DOCUMENT RESUME

ED 139 636 SE 022 360

TITLE Science in Basic Functional Education: Philosophy, Approaches, Methods and Materials. Report of a Preparatory Working Group Meeting (Seoul, Rep. of Korea, July 7-12, 1975).
INSTITUTION United Nations Educational, Scientific, and Cultural Organization, Bangkok (Thailand). Regional Office for Education in Asia.
REPORT NO BKAS-75-RHN-641-400
PUB DATE 75
NOTE 56p.; Some tables may be marginally legible due to small print of the original document
AVAILABLE FROM UNIPUB, Inc., P.O. Box 443, New York, New York 10016 ($6.00)

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Asian Studies; Curriculum; Developing Nations; Educational Assessment; *Elementary Education; Elementary School Science; Foreign Countries; Instruction; *Meetings; *Science Education; *Secondary Education; Secondary School Science
IDENTIFIERS *Asia

ABSTRACT

This report presents papers delivered at a 1975 meeting on science education held in the Republic of Korea and attended by participants from India, Japan, Republic of Korea, Malaysia, Phillipines, Singapore, and Sri Lanka. The objectives of the meeting were: (1) to explore problems, issues, approaches, and strategies in science education at the basic level, for school children and out-of-school children, youths, and adults, and trends of innovative efforts to relate them to the development goals of the countries; (2) to evolve a philosophy of science education at the basic level in relation to the emerging needs and trends in developments in the spheres of education and science and technology in the Asian region; and (3) to suggest guidelines on the development of a new approach to science education and the preparation of modules and instructional materials. (MH)

Unesco. Asian Centre of Educational Innovation for Development. Preparatory Working Group Meeting, Seoul, 7-12 July 1975.

Science in basic functional education: philosophy, approaches, methods and materials, report [of the meeting] Bangkok, Unesco Regional Office for Education in Asia, 1975.

p. (Asian Programme of Educational Innovation for Development)

1. EDUCATIONAL INNOVATION - ASIA. 2. SCIENCE EDUCATION. I. Unesco. Regional Office for Education in Asia, Bangkok. II. Series.

371.39

ASIAN PROGRAMME OF EDUCATIONAL INNOVATION FOR DEVELOPMENT (ACEID)

SCIENCE IN BASIC FUNCTIONAL EDUCATION: PHILOSOPHY, APPROACHES, METHODS AND MATERIALS

Report of a Preparatory Working Group Meeting
(Seoul, Rep. of Korea, 7-12 July 1975)

UNESCO REGIONAL OFFICE FOR EDUCATION IN ASIA
Bangkok, 1975

Second printing March 1976

Published by the Unesco Regional Office for Education in Asia
920 Sukhumvit Road
C.P.O. Box 1425
Bangkok, Thailand

Opinions expressed in this publication represent the views of the participants of the Preparatory Group Meeting and do not necessarily coincide with the official position of Unesco. No expression of opinion is intended herein concerning the legal status or the delimitations of the frontiers of any country or territory.

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Preface

The Preparatory Working Group Meeting on Science Education was held at Seoul, Republic of Korea from 7-12 July 1975 under the Asian Programme of Educational Innovation for Development (APEID).

The Meeting was organized jointly by the Korean Educational Development Institute (KEDI), an Associated Centre of ACEID, and the Asian Centre of Educational Innovation for Development (ACEID), Unesco Regional Office for Education in Asia, with the co-operation of the Ministry of Education, Republic of Korea and Korean National Commission for Unesco. The Meeting was attended by participants from seven countries,* and observers from SEAMEO, Ministry of Education, Republic of Korea, and Unesco experts.

This Meeting was preparatory for the APEID - Technical Working Group Meeting on Science Education to be held in Quezon City, Philippines, in October 1975, and charged with the formulation of a frame of reference and guidelines for the latter meeting.

The objectives of the Meeting were:

i) To explore problems, issues, approaches and strategies in science education at the basic level, for school children and out-of-school children, youths and adults and trends of innovative efforts to relate them to the development goals of the countries.

ii) To evolve a philosophy of science education at the basic level, in the light of the aforesaid explorations and in relation to the emerging needs and trends in developments in the spheres of education and science and technology in the Asian region.

iii) To suggest guidelines on (a) the development of a new approach/approaches to science education at the basic level and appropriate strategies and methods for translating the approach/approaches into instructional programmes and on (b) the preparation of modules and instructional materials in other forms.

The Meeting opened with the address of welcome by Dr. Yung Dug Lee, Director of KEDI and by Dr. A. Latif, Chief of ACEID.

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* India, Japan, Republic of Korea, Malaysia, Philippines, Singapore and Sri Lanka.

Dr. Lee in his address observed that we are now living in an era in which many problems of new dimensions are continuously challenging us, redirecting the paths along which educational reform must be effected. Fundamental reforms in education are essential as a means to keep abreast of the changing needs of society.

The volume of scientific knowledge and information is expanding at an accelerating speed. This reality renders it necessary to develop in students high standards of scientific modes of thinking, learning and inquiry, which would set in motion a self-generating mechanism for further production of knowledge. Reforms in the goals, contents and methods of education must be appropriately buttressed by reforms in educational management. It is also essential that reorientation of the curriculum content and organization be implemented concurrently with relevant in-service teacher education programmes, through which the new views concerning the objectives of science education and the attendant curriculum changes may be properly understood and assimilated by the teaching staff. Critical reappraisal and bold innovation are due in all areas of learning and education, and the needs are more urgent in science education, whose goals and concepts must be redefined in terms of the problems we face in Asia. The task facing us calls for a highly sophisticated and comprehensive approach. Some systematic thinking on a general philosophical plane should be combined with concentrated studies addressed to specific cases. The problems we face in Asia nowadays may bear unique characteristics, but the majority of them are of such a nature as to require co-operative endeavour between the countries in the Asian region and the world at large.

Dr. Latif, in welcoming the participants and observers briefly introduced the nature and significance of the meeting and explained the background objectives and operational modalities of APEID and the role that KEDI and other Associated Centres have played in Regional co-operation in educational innovation.

Dr. Yung Dug Lee (Republic of Korea) was elected chairman; Dr. Dolores Hernandez (Philippines) co-chairman; and Messrs. Beng Thiam Koh (Singapore) and N. K. Sanyal (India) rapporteurs. Dr. D. Hernandez (Philippines) and Dr. V. Prakash (Malaysia) were elected chairmen of the two groups.

The organizing committee consisted of Dr. Se Ho Shin (KEDI) Director of the Meeting, Dr. M. C. Pant, Specialist in Science Education (ACEID), and Mr. Sah Myung Hong, (KEDI) the Secretary of the Meeting.

The Meeting, in the first few plenary sessions, discussed the country reports and other experiences presented by the participants, identified the main trends, problems and gaps in science education in the Asian region, and deliberated on the emerging concept of national development. The meeting then divided itself into two groups. One group analysed the role of basic education as functional to national development goals with implications for science education at the basic level. The second group looked at scientific and technological development as functional to national development goals with implications for science education at the basic level. Both the groups met again in plenary sessions and synthesised the groups' thinking into philosophy, aims and objectives of science education for national development. The plenary then suggested guidelines for developing new approaches, strategies and methods for translating these into instructional programmes.

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

Chapter I

SOME INNOVATIVE EFFORTS IN SCIENCE EDUCATION

This chapter is based on country reports submitted by the participants from Japan, Republic of Korea, Philippines and Singapore and oral presentations made by participants from India, and Malaysia. It has been augmented by other materials available in the Meeting and observations and comments made during discussions.

In all of the participating countries, strong emphasis is being laid on the improvement and expansion of science education throughout the school stage. It is recognized by the national authorities that an understanding of science and its processes is necessity for the children and youth of today and that without this understanding they may not be able to take their part in national development. It is also being more and more recognized that the teaching of science is not limited to just one subject among the many in the curriculum, but is one of the best vehicles for educating the child by helping him to sharpen his sense of curiosity, critical thinking and use of the scientific method for identifying and solving his problems. This is being reflected in designing the new primary or lower secondary science courses as 'integrated science' or even by integrating the subject of science with language, mathematics and social studies.

The new primary and lower secondary science courses are being made more 'activity centred', encouraging the discovery approach, with an emphasis on pupil activity. As the revised syllabuses are wider in scope, much of the factual content, which is not quite essential at this stage of schooling, has been pruned down in these courses.

In order to cope with the change some countries have adopted a gradual approach; from the current science syllabuses they have selected some topics which lend themselves to 'activity approach', and have developed for these topics instructional materials like teachers guides and textbooks. The rest of the topics are taught by the teachers in the traditional way.

As the emphasis in the new science courses is on 'doing' rather than 'reading', various attempts are being made to develop simple science equipment with high instructional value. Most countries have established science equipment designing and production centres. These operate either as independent units or as parts of the Science Curriculum Development Centres.

Science in basic functional education

Use of ETV and films to enrich science teaching is increasing. In Japan, about 70 per cent of the primary schools and 30 per cent of the lower secondary schools are utilizing the ETV science programmes. ETV is playing a significant role in science teaching in primary and lower secondary classes in Singapore. Its area of greatest influence is the lower secondary stage and programmes at this level are aimed at enriching the experiences of the pupils.

A variety of printed instructional materials like teachers' guides, students' work books, supplementary readers, and science magazines are being developed to support the science teaching programmes.

A recent innovation in the Philippines is the preparation of a series of modules on the scientific principles behind agricultural practices. Another innovative project is the ISOS (In-School-Off-School Project). This is an alternative delivery system which enables one teacher to teach a larger number of students. The project utilizes the concept of continuous progression. Self-learning kits in science and maths have been developed and are being used in the experimental schools.

Extending science education opportunities to a larger number of institutions, especially in the rural areas, and promotion of scientific literacy through youth centres are being attempted in India. Integration of formal and non-formal education is being adopted in some countries.

As the teacher remains the pivot of the teaching-learning process, a variety of in-service training programmes are being innovated in participating Member States. Skills for improvizing simple science equipment from locally available materials are being encouraged both in the pre-service and in-service education programmes.

Self-instructional materials for teachers to upgrade and update their science knowledge and skills are being developed and have helped greatly in improving the quality of teachers.

The major concern behind all of these innovations in the field of science education is to bring about a change which will make education functional, encompassing formal schooling and non-formal instruction and aimed at expanding and improving opportunities for the kinds of learning fundamental to life and work so as to meet the minimum needs of all.

Chapter II

TRENDS, PROBLEMS AND GAPS

An analysis of the Asian educational development efforts of the last decade shows clearly that greater and greater emphasis is being placed by the Member States on the improvement of science education. High priority is being accorded to science education, its expansion and its qualitative improvement in national development plans. Various innovative efforts are being made by the countries to meet the challenge of teaching better science within the limited available resources.

A review of the presentation of country reports by the participants indicates the emergence of certain common trends, problems and gaps. These can be conveniently grouped under the following heads:

Trends

A. Curriculum organization and methods

1. There is a growing trend towards (a) relating science education to the developmental needs of the nation (child, family, society and community) at the basic level of schooling and (b) a shift from factual teaching to conceptual understanding through application of acquired knowledge and skills to daily life problems.
2. Establishment of science curriculum centres for designing, testing and utilizing instructional materials.
3. Progressive development of indigenous curriculum programmes instead of adoption or adaptation of foreign programmes.
4. Tendency towards a unified or integrated approach of content not only within the various branches of science but also within the areas of social sciences and humanities.
5. Stress on first-hand experiences by pupils in the learning process and emphasis on the inquiry approach.
6. Developing new instructional and management systems.
7. Increasing use of clinical, micro-testing or/and pilot testing before large-scale introduction of a change.
8. Picking out some topics or areas of the existing curriculum which lend themselves to an activity approach and preparing supporting materials for teachers for developing an inquiry approach to teaching science.

9. Preparation of curricular and appropriate instructional materials related to some selected developmental areas; e.g., agriculture.

10. Increasing use of formative evaluation.

11. Greater concern for affective and psychomotor domain objectives.

B. Materials and media

1. Establishment of centres or units for design and production of science equipment utilizing indigenous resources.
2. Increasing use of mass media and audio-visual teaching aids.
3. Growing interest in developing new instructional resources like kits, scientific educational toys and simple self-learning materials.
4. Use of integrated package programmes including syllabuses, textbooks, teachers' guides, teaching aids, training and evaluation materials.
5. Development of self instructional materials for use by teachers in areas which are more amenable to such treatment.

C. Non-formal education

1. More emphasis on out-of-class science activities - science centres, science fairs, science clubs, field studies, or science periodicals.
2. Greater use of science periodicals, publications and radio and television programmes.

D. Training

1. An awareness of the need to revise pre-service training in line with the new school curricula.
2. Linking in-service teacher training with curriculum change.

E. Collaboration

1. National level - Association of expertise from universities, developmental institutes, teacher training colleges, professional teacher organizations and classroom teachers on consultancy/part-time basis in development of curriculum change programmes.
2. Regional level - Greater inter-country co-operation in developing programmes through collaboration and sharing of experiences.
3. International level - Participant exchange programmes, information and consultancy services.

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Problems and gaps

A. Curriculum and methods

1. Lack of clear and viable objectives for science education at the basic level in terms of pupils attainment, and failure in consistently translating them into materials and methods of instruction.
2. Persistence of rote learning in classrooms despite attempts to make science learning investigatory and inquiry-oriented.
3. Science curriculum still contains too many unrelated facts.
4. A fragmented rather than a systems approach to changes in science curriculum due to:
   a) piecemeal nature of efforts without linking curriculum development to national policy with the assurance of continuity of efforts and availability of support.
   b) lack of integration of efforts to link and co-ordinate with changes in teacher education, material production, instructional and management systems.
5. Lack of validity, reliability and objectivity in evaluation practices and examination systems and failure to utilize evaluation results for instructional purposes.
6. Lack of research base in developing innovative programmes.

B. Materials and media

1. Persistence of lack of adequate supply of science equipment despite:
   a) Establishment of science equipment design centres;
   b) Foreign aid for supply of equipment.
2. Neglect of identification and mobilization of alternative resources and means available in the community and environment.
3. Lack of relevant instructional materials in national languages.
4. Lack of standardized scientific terminology in national languages.

C. Training

1. Lack of definition of the new roles and basic competencies of teachers, resulting in inadequate pre-service teacher training programmes.
2. Ineffective in-service training courses due to one or more of the following reasons:
   a) short duration;

b) lack of incentive or motivation;

c) transmission losses in multiple-tier training programme;

d) feeling of insecurity by the teachers;

e) inadequate planning and preparation on the part of trainers.

D. <u>Administrative</u>

1. Lack of appreciation for the creation and identification of needed resources for learning of science through activity approach.
2. Rigidity of administrative rules and procedures - lack of communication, co-ordination and diffusion at various levels.
3. Lack of orientation of supervisors and policy makers.
4. Lack of professional approach and expertise in designing and planning innovations in science education.
5. Ever-growing size of classes at the first level of education.

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Chapter III

PHILOSOPHY, AIMS AND OBJECTIVES OF SCIENCE EDUCATION FOR NATIONAL DEVELOPMENT

Introduction

The last few decades have seen an unprecedented growth in scientific knowledge and its application to technology. Science and technology have started to make an impact on the everyday life of all citizens, which makes it imperative that all should have at least some understanding and appreciation of those aspects of science which affect their daily life and future. Experience has shown that the economic and social development which might be expected to accrue from an understanding and application of science have unfortunately not materialized in many Asian countries. The reason for this appears to be that a large number of people in Asia are still illiterate and have not gone through the systematic occupational training which would help them to apply the skills required for drastically improved productivity. This demands that the teaching of science permeate life as a whole to enable citizens not only to have a better understanding of the surrounding world but also to improve their material status.

Science education at basic level should not merely transmit scientific literacy and numeracy to a broadening stream of the population but should also concern itself with preparing the base for development of scientific and technological manpower which is so necessary and indispensable for national development.

Emerging concept of national development

In the recent past, national development was primarily referred to in terms of economic growth and was equated to an increasing Gross National Product (GNP). Experience has however shown that an increase in GNP does not necessarily result in the improvement of the levels of living and well-being of the entire nation; it may have the opposite effect and result in the rich getting richer and the poor getting poorer. Unemployment, inequitable distribution of wealth, hunger and malnutrition, ill health, illiteracy and other similar problems have continued in many places in spite of a rise in GNP. This has led to the emergence of a new concept of national development which includes new social indicators such as the reduction of: (a) unemployment, (b) inequitable distribution of income, (c) the gap between rich and poor, (d) illiteracy and ignorance, (e) ill health and malnutrition and (f) poor housing and other social problems.

Science education at basic level

The meeting reviewed science education at basic level as both (a) a component of education at the basic level and (b) a part of overall scientific and technological development. From these two perspectives, it began by establishing the role of education and of science and technology in the context of the newer concept of national development.

Basic education as functional to national development goals with implications for science education at the basic level

The human resource is one of the major strengths of Asian countries. The most urgent task is to improve and mobilize this resource to achieve national development goals. Education is perhaps the best vehicle available to us to achieve this end by widening human horizons through a programme of functional education and practical training for the development of skills. The participating Member States are moving in the direction of making their educational system, at least at the basic level, available and relevant to the entire society.

The new concept of this basic functional education has a three-fold aim. First, it has to cover the total needs of the learners including their health and nutrition. Second, it should provide training in appropriate employable skills to enhance the capacity for development. Third, it must extend educational opportunities to the disadvantaged groups of the population.

Basic functional education should be able to impart such knowledge to children and adults as will help them to achieve better efficiency in solving their day-to-day problems, resulting in greater productivity and a higher standard of living.

Science education should be recognized as an essential part of this basic functional education and should focus on preparing children to deal with real problems, particularly those brought about by the impact of technology on the physical, cultural and socio-economic environments.

Science and social development: In view of the need to link science education with the national development, the teaching of science should be geared to contributing to attitudinal change.

Modernization of ways of living and health habits as well as of agricultural practices and industrial methods are indicators of the acceptance of change. The speed and facility with which changes occur will depend on the creation of a climate of opinion favourable to scientific ideas, and on the achievement of some basic degree of 'scientific literacy' whereby a majority of people have some understanding at least of the simpler scientific principles.

This has considerable implications for all types and levels of education, both within and outside the formal system, as well as for the strategies, resources and methods used in teaching science itself. Elements singled out for attention from the earliest stage of education include health and nutrition, sanitation, development of skills, care and conservation of natural resources, and basic attitudes of inquiry and objectivity.

Science and individual development: Science education should lead to the desirable outcomes of critical thinking and understanding of the scientific methods and processes of science so that nothing is acceptable unless supported by sound evidence. The development of such behaviour in individuals should lead to a society which will fully appreciate the potentialities of science and support scientific enterprise.

There are however a number of practical difficulties in ensuring a smooth, effective and full integration of science into the formal and non-formal education systems and normal life. Some of the factors responsible for this are superstitions, cultural attitudes, lack of relation of science to everyday life and lack of recognition of the vital place of science in the school curriculum. To make science education meaningful, it is necessary to relate science at every level of education to local problems, needs and realities; that is, to real-life situations.

Science and technology development as functional to national development goals with implications for science education at the basic level

In recent years, a great drive has been set in motion for the social and economic application of science and technology to a vast range of human needs. This role of science and technology in economic and social progress has become a major concern of educationists, scientists, sociologists and politicians. The tremendous growth witnessed in science and technology is the result of a better use by man of his mental capacities which can be developed only through proper and meaningful education.

Whereas in advanced countries the massive impact of science and technology is visible in all sectors of human activity, this impact in Asian countries tends to be limited to a few areas like industrial production. Asia has experienced evolutionary development in the past, as shown by the abundant evidence of scientific thought and discovery in ancient India and China. This is of great importance in considering the application of science and technology to the new pattern of development which is emerging in Member States. Isolated blossomings are however not enough to establish development as a self-generating and self-sustaining process. It is safe to assume that a critical stage occurs when the right pooling of knowledge and understanding of the scientific, technical, social and economic aspects has been built up to generate a self-sustaining process which, once properly started, has a good chance of propagating itself over a wide front.

Science in basic functional education

The relatively slow pace of development in the past has now accelerated to such a degree that an individual encounters not merely a change but successive waves of economic and social change in his life time. This new pace of development demands an urgency in defining clearly the objectives for the growth of the scientific and technological enterprises in Asian countries and enunciating relevant policies for the utilization of science and technology for national development. Some Asian countries have already made a start in this direction.

Science and technology are now commonly regarded as critical factors in national development. This demands that more and more people should have scientific literacy and, for this, science teaching should become an integral part of any programme of basic functional education.

The Conference on the Application of Science and Technology in Asia (CASTASIA) has observed in the publication "Science and Technology in Asian Development" the following: "Science education is the principal means, particularly in the developing countries, for transmitting scientific literacy to a broadening stream of population as well as for creating the scientific and technological manpower ... indispensable for economic and social advance. Science education policy should therefore be viewed as an integral part of a national education development policy, of which it is a leading sector."

Economic development and manpower: The development of scientific and technological manpower is perhaps the most crucial factor bearing on the total development of a country. Even if all the capital and raw materials are physically available, they can become productive only when the scientists, technologists and skilled people are available in adequate numbers. As the application of science and technology to development on the one hand and science education and research on the other are interdependent, the proper teaching of science constitutes a high-priority pre-investment for a country.

Improvement of educational opportunities and locating and nurturing talent in science can make important contributions in this regard. The teaching of science is not to be geared only to producing scientists and technologists, but also to producing a large base of intelligent users of the scientific enterprise by constantly enlarging 'scientific literacy' and making it more sophisticated.

Suggested goal for science in basic education for development

In the light of the foregoing considerations, the goal of teaching science at the basic level as a component of basic functional education and also as a component of scientific and technological development should be to create in the learners an awareness of their environment – physical, biological and social – and of the national development efforts of the country so as to fit them into and prepare them to play their part in society. Additionally, in a society where the scientific enterprise has begun to influence daily lives, science teaching should train the people gradually in the fundamental principles which govern scientific and technological processes and thereby encourage them to develop proper scientific attitudes and the necessary technological skills.

More specifically, suggested criteria for achieving the aims of science education at the basic level are given below:

1. Science education should be functional for all children at the first level and for all those who have missed the opportunity of education of this type. This latter category includes out-of-school children, youths and adults.

2. Science education at the basic level should be functional in terms of national development efforts to improve the quality of life of the people in such realms as promotion of health and nutrition, conservation of energy, development of agriculture, control of population and efficient use of resources.

3. Science education at the basic level should contribute to the development of creativity, scientific thinking, scientific attitudes, problem-solving skills as well as the acquisition of science concepts, principles, and processes.

4. Science education should be related to the environment of the learners, particularly to the changes taking place in their immediate surroundings, social and natural.

5. Science education should develop the ability, interest and confidence of the learners to prepare them to continue learning on their own and to apply the new knowledge to improve the quality of life and the environment.

6. Science education should be related to other areas of the curriculum.

Chapter IV

APPROACHES AND BROAD STRATEGIES FOR CURRICULUM AND INSTRUCTIONAL DESIGN

Curriculum design

In the light of the philosophy of science education at the basic level discussed earlier, a new approach to the teaching of science will have to be considered, inevitably involving a change in the curriculum. The change in curriculum from this point of view will not be the prerogative of the educationists alone. The whole resources of the community must be involved in this change so that the curriculum design reflects the development needs of the country and associates all the agencies which go to make this development possible.

To undertake such a change in the curriculum, two broad approaches could be taken:

a) a curriculum based on structure of knowledge;

b) a curriculum based on societal needs.

In the first approach, the element of relevance could be introduced by application of the concepts, skills and attitudes to daily experiences and to changes in the environment.

In the second approach the concepts, principles and skills are learned in the process of examining the situation and applying remedial measures.

The possible danger in the first approach may be the neglect of real-life problems and negative attitudes towards science due to an over-emphasis on concept learning. In the second approach there may be an overstressing of factual information at the expense of conceptual understanding. In order to obviate these dangers, the two approaches should not be considered as dichotomous but should be judiciously combined to be mutually supportive.

To link science teaching to the task of national development, the content of learning experiences has to be relevant to the needs of the learner, the general educational objectives and the aspirations of the country to be fulfilled through its various development programmes.

In the early stages, more attention should be given to the observation and study of the environment with the development of concepts derived from such observations. Progressively, the consideration of conceptual understanding should receive more attention but the study of the environment should not be neglected. Towards the end of the first cycle, more formalized activities, based on structure of knowledge, should become prominent. Even at that stage, the study of the environment in relation to the attainment level of conceptual understanding and problem skills should be maintained. This new mixed approach should be based on empirical studies, for the conducting of which guidelines should be established by the Technical Working Group.

Criteria for selection of content

In selecting the content for the new curriculum, the following criteria are suggested. The curriculum should be:

a) Relevant to real-life and work experiences of the learners, in particular to the changes taking place in these domains.

b) Significant to the fulfilment of the needs of the learners as individuals or as members of a family and community.

c) Feasible in terms of maturity of the learners and the availability of resources required.

d) Consistent with new knowledge.

The learning system as a whole

Curriculum design should also give consideration to the following:

a) In the past it has been the tendency to develop science curriculum based on a single approach. (Traditional, Process, Inquiry, Discovery, etc.)

b) Methodology should fit the need of particular types of learning, and different teaching methods should be used. For example, some forms of group work should be provided for experiences in socialization, interaction and co-operative work; some forms of self-instruction, (self-pacing individualized instruction) should be utilized for individual needs; practice of problem-solving skills under a variety of real-life situations to ensure mastery for skill acquisition.

c) Drills are necessary for skill acquisition.

d) A variety of instructional materials and media should be employed in suitable combinations for effective learning within the constraints of availability, teachers' competencies and the maturity of learners.

In the systemic approach to curriculum design it is important to specify the objectives, concepts and types of experiences needed to attain the expected outcomes. Samples of expected learners' attainments and appropriate learning experiences and exercises are given in Annex IV.

In the light of the above observations, any curriculum change will therefore require the formulation of appropriate instructional and management systems. The concept of such a systemic approach may be illustrated by the experience of the Republic of Korea.

Model of instructional system

In the Korean experience the total schooling is regarded as a systems operation. Teachers, students, curriculum, materials and equipment are some of the system's components linked together. Any change in one component inevitably invites change in other components. Many innovational projects have been undertaken in the past to bring about changes in one or two components only. It is not surprising that many of such projects did not survive long. With these observations in mind, KEDI developed a new instructional and management systems model (Annex V) in an effort to reform the country's primary and middle schools. The instructional system is characterized by its five stages of instructional flow: (1) planning, (2) diagnosis, (3) teaching-learning, (4) extended learning and (5) evaluation. Under each stage, desired curriculum materials, tasks to be done and working guidelines for teachers are described and/or prescribed on the basis of recent theories and research findings in the fields of learning, instruction and curriculum.

The KEDI model of instructional system has, however, been developed taking into consideration the components from the educational field alone. The objectives of basic functional education enlarge the scope of instruction and envisage the collaboration, with all available means, of all the agencies concerned with the development of the country. There is therefore a greater need to make effective linkages with such agencies in actual instructional programmes.

Management system

To meet the new needs of basic functional education, the educational management system, apart from developing its intra-linkages, has to develop inter-linkages with management system of other development areas such as agriculture, health and industries. This will assist the teacher in coping with the increased tasks of implementing the instructional programmes through inputs of available human and material resources from these areas.

A new management system is also being developed by KEDI as a support to the instructional system. Alternative ways of instructional media utilization, staffing, student grouping, classroom and other physical facilities, and other utilization plans are proposed and prescribed on the basis of theories of advanced modern management sciences.

Management as a service function

In the broadened concept of education as presented in this report, the schematic view of change would be not merely to link various aspects of the instructional system but also to establish, identify and promote linkages of the instructional system with other systems (and sub-systems) such as agriculture, science and technology, health and nutrition and industry. Another dimension of the systemic view of change is the interdisciplinary treatment. Management as a service function would deal with such matters as:

- Promotion and organization of a climate favourable to educational innovation.
- Improvement of decision-making and communication skills to ensure collaborative action among concerned agencies and decision makers.

The personnel who are concerned with the management of centres and institutions for the design and implementation of innovation will need to develop skills for analysing the systemic nature of change process to increase self-awareness and interpersonal effectiveness for collaborative work and to acquire competencies for designing and evaluating project strategies at local and national levels.

The meeting noted that such a programme of training had already been developed for key personnel concerned with educational innovations in general and suggested that the key personnel in the Member States concerned with innovations in science education should receive the benefit of such programmes: the Meeting felt that their involvement would raise the quality of the programmes as the experiences of educational innovations in Asian Member States have mostly been taken up in the area of science education.

Administrators and supervisors

There is a need to brief the administrators on the needs and nature of innovations for science education. Instead of trying to acquaint administrators with the technical aspects of the proposed change, the expected outcomes in terms of the impact on national development should be stressed. This should preferably be attempted through some visual presentation of actual attainments.

Supervisors now perform two functions – regulatory and extension. These should be separated. The extension function should have a direct link with research and development.

Professionalization

Although designing of the curriculum has been institutionalized and systematized, it still suffers from the lack of an empirical research base and professional approach. In view of the problems identified and the new directions proposed, development of a research base and raising the professional standards of work must be two of the elements which should receive high priority.

METHODS, MATERIALS AND MEDIA

Curriculum centres

National centres promoting innovations in science education and in other areas of education, although still very young, have already produced very encouraging results and have contributed to making the educational systems of their countries much more dynamic than before. It was in recognition of their achievements that the Third Regional Conference of Ministers of Education and Those Responsible for Economic Planning in Asia (MINEDAS) which was held in Singapore in 1971 proposed the creation of a mechanism for promoting exchanges of the valuable transferable experiences generated by these centres among the Asian Member States, adding that educational innovation should be related to goals of national development.

With many of these centres now well established and having acquired experience and confidence, they are in a position to take an effective part in undertaking reforms more directly linked to development in collaboration with other agencies within and/or with Member States. Networks of educational institutions covering national or regional needs and co-operating with the national development centres have been established.

In view of the broader and more functional role of basic science education, these centres will need expertise of other kinds under arrangements which will vary from country to country. Also the network of institutions co-operating with the national centres may continue to be expanded to include other types of institutions and professional groups. This may necessitate strong governmental support.

Similar networks at sub-national levels would need to be established or expanded in countries where such centres already exist as a part of the national organization.

Instructional materials

There should be a variety of instructional materials, the use of which will be dependent on the area of study and on the availability of resources. These should be complementary to one other and relevant to the content being learned.

Where appropriate and available, mass media should be encouraged. There is already a growing trend towards using mass media in conjunction with other media such as correspondence instruction and face-to-face instruction.

The introduction of new materials without some changes in the instructional and management systems which are usually based on the assumption of traditional means, materials and modes of learning is likely to create confusion rather than leading to more effective learning. Hence the need for designing learning and management systems based on the curriculum, available resources, media of learning and desired combinations of teaching methods, is emphasized.

Some guidelines for the production of instructional materials are given in Annex VI.

Equipment

National equipment centres or units have been set up in a number of Member States. There are many problems associated with the design, production and supply of equipment. There has not always been sufficient attention given to the co-ordination of these functions with local manufacturing and marketing organizations. It is often beyond the capacity of the national equipment centres to supply the equipment needed througout the entire country. At this stage of education, however, it should be possible to meet many of the needs from the use of the environment as well as locally available materials.

Centres should help the teachers in the task by supplying the relevant and necessary guidance. Some of these materials could be produced by the teachers with the assistance of pupils which would incidentally promote positive attitudes towards work. The facilities in schools where some craft training is provided could be used for this purpose and in other cases, simple tools could be supplied.

Evaluation

Many of the participating Member States have already done away with terminal examinations at the end of the basic level. Formative continuous evaluation is now a prominent trend. This may take the forms of self-evaluation or teacher evaluation.

Formative and summative evaluation provide a feedback for redesigning the curriculum and teaching methods which should be flexible to permit changes by the teachers. Reports of the teachers on their experiences could also provide useful feedback to the curriculum development centres. This will build up teachers' confidence and they will identify themselves with the changes brought about as a result of their suggestions. Curriculum design centres would also receive information on the suitability of the curriculum under a variety of situations and make changes on the basis of empirical evidence thus gathered.

Modules

Students usually learn by using textbooks. Most teachers admit that there are weaknesses in textbooks. Textbook-centred learning mostly takes care of the facts, principles and generalizations of science. The important objectives of skill development, attitudinal change and applications are not catered for. These weaknesses become especially evident when it is desired to make learning more meaningful for children by relating learning experiences more closely to their environments than allowed by a textbook. The learning module offers one way of overcoming this weakness by giving flexibility in the choice of topics to be learned. Hence, it allows for a more personal and individualized way of learning. Modules can be used as supplementary materials or on a self-instructional, self-pacing basis. They can help the teacher to give more personal attention to individual children and make better use of class time. Modules can also be used to brief and inform busy administrators about new programmes, projects, and developments.

Teacher education modules would be useful at both pre-service and in-service levels. Modules could be used to acquaint college students with actual school situations.

Teachers in the schools can refer to modules as their individual schedules permit. These modules could then form a very sound basis for discussion at subsequent in-service seminars.

Some suggestions for the production of modules are presented in Annex VII.

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Chapter VI

NEW ROLES OF THE TEACHER, AND TEACHER EDUCATION

In the context of national development, additional competencies are needed for the new role of the teacher as a guide and helper to the child in and out of school. Instead of being merely a transmitter of knowledge in the classroom, the teacher has to play the roles of community leader, resource finder, organizer, co-ordinator and adviser. This demands a continuous upgrading of the basic and professional qualifications of the teacher. In order to achieve this, the professional training of Basic Functional Education teachers should include a study of science as a compulsory subject in the teacher training curriculum.

Teacher training

Pre-service training. In the past, pre-service training has not been able to prepare the teacher adequately to meet his classroom needs, particularly in the area of science education. With the changing trend of science education, teachers too often find themselves attending in-service courses almost immediately after completing pre-service training.

With the new role the teacher is expected to play to link science with the developmental needs of the society, pre-service teacher training courses for teachers of basic functional education should:

1. include the study of science as a compulsory subject;
2. attempt to closely integrate practice and theory (didactic aspects, and methods, techniques and procedures);
3. prepare the trainee to identify and make use of his environment as much as possible;
4. develop manipulative skills in the use of simple tools to improvise simple science-teaching equipment from readily available materials;
5. enable the trainee to respond positively to the needs of children as well as to the development needs of the community;
6. bridge the gap between the regular teachers' work and that of others engaged in developmental activities by providing experiences of participating in non-formal education programmes.

In-service training. The responsibilities of the teacher have increased in the past years on account of educational reforms undertaken by the countries and there is evidence of a growing feeling of resentment. Changes in curriculum are not likely to be welcomed by teachers if they imply acceptance of an even greater burden by the teachers.

One problem is that teachers will have to obtain assistance to understand the rapidly increasing new scientific knowledge so that they will be able to translate it in such a way that pupils' learning will be facilitated.

Another problem is that the teachers have been assigned new types of roles and they are expected to use new types of media for which they are not adequately prepared. If they were, in the new types of learning programmes which require independent study on the part of the learners to cover a part of the curriculum and in the supply of learning materials which can relieve them of a part of their teaching load, the teachers would have been active promoters and would have achieved greater professional satisfaction from their work.

For the functional aspects of the curriculum the teachers, especially in the rural areas, should be able to utilize the services of paraprofessionals like farmers, craftsmen and other resource persons. In order to use these resources properly the teachers will have to assume a new role for which they will need suitable preparation.

The ill-planned in-service training courses in the past have proved to be inadequate. There is a need for reorientation of the training programmes in several respects viz. in-service training courses should be supplemented by TV and other mass media; there should be arrangements for continuing education and facilities in designated schools to which teachers from nearby schools could turn in accordance with their needs. (e.g. the Philippines experience where some middle and high schools are designated for this purpose under the direction of the regional and national science education centres).

In-service courses should be more challenging than they are in the present practice of merely covering the course at the expected learning attainment levels of the pupils. For instance, for the development of problem-solving skills, more demanding situations than those prescribed for pupils should be included in the courses; similarly, background materials relevant to but of much higher level than that provided for the pupils should be supplied.

Teacher competencies

Before the introduction of any curriculum change, the new or expected roles of the teachers should be identified, the requisite competencies determined and appropriate materials and training programmes and an incentive system for making attending courses more attractive should be planned and implemented. Subsequent to the introduction of the change, the effectiveness of the materials and training courses could be evaluated in terms of teacher performance.

A sample list of teacher competencies is provided in Annex VIII.

Detailed guidelines on the new role of science teacher and his competencies should be prepared by the Technical Working Group.

Chapter VII

RESOURCE MOBILIZATION

The intimate relationship between the economic development of a country and the education of its people is too well recognized to be reiterated. By giving the highest priority to the development of education at all levels, with special emphasis on science education, there can be an adequate response to the rising expectations in the developing countries.

The Asian countries in general have vast human and natural resources which are either untapped, under-utilized or unutilized due to various factors. The mobilization of all these resources is an important strategy in implementation of any development programme.

In the context of linking science education to national development, the mobilization of resources assumes high priority. These resources can be grouped under two broad categories - human resources and physical or material resources.

A. Human resources

1. The teacher. The teacher continues to be the pivot of any programme of education, and is probably the most important human resource. Capabilities of teachers must be improved by better training, both through pre-service and in-service programmes so that they are able to cope with the new role expected of them from mere transmitter of information to that of community leader and resource finder.

The other dimension of the problem arises from the fact that there is a constant increase in the already-large class size in almost every country and the activity approach and methodology of science teaching cannot be effective in such large size classes. Hence the need for training more teachers.

2. The para-teacher. In spite of a well-developed pre-service teacher training programme supported by periodical in-service training programmes, it would be difficult for teachers to have all the necessary information and skills to discharge their new role. They have therefore to utilize more and more the assistance of para-professional teachers from other fields (agriculture specialists, extension workers, health visitors, doctors, mechanics, engineers, knowledgeable farmers) by inviting them to the school for talks, lectures or demonstrations or to take the children out to real-life situations to obtain first-hand experiences.

3. Increasing use of multi-media approach. There is an increasing trend to use the multi-media approach in the teaching of science. The various

media which are to be used in science education will need the development of software of different types. To do this, human resources in the form of specialists such as scientists, curriculum developers, textbook and other instructional material writers, script developers and producers of audio-visual aids or evaluators will have to be mobilized.

4. Teacher training at the in-service level. To make training programmes effective, adequate numbers of competent teacher educators will be needed who can not only train but also maintain a follow-up programme of supervision.

5. Research base for innovation. There is a need for developing a cadre of researchers in science education so that all curriculum changes are based and planned on appropriate research findings.

6. Expertise of university and research scientists. There is a need to obtain the expert advice of the scientists and university specialists for the improvement of science education programmes in the context of basic functional education, so as to minimize the gap between the frontiers of science and classroom instruction.

7. Supervisory cadre. As the classroom teachers now have to play many roles, the development of a cadre of science supervisors capable of assisting them in methods and materials is an essential ingredient for the success of the new programmes of basic functional education.

8. Regional expertise. There is considerable isolated expertise available in the different Member States of the region which is a valuable resource that can be mobilized. All such expertise needs to be pooled through an agency like ACEID and put to effective use through a well-co-ordinated exchange programme.

B. Physical and material resources

The physical and material resources for the successful implementation of basic fundamental education can be considered at three levels.

1. Local-level resources. Some of the locally available materials required for science education at the basic level are identified below. Many of them are readily available from the environment of the community; others will have to be improvised. Teachers may required guidance and assistance in utilizing these resources.

a) School

(1) A variety of learning materials within the school, including textbooks, workbooks, curriculum and teacher guides, self-learning materials and modules (based on research findings) in national languages;

(2) Science equipment and kits;

(3) Audio-visual teaching aids - like graphic materials, films, filmstrips, slides.

b) Environment

(1) Flora and fauna, rocks and soils, natural phenomena, agricultural farms, forests, dairies, poultries, fisheries, mining and industrial establishments;

(2) Other community facilities such as libraries, health centres, hospitals, transport stations, power stations, post offices, telephone exchange, veterinary clinics, meteorological stations, radio stations.

2. <u>National-level resources.</u> A large number of national-level resources are available for educational purposes. Teachers must be able to recognize and utilize these resources in planning their teaching programmes, particularly in science. A suggestive list would be museums, botanical and zoological gardens, aquariums, marine laboratories, transport stations, workshops and factories, broadcasting networks, science fairs and exhibitions, science centres, meteorological observatories, observatories, aerodromes.

3. <u>Regional-level resources.</u> There could be exchange of sample teaching materials, books, teaching aids and other equipment for study and use within the region.

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ANNEX I

LIST OF PARTICIPANTS AND OBSERVERS

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ANNEX II

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Co-Chairman	: Dr. Dolores Hernandez (Philippines)
Rapporteurs	: Mr. N.K. Sanyal (India)
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Dr. D. Hernandez (Philippines)

Mr. N.K. Sanyal (India)

Mr. B.T. Koh (Singapore)

Dr. Se Ho Shin (Republic of Korea)

Mr. Sah Myung Hong (Republic of Korea): Secretary

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Dr. Se Ho Shin (Republic of Korea)

Mr. Chin Pin Seng (RECSAM)

Dr. D. Hernandez (Philippines)

Dr. M.C. Pant (ACEID)

ANNEX III

AGENDA OF THE MEETING

1. Statements of Welcome by Co-organizers of the Meeting
2. Introduction of Participants and Observers
3. Election of Officers
4. Consideration of Provisional Schedule of Work and Review on terms of reference.
5. What is APEID, ACEID and KEDI - Slide tape presentations.
6. Orientation on, and Review of Module development in science education
7. a) Discussion on problems, gaps and prospects of science education in the context of Science and Technology for development.

   b) Review and synthesis of various developmental efforts in all branches of Science and Technology and the new trends of Development Education.

   c) On the basis of the above deliberations, formulation of a new philosophy and approaches of "Science Education for Development."
8. Consideration of APEID Work Plan on Science Education with a view to suggest adjustments and guidelines on strategies for implementation.
9. Formulation of suggested draft terms of reference and agenda for the subsequent Technical Working Group Meeting.
10. Deliberation on expected learners' attainments in science and the implication on new role competencies of teachers.
11. Prepare general guidelines on exemplar module development in Science for Basic Functional Education both in school and out-of-school and In-service Teacher Education.
12. Preparation of guidelines for the design of operational details for module development.

ANNEX IV

EXPECTED LEARNERS' ATTAINMENTS AND APPROPRIATE LEARNING EXPERIENCES AND EXERCISES

A. Sample objectives

1. Applying the processes of science to life situations as a basis for learning the scientific method and developing scientific attitudes.

   To observe
   To communicate
   To measure
   To infer
   To formulate hypotheses
   To interpret data
   To make generalizations

2. Learning to think

   creatively
   critically

3. Applying knowledge and science processes to

   a) understanding and solving problems of

      i) daily life
      ii) school situations
      iii) community situations
      iv) prevailing beliefs

   b) learning in other areas

4. Promoting positive attitudes towards science and a continuing interest in science.

5. Learning how to learn; for instance:

   a) develop the attitude for wanting to learn.
   b) know the sources of information in the community.

6. Eagerness to promote and readiness to accept changes and to adapt to new ideas

B. Sample experiences

Below are some sample experiences which may be used to attain some of the objectives:

1. To help develop creative thinking

   a) involvement of the learner in planning, organizing and evaluating learning activities.

b) use of 'game' situations as an approach in science teaching; e.g., have the pupils formulate rules in a learning situation as they would to play a game; use of simulations, competitions, crossword puzzles.

c) use of construction activities.

d) have pupils plan experiments using materials in the environment; have them suggest substitutes for materials not available.

2. To help develop critical thinking

Provide experiences that will make the learner

a) distinguish between inferences and observations
b) make judgements on basis of evidence
c) generalize on basis of several cases

3. Promotion of positive attitudes towards science.

Provide experiences such that the learner is involved, experiences success and has some tangible product.

4. To inculcate an eagerness to promote and readiness to accept changes and to adapt to new ideas. This could be attained by using a variety of experiences, open ended activities and situations which promote creativity.

5. To develop learning how to learn:

This objective would be attained if the other aforesaid objectives are achieved.

C. Sample concepts

A list of some science concepts which could be used for the Basic Functional Education programme, is given below.

1. Human body

digestion, respiration
muscles, bones, sensory information
energy
toxic substances
diseases
growth and development

2. Home

water supply
energy in the house
food and meal preparation
sewage disposal

3. Natural environment

Soil, air, water, weather
plants and animals
populations

4. The community

population density
community resources

The Technical Working Group will be expected to report on the experiences in this regard:

1. whether these are being used in their countries
2. whether they will promote better science learning
3. give examples of their own.

D. Sample resources in the community

plants, animals, soil, different types of seeds, flowers and fruits, insects.
candles, kerosene, different household ware, glass or plastic containers.
farmers, health workers, craftsmen.

E. Sample questions and investigations

These may be concerned with school, home, community, learners own life, natural phenomena.

1. Why do we irrigate crops after applying fertilizer?
2. What steps are taken in homes to save stored grains from insects?
3. Why does malaria break out during rainy seasons?
4. Why should we wash fruits before eating them?
5. Why do metals feel cold on touching them?
6. Why does water form on the outside surface of a glass tumbler when ice is put in it?

The following investigations could be carried out:

1. investigating the water supply in the community,
2. investigating the quality of water in the community,
3. investigating the traditional methods of preserving of food.

ANNEX V

A GENERAL INSTRUCTIONAL SYSTEM MODEL

Evolved by the Korean Educational Development Institute (KEDI)

A. Need for the development of a new instructional system

The inefficiency and inappropriateness of conventional instructional system in primary and middle schools of the Republic of Korea is now evident everywhere. Overcrowdedness and self-contained classrooms with very little teaching-learning resources other than teacher, textbook and blackboard are some of the typical characteristics of Korean classroom in primary and middle schools. It also has been continuously pointed out by many scholars, teachers and parents that many of the current materials and procedures are inadequate and that need for improvement is urgent.

Some efforts have been made to bring about necessary changes in various aspects of the educational process through various means. Of these efforts, some paid special attention to teacher training, and others emphasized curriculum renovation and still others focused on teaching-learning material development. The use of educational technology has been advocated by some scholars and teachers from time-to-time. Inspite of the mounting effort to renovate Korean education during recent decades, no efforts have ever paid attention to the comprehensive nature of schooling as a system operation. Curriculum materials, instructional procedures, teachers, students, facilities and equipment are some of the important components which are in linkage with one another to constitute a system.

What is implied in the above is that change in one component inevitably invites changes in one or more related components. Many innovational efforts in the past tended to overlook this system-nature underlying the educational practices. It is not surprising that most of these innovative efforts did not survive long.

B. Philosophy and guidelines

Given the overcrowded and self-contained classrooms and some administrative and clerical burdens, it is a common practice among teachers to begin the instruction of a unit without any effort to identify the deficiencies their students might have in learning the unit. In general, teachers give instruction which is best suited to the average student and give hardly any consideration to the needs of either the accelerated or slow learners.

The aforementioned situations have helped in moulding the teacher as a medium and authority who gives orders. This results in the learning environment being of a calm and expository type, where the students are at the receiving end and respond only when they are required to do so. With these observations in mind, KEDI envisioned the following as the goals of the new system: these have been the philosophical and pedagogical guidelines for developing the system model.

1. Individual students are to be provided with more learning experiences with special emphasis on the development of higher mental processes such as problem solving, critical thinking, and creative production.

2. Individual students are to be provided with more learning experiences for better internalization and acquisition of values and attitudes, productive skills and knowledge that are uniquely needed for national development.

3. Learning progress of individual students is periodically monitored, and the results are to be fed back into the teaching-learning processes.

4. Individual students should have more opportunities for self-directed learning.

5. A variety of learning resources through supplementary instructional materials and media are to be available for the mastery of major instructional objectives.

6. Individual students should have access to a variety of learning resources and measures such as supplementary and enrichment programmes, and flexible classroom organization adapted for individual differences in learning rate.

The above may also be taken as 'desired changes' for which the new system model is being developed and tried-out by KEDI.

The general instructional system model will be described in the following section.

C. The KEDI General Instructional System Model

It is most desirable for the teacher to plan instruction according to the need and ability of each student in the class and to let each student master the learning task at his own pace, but the large number of students in a class makes this procedure very difficult, if not impossible, for the teacher. Therefore, KEDI has developed a new Instructional System Model which is able to take into consideration the academic progress of individual students, but does not overload the teacher with management problems.

According to the KEDI instructional model, instruction for a learning task goes through five stages as shown in Figure 1. In Planning, a teacher makes lesson plans and management plans for the learning task. In Diagnosis, a teacher identifies deficiencies of students in prerequisites for the learning task and makes provisions for remedial work. In the Teaching/Learning stage, main teaching and learning activities take place. In the Extended Learning stage, enrichment and/or remedial instruction are provided, based on the formative test results. In Evaluation, at the completion of instruction for a learning task or tasks, a summative evaluation is conducted.

Figure 1. General Model of KEDI Instructional System

	I	II	III	IV	V
General Model	Planning →	Diagnosis →	Teaching/ Learning →	Extended Learning →	Evaluation
Instructional Time Required		10 %	70-80 %	10-20 %	

Estimated Number of Instructional Units (Units of Learning) Per Semester[1]

Korean	10-12	Science	6-8
Mathematics	6-8	Moral Education	4-6
Social Studies	6-8	Music	4-6

Each stage will be described in detail below.

1. Planning

In planning instruction for a learning task, the most important precondition is to identify the instructional objectives and their interrelations through task analysis. This task analysis along with the detailed teacher's guide for each instructional unit will be made by the KEDI research team and distributed to individual teachers. The teacher should have a clear understanding of the terminal objectives and the structure of the learning task through careful study of the teacher's guide. As it is shown in Figure 2, teachers are also supposed to finalize lesson and management plans.

Lesson plans are included in the teacher's guide, but the teacher needs to make some modifications so that they conform to the characteristics of the community and to particular students in the class.

In other words, the teacher should make detailed plans for student learning activities as well as teacher activities, using the teacher's guide as the guideline. The teacher should make provisions for latent curriculum and make a plan for evaluation activities. KEDI will send the ITV schedule to each individual teacher but the detailed daily time schedule is the responsibility of each individual teacher, who must also plan for use of special facilities or equipment if they are needed.

1. In this model, an instructional unit is defined as a learning task or tasks requiring approximately eight to sixteen lesson hours of instruction. In designing an instructional unit, consideration is given to the unit structure in textbooks as well as to the internal structure of the learning tasks.

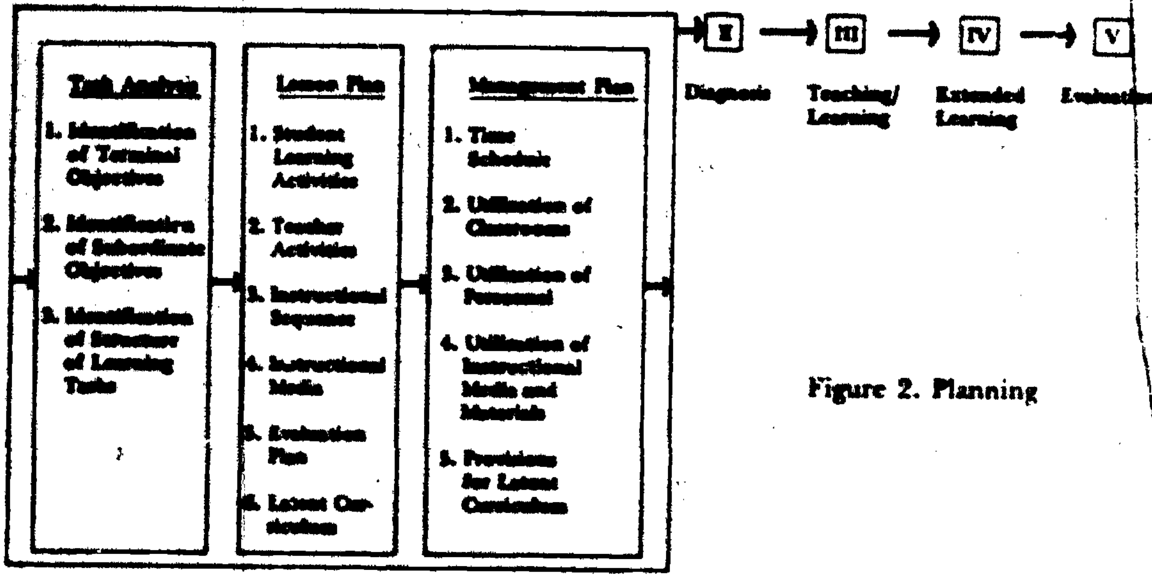


Figure 2. Planning

2. Diagnosis

The second stage is diagnosis (Figure 3). The purpose of this stage is to identify students' deficiencies in the prerequisities for the learning task and provide them with remedial instruction at the outset of instruction. If diagnostic tests show that the students have major deficiencies in their prior learning, a remedial programme should be provided to make up the deficiencies whenever possible. For example, when the lesson unit is division, students should have mastered multiplication previously. Therefore, the teacher should identify and help those students who are having difficulty in multiplication.

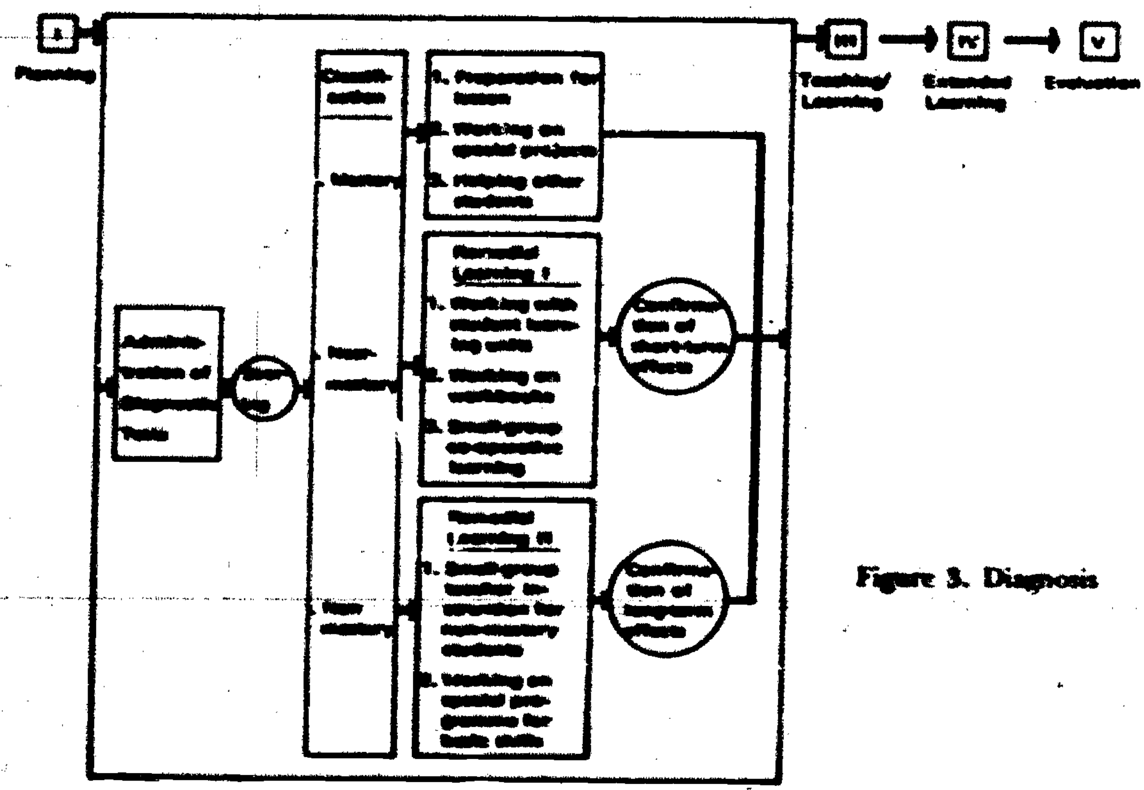


Figure 3. Diagnosis

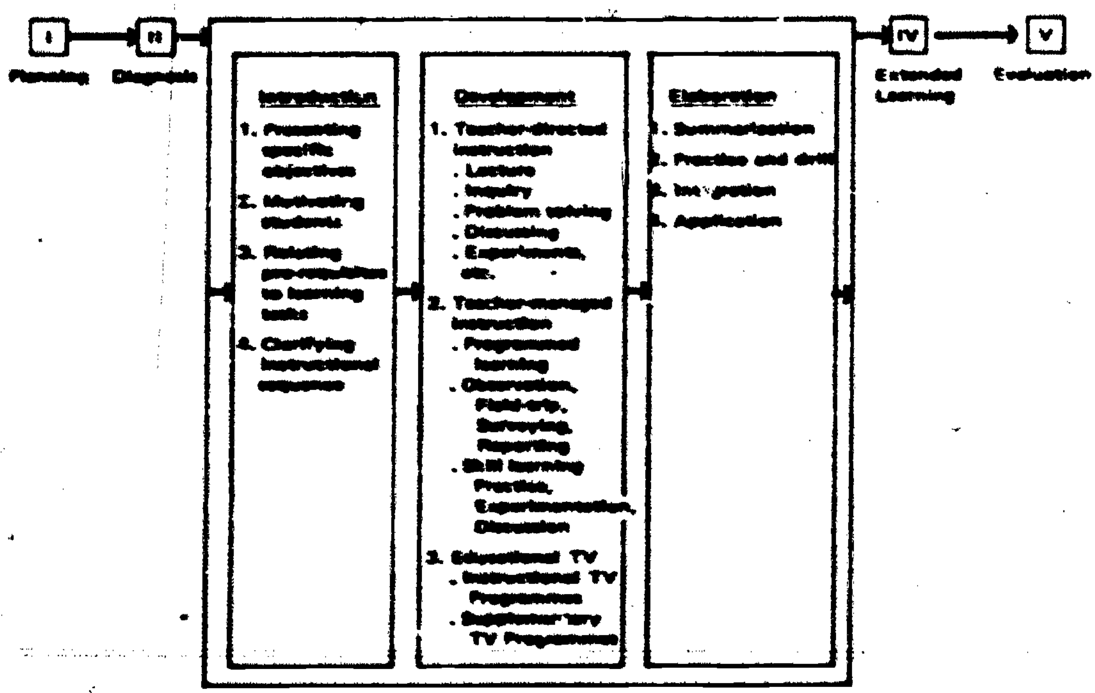
Although it is not always necessary to have a diagnostic test at the beginning of each unit in all subjects, in science and mathematics such prior testing is usually done. Diagnostic tests and instructors' manuals for their use have been developed by KEDI. Teachers' manuals also contain suggestions for remedial instruction for students with deficiencies.

On the basis of diagnostic test results, the teacher should provide appropriate learning experiences for each student. The students who have mastered previous learning tasks can either help other classmates or prepare for the next unit. The students who have minor deficiencies can either study independently at home with programmed materials and/or workbooks or get some help from more successful classmates. In the subsequent class session, the teacher needs to check on the assignments and be sure that all students have mastered the necessary learning tasks for the lesson unit. The students who have serious deficiencies may have teacher-directed small-group remedial instruction. It can be a programme of several hours, or a semester-long special programme to improve reading or arithmetic skills.

3. <u>Teaching/Learning</u>

As Figure 4 reveals, here actual teaching and learning activities take place and approximately two-thirds of the total instructional time is spent in the teaching/learning stage. This stage can be further divided into three steps: (a) Introduction, (b) Development, and (c) Elaboration.

Figure 4. Teaching/Learning



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In Introduction, teachers are encouraged to use the teacher's guide prepared by KEDI to clarify instructional objectives for their students, and to relate a student's previous learning to the present learning task. In Development, the content of the instructional unit is presented to students who respond to the stimuli to attain the mastery of the task(s). A teacher may direct instruction by using the teachers' guide developed by KEDI, or may manage ITV or programmed instruction, or student discussion.

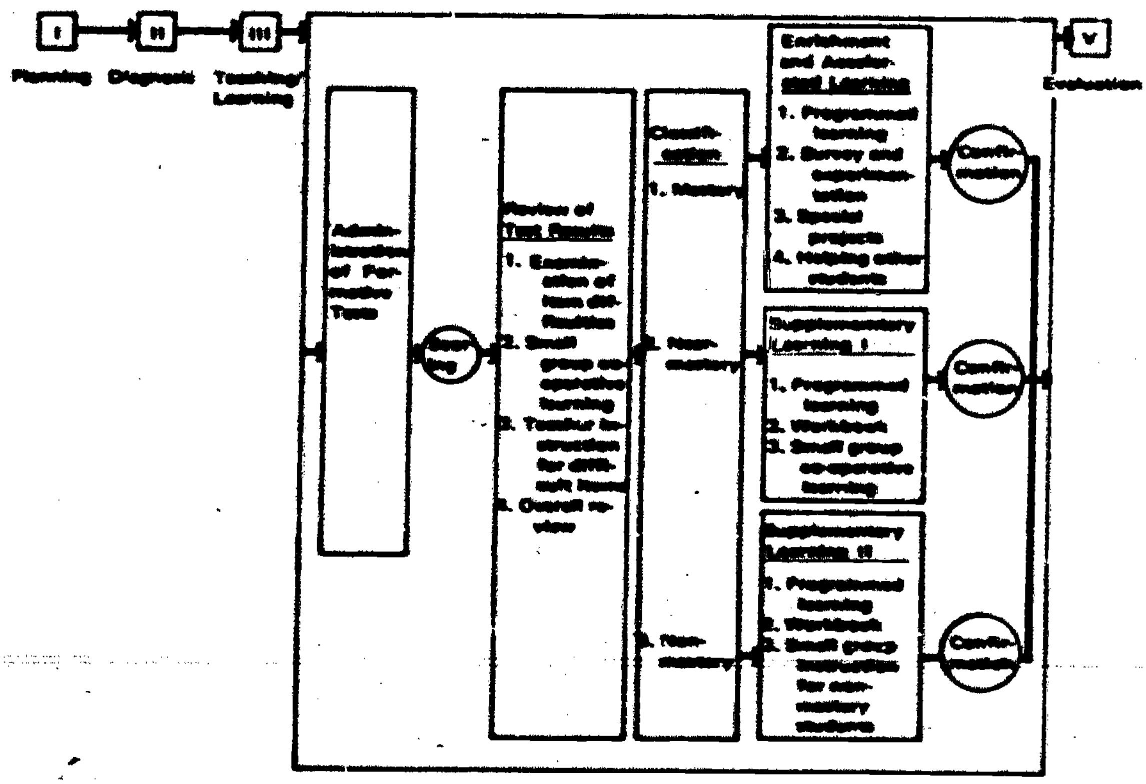
The last step of Teaching/Learning is Elaboration. In Elaboration, the teacher summarizes what has been studied, ensuring student learning through practice and drill, and helping students to make applications and generalizations from what they have learned.

4. Extended Learning

Administration of formative tests, and provisions for enrichment, accelerated and supplementary learning are the major activities in the stage of Extended Learning. Formative tests are given to students in the course of instruction in order to identify particular difficulties and to improve instructional activities and strategies. (See Figure 5 below)

It would be desirable to have the formative test every two or three lesson hours, but because of the shortage of time the KEDI instructional system model requires such evaluation only once for approximately every four lesson hours. Teachers use the evaluation materials developed by KEDI.

Figure 5. Extended Learning



As a result of the evaluation, teachers are able to identify the particular difficulties encountered by students and thus give more individualized assistance. Also, teachers are able to classify students into three categories: mastery, near-mastery, and non-mastery.

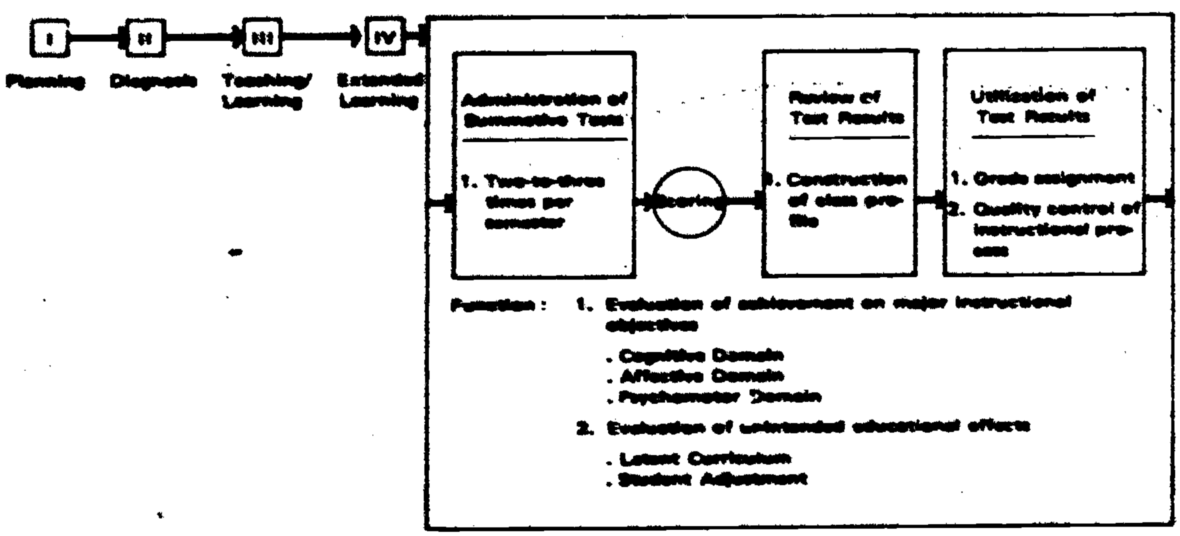
To those who achieve complete mastery of the task, special projects or programmed instruction are provided for enrichment, and sometimes these students also reinforce their learning by helping other classmates. To those who achieve only partial mastery of the task, programmed or other instructional materials are specified for independent learning. Sometimes, these students get help from those who have achieved complete mastery of the task.

The teachers themselves use the programmed materials and workbooks to give compensatory lessons to those who have greatest difficulty with the task. They also personally check the students' work to ascertain the results of the enrichment and supplementary learning experiences.

5. Evaluation

Evaluation is the last stage of the KEDI Instructional Model. In this stage, summative tests (see Figure 6 below) are administered to students for the purpose of evaluating their achievement on major instructional objectives in the cognitive, affective, and psychomotor domains as well as evaluation of unintended educational effects.

Figure 6. Evaluation



A summative test may be given at the completion of each unit, but to avoid the drastic reduction of instructional time this causes, the KEDI Instructional Model requires a summative test only after completion of from two to three instructional units. Although the KEDI provides teachers with test items and other evaluation materials in all of the subject areas, teachers may decide to use their own tests. With the test results, teachers construct a classroom profile of student achievement in each subject area, and assign grades to students. A teacher can also use these results to evaluate the effectiveness of his own instruction.

Brief introduction to KEDI school management system

A. Need for new school management system

The new instructional system proposed by KEDI requires substantial changes in school administration and management practices. Whereas the instructional system mostly describes the desired conditions for teaching/learning activities within the classroom, the management system specifies mechanics and operational procedures of supplying the necessary support required for the creation and maintenance of appropriate teaching/learning conditions. In this regard, the school management system may be taken as a supporting structure to the instructional system.

The new instructional system prescribes a variety of new inputs. Under the new system, students learn through different instructional media, a variety of materials, and from different teachers in different settings. A set of input variables may be classified as follows:

Instructional Media	Instructional and Learning Materials	Student Organization	Staff Organization
Teacher Instruction (TI)	Textbook	Large Group (120-180)	Master Teacher
Programmed Self-Instruction (PI)	Workbook	Intermediate Group (60-80)	Master-teacher
Instructional TV	Teachers' Guide	Small Group (15-20)	Regular Teacher
Instructional Radio (IR)	Tests (DT. FT. ST) Supplementary and Enrichment materials		Teacher-Aid

The provision and effective utilization of these inputs, many of them new to Korean teachers and administrators, may require quite different management patterns with regard to the tasks of the school principal, supervisors, teachers, and administrative and clerical staff.

B. Philosophy and guidelines

1. The teacher devotes more time as an instructional manager who plans and creates teaching/learning processes and evaluates the outcomes rather than as a medium or knowledge transmitter in terms of the labour-intensified, chalk-talk method.
2. More competent teachers are recognized.
3. Teachers have at least two or more specialized subject areas in the curriculum with which they can identify themselves as expert teachers.

4. Individual students, regardless of where they reside, will have more chance to be taught equally well.
5. Teachers, principals and supervisors are well aware of instructional objectives by grade, subject matter, and unit level.
6. Effective management is judged in terms of objectives achieved.
7. Evaluation data are better utilized by teachers, administrators, supervisors, students and parents.
8. More flexibility is practised in grouping students and facilities utilization.
9. A large instructional unit of about five classrooms will be the central focus of instructional management.
10. Cost-effectiveness of schooling will rise when bold re-allocation of the school budget is attempted so that more money is spent directly for the achievement of objectives.

ANNEX VI

GUIDELINES FOR THE PRODUCTION OF INSTRUCTIONAL MATERIALS

Three aspects of materials to be developed and supplied

- Kinds of materials ;
- Criteria for selection, production and utilization of materials ;
- Production of materials.

Kinds of materials

1. Materials for students' self-learning; e.g., programmed and semi-programmed packages, modules, supplementary readers ;
2. Materials for teachers; e.g., teachers' guides, supplementary background readers, teachers' modules ;
3. Teaching aids: TV, radio and simple audio-visual aids ;
4. Evaluation materials (diagnostic, formative, summative);
5. Professional reference materials ;
6. Equipment ;
7. Materials on the use of community resources ;
8. Information sheets on sources of supply of technical bulletins, materials such as from government agencies, health, agriculture and agencies like manufacturing firms, travel agencies ;
9. Information sheets on the facilities established by educational and other agencies for use of teachers ; e.g., services provided by curriculum centres, teachers' colleges, professional associations and science centres.
10. Materials produced by educational institutions and teachers, such as improvised equipment, simple experimental designs

The mechanism for promoting the production, supply and exchange of materials

The Technical Working Group should consider setting up an appropriate mechanism to promote the development of instructional materials by teachers. Participants should bring information on existing facilities and arrangements for production and supply of the types of materials mentioned above and other information that might be relevant. They should also bring with them samples of materials available.

Annex VI

Criteria of selection of materials

There should be a proper organizational arrangement to ensure that the necessary materials meet the teachers' needs in the context of the curriculum produced, and that suitable existing materials are identified and disseminated. In this connection, it would be necessary to observe some criteria for selection.

1. Materials for students or teachers should have gone through a process of tryout and evaluation.
2. These materials should be relevant to the set objectives.
3. They must be usable, simple in operation, interesting and inexpensive.
4. They should be safe for handling by pupils.

The teachers must use the wide variety of materials which might be available to them or produced by them if in their judgement they would improve the effectiveness of their teaching. They should however make sure that the materials have either been produced by the agencies or persons who have the requisite competence.

Production of materials

Various agencies would be involved in the production of materials such as the following:

1. Curriculum design centres and material production centres. These centres could also be mainly responsible for the dissemination of information on available materials.
2. Teacher training institutions, especially with the help of post-graduate students who could work on materials as part of their research.
3. Teachers' associations and individual teachers.
4. Developmental agencies and their extension wings.

ANNEX VII

SUGGESTIONS FOR THE PRODUCTION OF MODULES

It should be recognized that modules of different levels of sophistication, from multi-media packaged learning kits to simple printed materials, can be prepared. Generally, learning modules have the following characteristics or elements:

- small units of learning which can be covered in a few weeks' time or less;
- well-specified objectives in terms of expected pupil behaviours or concepts;
- specification of entry behaviour and concepts;
- pre-test to determine pupil's readiness for the unit;
- design of instruction to achieve specified objectives or enabling activities;
- self-evaluation measures (formative evaluation) at appropriate intervals during the learning process;
- providing additional experiences for remedial work (e.g., use of a variety of media where possible)
- providing sources of information;
- containing an end-of-the-unit test
- may or may not have an accompanying teachers' guide.

Some suggested topics for development materials

A. Materials for teacher education

1. How to prepare an inventory of:
   a) Local resources available for use in science education;
   b) Local activities involving scientific processes;
   c) Ways in which a knowledge of principles of science could be applied to help local people in matters of hygiene, health, nutrition and agriculture.
2. How to improve the techniques involved in asking questions, conducting discussions and making diagnoses regarding causes of student errors and constructing evaluative measures.

3. How to integrate television lessons and films into the ordinary school programme.

4. Modules concerning development of desirable teacher competencies.

5. Materials especially prepared for teachers who are unfamiliar with inquiry and discovery methods of teaching. Exercises should be suited to age, background and experience and lead to a genuine understanding of the method.

6. How to construct simple equipment.

B. <u>Materials for use of pupils</u>

Some areas of content where modules could be developed for both formal and non-formal situations.

1. Science concepts relevant to safety; for instance, traffic, poisons, fire.

2. Environmental awareness: pollution, conservation.

3. Health, hygiene, nutrition.

4. Science concepts illustrated in daily life in an agricultural environment, fishing environment, and industrial environment.

C. <u>Materials for others</u>

1. Materials to show administrators the aims, objectives, methods and implications of modern science education.

2. How to establish and maintain an inventory of science teaching aids and equipment that can be continually updated in order to show current needs and priorities.

ANNEX VIII

SAMPLE LIST OF TEACHER COMPETENCIES

1. They must be familiar with the community in which the school is located—its culture, language, beliefs, norms and common practices.
2. They should know the government agencies, organizations and associations whose activities relate to, or could be used to contribute to, pupil's learning and utilize these effectively.
3. They must have the competency to analyze government programmes in terms of their subject areas.
4. They must comprehend what creativity (or the application of imagination) is and how they can enhance it in the learner.
5. They must be able to utilize and enlist the co-operation of para-professionals and resource personnel from the community.
6. They must be able to organize learning activities to fit the environment and give <u>responsibility</u> for <u>learning</u> to the <u>learner.</u>
7. They must be able to diagnose learning difficulties of the child and provide remedial measures.
8. With regard to equipment, they should know what they have, what they need and should always be ready to obtain the right equipment when the opportunity arises.
9. They must be able to use formative evaluation competently:
   - a) to help the learner attain learning objectives and
   - b) to help diagnose their curriculum and instructional procedures.
10. They must know the resources available in the community and be able to use new media.
11. They must bring their knowledge of science and technology periodically up to date.
12. They should be able to relate science concepts to the immediate environment and vice versa.
13. They themselves should exhibit an inquiry-oriented attitude, suspending judgement until all evidence is available.

14. They should be able to identify materials and resources available in the environment and from the community for use in their teaching.

15. They should have adequate skills for developing simple improvizations of science equipment.

ANNEX IX

LIST OF DOCUMENTS

1. General Information
2. Agenda
3. Annotated Agenda
4. Leading Questions for Discussion
5. Note on Concept of Basic Functional Education
6. APEID Programme on Science Education (Programme Area 6 - Report on Work Plans of APEID - 1973)
7. Time Schedule
8. Country Reports
   - 8-1 Japan
   - 8-2 Republic of Korea
   - 8-3 Philippines
   - 8-4 Singapore

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