the practical activities of the topic. The four basic components of an ecosystem, namely, abiotic substances, producers, consumers or microconsumers and decomposers or micro-decomposers, are considered. Some of the most urgent topics concerning environmental education currently such as pollution, conservation, quality of life, population control and resource management are delineated so as to point out that water pollution is one such environmental problem.

A discussion on water pollution follows. The different types of water pollution, the causal agents of these types of pollution and their effects on the ecosystem are considered. The detection of the degree of water pollution using such tests as the Biochemical Oxygen Demand (B.O.D.) and indicator organisms are discussed. Values education is briefly treated as an important component of environmental education.

The section that follows gives details of the concepts and teaching-learning strategies involved in this topic. They are categorised into classroom and field work sessions to assist the teacher in the organization of the activities for the teaching-learning. The details of the practical activities for students are given. Possible student projects are discussed. Student exercises which involve the analysis of a given set of data are also considered. Such exercises would entail drawing of inferences and decision-making on the part of students.

Evaluation is an important component of any curriculum. However, not all the aims and objectives of this topic can be measured in the more conventional ways, and so teachers have to assess these aims and objectives. This aspect of evaluation with particular reference to environmental education is discussed.

Title of the Unit: THE CELL CYCLE
(A teaching unit for students of secondary/ higher secondary levels)

Prepared by Dr. M. Arslan, Chairman,
Biology Department, Quaid-I-Azam University,
Islamabad, Pakistan

About the Unit: The key concepts covered under this Unit are: (i) Nucleus; (ii) Chromosomes; (iii) Mitosis; (iv) Meiosis; and (v) Sex determination.

This teaching Unit has been prepared to provide the students with information as well as concepts regarding the cell cycle. The main objective of the Unit is focused on the identification of the cell cycle as the process responsible for hereditary continuity in living organisms.

Writing of this Unit was urged by the fact that due consideration is not given to these concepts in some of the textbooks prescribed for the secondary level. In other textbooks, the subject has been treated in such details that it becomes difficult for the student to sift out the material whcih may present a unified picture of the stages of the cell cycle and is of relevance for understanding other topics like genetics, DNA replication and reproduction.

An attempt has, therefore, been made to present the material in a concise but accurate manner. Many of the details of cell division which may become a barrier to the understanding of the more basic concepts by the students at this level, have been left out.

The Unit should help the student in comprehending the phenomenon of cell multiplication which is the basis of growth and reproduction at the organismal level. One part of the Unit also describes the chromosomal basis of sex determination.

At the end of each section, certain guidelines have been given for consideration by the teacher which may help to identify and emphasize the specific conceptual outcome from the information contained in that section.

It is hoped that the Unit will serve to provide information about some of the specific topics of cell biology and will furnish the necessary background and rationale for the study of genetics at the secondary or higher secondary school levels.

The Unit has been designed:

1. To provide a basic understanding of the cell cycle and the process of cell reproduction (cell division) in eukaryotes.1/
2. To comprehend that cell reproduction is not only responsible for an increase in the number of cells but also furnishes the mechanism for genetic continuity.

1/ Cells containing a discrete nucleus.

3. To provide a brief description of the nucleus and chromosomes since these cell components play a central role in cell reproduction.

4. To discuss the different stages of mitosis with regard to changes in the shape of the chromosomes and their movements in relationship to spindle formation.

5. To emphasize that during the cell cycle, duplication of chromosomal material occurs when the cell is not dividing (interphase) and that mitosis is responsible for the equal (quantitatively and qualitatively) distribution of the chromosomes to the two daughter cells.

6. To explain the need of a special type of division (meiosis) in cells which are destined to become gametes in sexually reproducing organisms.

7. To describe the stages of meiosis which consists of two consecutive cell divisions but only one replication of chromosomes.

8. To comprehend the significance of pairing and chiasmata formation during meiosis.

9. To find a basis of genetic variation as a result of the behaviour of chromosomes during meiosis.

10. To explain the chromosomal basis of sex determination.

Title of the Unit: ENVIRONMENTAL BIOLOGY UTILIZING FIELD STUDIES CENTRES
(A teaching unit designed for senior secondary students to study a "Terrestrial Ecosystem")

Prepared by Mrs. D.D.P. Jayakody, Officer, Planning and Research Branch, Ministry of Education, Colombo, Sri Lanka

About the Unit: Since the present day education emphasises mostly on learning rather than teaching, the present Unit is an attempt to link biology education with the real-life situations, using environment as a resource, whereby students could work like scientists and learn by doing and thus link up the classroom learning with the natural situation.

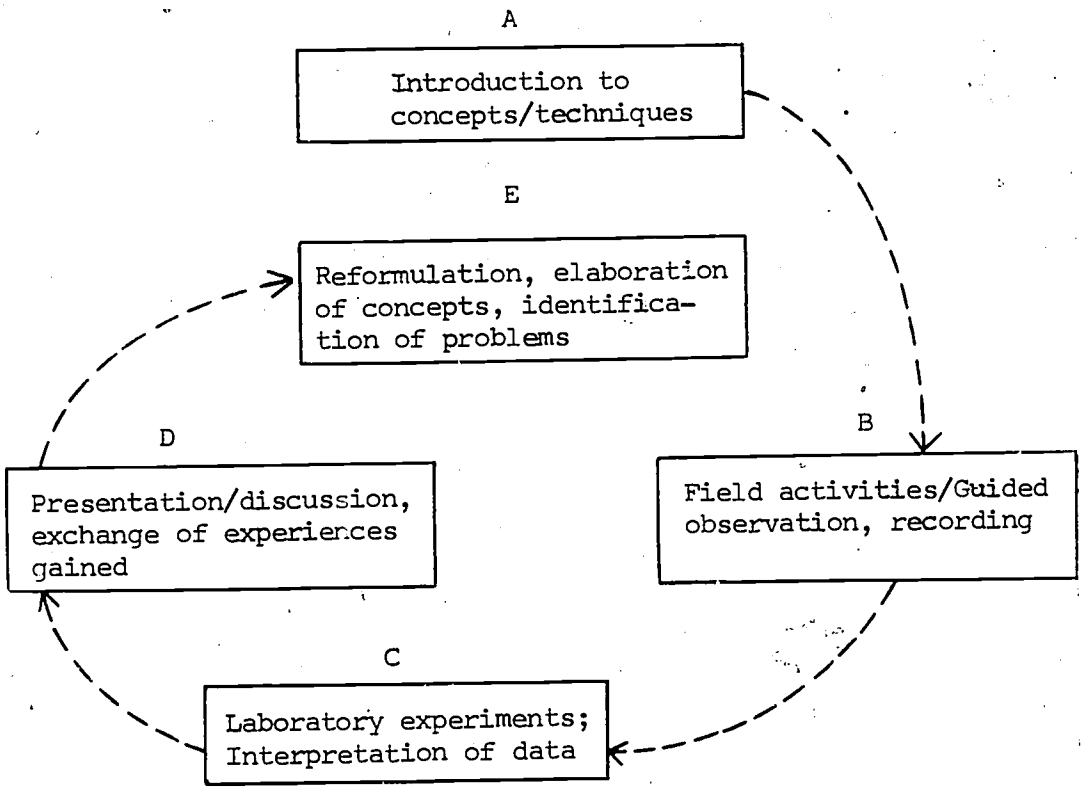
The Unit focuses on studying of biological concepts, interrelationships of organisms and identifying problems of the local terrestrial habitats and can be used by senior secondary students who are the ones who either proceed for tertiary education or have already reached the terminal stage of school education.

The aim of the Unit is to provide guidelines for students to carry out field activities in a local terrestrial habitat for studying biology in order:

1. To acquire knowledge, skills and attitudes by utilizing real-life situations.

2. To improve the quality of the environment by educating the youth so that they would have a positive attitude towards the environment.

3. To realize that an ecosystem is not a mere collection of organisms or an accidental mixture of species but a highly organized system, where the individual members are interacting with each other.



The scheme of the Unit

The Unit is so designed that the teacher can carry out continuous assessment of the students at any appropriate stage while studies are being conducted. However, in order to evaluate the knowledge gained, skills developed and the attitudinal changes, a post-test is included.

Title of the Unit: POSSIBILITY OF GAMETES FORMATION IN DIHYBRID CROSS
(A teacher training unit)

Prepared by Dr. Pisarn Soydhurum and
Mrs. Nantiya Boonklurb, Biology Design Team,
The Institute for the Promotion of Teaching
Science and Technology, Bangkok, Thailand

About the Unit: This Unit is designed to provide the high school biology teachers the understanding and skills required for the teaching of a concept in genetics. (The middle school biology teachers can also be the target group if the concept of dihybrid cross is taught at this level in some countries).

In the study of Mendelian genetics, it was found that sometimes the concept on possibility of gamete formation, particularly in dihybrid cross, is somewhat complicated for many students. Thus, an activity has been designed to help students have a clear understanding, on the one hand, and provide a practical experience in dealing with probability problems, on the other. In using this teaching Unit, it is essential for the teachers to be familiar with the activity both in terms of the concept and skills. For this Unit, pairs of beads have been used to show the independent segregation of the genes. Guidelines and additional information are provided for teachers and simulation technique is also recommended.

After the completion of the Unit, the teacher should be able to use the suggested laboratory technique effectively for his/her genetics teaching on the concept of possibility of gamete formation in dihybrid cross.

The major concept developed in the Unit is that when two characteristics of organisms are simultaneously considered in a cross, such a cross is called a dihybrid cross, in which four kinds of gametes could be formed with equal chances.

Title of the Unit: TYPES OF VARIATIONS
(A teaching unit for secondary school biology)

Prepared by Dr. Pisarn Soydhurum and
Mrs. Nantiya Boonklurb, Biology Design Team,
The Institute for the Promotion of Teaching
Science and Technology, Bangkok, Thailand

About the Unit: This teaching unit is for the biology students at the high school level where the sub-topic 'types of variations' is included under genetics. Practical work has been designed in order that students will have opportunities to observe and record variations and use numbers. Facts and phenomena observed in learners' daily life are used in the activities.

Biology teachers generally just tell their students about the definition of the two types of variations and give some examples to illustrate the phenomenon. It is therefore felt that the students will have a better understanding and more objectives of biology

instruction will be fulfilled if practical activities are employed. The lesson will be more meaningful for the learners if the relationships between the concepts learnt in the class and the real-life situations are emphasized. The Unit has therefore been designed for this purpose. In this Unit, students will have opportunities to observe their own characteristics, as well as those of their friends. Moreover, science process skills such as numbering, recording and calculating are also involved in students' practical work.

After completion of this Unit, the students should be able to:

1. Observe characteristics of members in a class in a study of variation;
2. Record the data obtained from (1) in the table;
3. Conclude that for certain characteristics, a group of students can be classified into two sub-groups;
4. Measure the heights of members of the class;
5. Record data obtained from (4) in the table;
6. Conclude that for certain characteristics, the variation range from one end to the other has several intermediaries;
7. Define the term "continuous variation";
8. Define the term "discontinuous variation".

The content of the Unit illustrates that there are two types of variation: the continuous variation that varies from one end to another end with several intermediaries; and the discontinuous variation that consists of only two choices, for example, yes or no, present or absent.

Annex I

List of participants

India	Dr.(Mrs.) Shakuntala Bhattacharya Reader, Biology and Extra Curricular Science Department of Education in Science and Mathematics National Council of Educational Research and Training Sri Aurobindo Marg, New Delhi
Malaysia	Miss Indra Devi Somasundram Science Curriculum Officer Curriculum Development Centre Ministry of Education Pesiaran Duta, Kuala Lumpur
Nepal	Dr. Dil Raj Upadhyay Vocational Agriculture Expert Curriculum Textbook and Supervision Development Centre Harihar Bhavan, Pulchowk Lalitpur
Pakistan	Dr. M. Arslan Chairman, Biology Department Quaid-I-Azam University Islamabad
Sri Lanka	Mrs. D.D. Pushpa Jayakody Officer, Educational Planning and Research Branch Ministry of Education Colombo
Thailand	Dr. Pisarn Soydhurum Head, Biology Curriculum Development Team Institute for the Promotion of Teaching Science and Technology 924 Sukhumvit Road Bangkok

Thailand (cont'd)	Mrs. Nantiya Boonklurb Biology Curriculum Development Team Institute for the Promotion of Teaching Science and Technology 924 Sukhumvit Road Bangkok
Unesco ROEAP	Dr. Wimala D. Ponniah Regional Adviser in Environmental Education Unesco Regional Office for Education in Asia and the Pacific 920 Sukhumvit Road Bangkok
	Dr. M.C. Pant Specialist in Science Education Asian Centre of Educational Innovation for Development (ACEID) Unesco Regional Office for Education in Asia and the Pacific 920 Sukhumvit Road Bangkok