Development and Production of School Science Equipment

by E. Apea and N.K. Lowe

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Education Division

Commonwealth Secretariat

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Introduction

In 1975 the Commonwealth Secretariat, acting on the recommendations of member states, initiated a programme of investigation and assistance in the field of low-cost production of school science equipment. The programme started with the publication in 1975 of The Production of School Science Equipment - a review of developments (1), and plans were then made to hold three regional seminars to consider the provision of relevant science teaching equipment from local and other sources.

To provide background material for the first of those meetings it was felt that studies of some of the existing centres, would be useful resource material. Four centres, each concerned in one way or another with getting science teaching apparatus into the classroom, were selected for the study. These studies were used at the first regional seminar held in Nassau, Bahamas in November 1976(2), and again at the second, held in Dar es Salaam, Tanzania in September 1977(3).

Subsequent feedback and requests have indicated that it would be useful to have the studies published as a separate publication, even though they were summarized and printed in the report of the first regional meeting.

The studies were originally carried out early in 1976 through funds provided by the Commonwealth Fund for Technical Co-operation. A further section has now been added to draw attention to some of the similarities and differences in the modes of operation and organization of the centres. It is not intended that any of the centres should be considered as models to be faithfully copied since they have to reflect the national goals and environmental realities they have been established to serve. Instead, each study focuses attention on problems and considerations which have to be accounted for when the establishment of some form of local production of school science teaching equipment is being considered.

Because the two regional seminars have deliberated on these factors, it is recommended that the seminar reports should be read in conjunction with this publication. The final seminar in the current programme will be held in Papua New Guinea in March 1979. It is expected that this meeting will draw together the work of the previous seminars and provide strong guidelines which can be used by a country wishing to start producing some of its own teaching materials.

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1. The Production of School Science Equipment - a review of developments. Commonwealth Secretariat publication, 1975.

2. Low-Cost Science Teaching Equipment
Report of a Commonwealth Regional Seminar/Workshop
Nassau, Bahamas, 16-26 November 1976.

3. Low-Cost Science Teaching Equipment:2
Report of a Commonwealth Regional Seminar/Workshop
Dar es Salaam, Tanzania, 20-30 September 1977.

Section 1

THE NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING: INDIA

Background

The predominant pattern of education in India comprises eight years of integrated elementary education, three years of secondary education with diversified courses to give it a vocational bias and make it a terminal point for entry into a trade or higher education, and three years of university education leading to a first degree. Some of the states have adopted a pattern of seven years of elementary education. However, in 1966 the Education Commission suggested a uniform pattern of 15 years' duration leading to the first degree (10 years of general education, two years of general or vocational education at the higher secondary level and three years for the first degree).

This pattern, referred to as the 10 + 2 system, has already been introduced in over half the states and will shortly be introduced in several more.

Statistics of Education

The First All-India Educational Survey was conducted in 1957 by the Ministry of Education. In 1965-66 the Second All-India Educational Survey was carried out by the National Council of Educational Research and Training (NCERT) for the Ministry of Education and Social Welfare and the Planning Commission. In 1973 the Ministry of Education decided to have the Third All-India Educational Survey. Though the full results of the survey have not been finally presented, some provisional data on school education have been released. These show that in 1973 there were 461,864 primary schools, 87,702 middle schools, 32,779 secondary schools, 6,805 higher secondary schools and 2,938 intermediate and junior colleges in the country. Altogether there were over 82 million pupils in school, of whom over 60 million were in classes I to V (primary).

National Curriculum Development

Traditionally, each state in India was free to decide its own policy for education and its own structure. But with a view to improving school education in the country as a whole, the National Council of Educational Research and Training (NCERT) was set up in 1961 by the Government of India. The NCERT is an autonomous body wholly financed by the Government. It functions as the academic adviser to the Ministry of Education and Social Welfare.

In the field of curriculum development the Council is involved in devising standard curricula in all the school subjects and in producing model syllabuses and teaching materials which are then offered to the states for adoption or adaptation to their requirements. Few other curriculum projects are in existence or have existed in recent times. The largest separate project was the Bombay Municipal Project, an activity developed by the All-India Science Teachers'

Association and assisted by the British Council with a Nuffield-based approach. As its name implies, this project was operative in the Municipality of Bombay. British Council assistance ceased in 1975. Another small project is in existence in Hoshangabad in Uttar Pradesh. This project is a rural education project based on an Institute for Rural Development. The project has been in existence for some three years, and is a science teaching project operating in 16 trial schools. The Physics Department of Delhi University is assisting with this project, particularly in its evaluation.

Both of these projects have incorporated material developed by the All-India Science Teachers' Association Study Groups.

The National Council of Educational Research and Training

The NCERT was established on 1 September 1961 with its headquarters in New Delhi. It undertakes, aids, promotes and co-ordinates research in all branches of education. It organizes extension services, and pre-service and in-service training mainly at advanced level. It undertakes and organizes studies, investigations and surveys relating to educational matters or the appraisal of educational programmes. It disseminates improved techniques and practices, and it acts as a clearing house for ideas and information on all matters relating to school education. It has its own publishing house, producing textbooks, supplementary readers, research monographs, educational journals and a variety of educational materials on a "no profit no loss" basis. It also has a large purpose-built workshop where science kits are designed and developed. Details of this workshop are given later.

The NCERT functions through six constituent units as shown in Diagram 1. These are the National Institute of Education (NIE) and

NATIONAL COUNCIL OF EDUCATION RESEARCH AND TRAINING

NATIONAL INSTITUTE OF EDUCATION

CENTRE FOR EDUCATIONAL TECHNOLOGY

POLICY, PLANNING AND EVALUATION UNIT

4 REGIONAL COLLEGES OF EDUCATION

15 FIELD OFFICES

ACADEMIC DEPARTMENTS/UNITS

- Dept of Education in Social Sciences and Humanities (with a special unit on languages)
- Dept of Education in Science and Maths
- Dept of Teacher Education
- Dept of Educational Psychology and Foundations of Education
- Dept of School Education
- Work Experience and Vocalization in Education Unit
- Examination Research Unit
- Examination Reform Unit
- National Talent Search Unit

SERVICE AND PRODUCTION DEPARTMENTS/UNITS

- Dept of Textbooks
- Dept of Teaching Aids
- Workshop Department
- Publication Department
- Survey and Data Processing Unit

COMMITTEES OF NCERT

- General Body
- Executive Committee
- Programme and Research Committee
- Educational Research and Innovation Committee (ERIC)

Diagram 1. The Structure of the NCERT

the Centre for Educational Technology (CET) at New Delhi, and the four Regional Colleges of Education (RCEs) at Ajmer, Bhopal, Bhubaneswar and Mysore. It maintains liaison with all relevant institutions furthering the aims of school education, and also with State Ministries of Education through a network of 15 field offices.

The National Institute of Education

The National Institute of Education (NIE) is concerned mainly with conducting research on problems of school education. As the diagram shows, it works through a number of academic departments (e.g. education in science and mathematics) and service and production departments and units (e.g. the teaching aids department, and the survey and data processing unit).

The National Talent Search Unit conducts an annual competition for final-year secondary students and provides scholarships in the basic sciences and mathematics to successful participants. The NIE also organizes several training programmes, seminars and workshops for teachers, teacher educators, educational administrators, and others.

The Centre for Educational Technology

The Centre for Educational Technology (CET) was set up by NCERT in 1973. It is concerned with the development of innovation in education using the various communication media. At present CET is operating a Satellite Instructional Television Experiment (SITE) using the Applied Technology Satellite No.6 loaned by the U.S.A. for one year (August 1975 to July 1976). This experiment involves 2,400 villages located in six states, and is a two-fold programme of primary teacher re-orientation and adult education. For the first of these programmes, by developing a multi-media package for training science teachers at the primary level (with SITE as one component of the package), it is hoped that a twelve-day training course for 96,000 primary school teachers will be possible. Since upwards of a million primary teachers will need retraining to meet the demands of the NCERT primary science curriculum, the project is of high importance.

The Policy, Planning and Evaluation Unit

The Policy, Planning and Evaluation Unit of NCERT acts as a clearing house for ideas and information on educational research and training, and an Educational Research and Innovation Committee (ERIC) was constituted to promote research and finance suitable research projects outside of NCERT.

Department of Education in Science and Mathematics

In 1963 the Government of India asked a UNESCO mission to report upon a desirable form of science and mathematics education for the country. The mission recommended a complete reform of the curriculum, and the provision of printed material and kits of equipment. The pattern of education for science and mathematics was suggested as being: Stage 1, Classes I-V; Stage 2, Classes VI-VIII; and Stage 3, Classes IX-XI.

At the first stage stress should be laid on obtaining information about the non-living nature, and arithmetic with some geometry. At the second stage a disciplinary approach to teaching Physics, Chemistry and Biology should be adopted. Biology and Physics should be introduced in Class IV, through to Class VI, whilst Chemistry should be introduced at Class V thereby allowing the basic Physics knowledge to allow a fuller development of the studies of the properties of matter in Chemistry. In the third stage a number of streams should be provided such as science, humanities, and technology. Only in the science stream would physics, chemistry and biology be taught.

Under the new twelve-year pattern of schooling (1975) the stages become: Stage 1, Classes I-V; Stage 2, Classes VI-VIII; Stage 3, Classes IX and X; and Stage 4, Classes XI and XII.

Science and mathematics will be taught to all up to the end of Stage 3, with streaming starting in Stage 4, thereby ensuring a general science background for all pupils.

Further recommendations made by the mission related to equipping schools for teaching science and mathematics. It was recommended that, since it would not be financially possible to provide science laboratories and equipment in all schools, at least a small demonstration bench should be provided. In addition a Central Science Workshop should be established which could carry out work along four major lines:

(a) Studying the equipment for teaching science that is manufactured by industry, and exploring how its quality could be improved.

(b) Designing, manufacturing and experimental testing of new teaching equipment.

(c) Utilization of the best Indian and foreign experience for designing and producing teaching equipment.

(d) Producing new designs for manufacture by industry.

Other recommendations included the training of science and mathematics teachers, and research in science and mathematics education.

Following these recommendations, a project for curriculum development materialized, and in September 1965 work began in the Department of Education in Science and Mathematics. UNESCO experts were made available to assist with the implementation of the curriculum development project, which was to develop not only the relevant syllabus but also textbooks, teachers' guides and kits of equipment related to the different subjects and levels of education. It was intended that the material should be as flexible as possible so that each state could adapt it to its own special needs without losing the spirit of the approach which was to be based upon experimentation and enquiry. To facilitate as widespread a representation as possible in the curriculum development work, 20 study groups were established in various university centres. They consisted not only of teachers but also of scientists. The tasks assigned to these study groups were to develop instructional material for the entire school stage in mathematics, and for the secondary stage from class V/VI upwards for physics, chemistry and biology.

These study groups appeared to have varying degrees of success, and a great deal of centralized co-ordination occurred to finalize the materials; for example the physics groups prepared separate materials and the final official version after some difficulties. (One set of materials developed by a study group is apparently the basis of the Bombay Municipality Project.)

The Central Science Workshop (now the Workshop Department) began designing and developing kits in 1968. The first were Physics 1, and a small chemistry kit for the middle schools. In 1969 a few prototypes of the primary science kit were developed, leading eventually to the comprehensive primary science kit which was contained in a box and had its own in-built demonstration table (flap) and chalkboard. The kit also contained a set of hand tools to enable the teacher to improvise some items for himself. The kit was developed for the village primary school which would only have the minimum of classroom fittings.

Physics Kit 2 and Chemistry Kit, followed by Biology were next developed, with the Physics Kit 3 the last to be developed. These kits were of two types, one for demonstration to class sizes of 35 to 40 and pupils' kits for groups of four to six students.

Implementation of the Science Education Project

The government prepared a plan of operation in conjunction with UNICEF/UNESCO for the pilot project on a national basis for the improvement of science teaching. Under this plan, UNICEF agreed to provide funds for (a) translating and printing the syllabus and instructional materials, (b) science laboratory equipment for training institutions, (c) teacher training, (d) the supply of kits to schools, and (d) a limited supply of paper for printing the instructional materials.

To implement the Science Education Project the states were encouraged to set up State Institutes of Science Education (SISEs) or science wings to their State Institutes of Education (SIEs). Some states already had such institutes. It was envisaged that these institutes would provide in-service training and orientation programmes for teachers. In addition, a number of key teacher training institutions were identified to assist in the project implementation. The basis of selection was made upon the suitability of staff and facilities. Initially 579 institutions were identified and received science equipment provided by UNICEF. It consisted of imported kits of traditional apparatus intended to equip the laboratories to a given standard. A later evaluation revealed that some of the institutions were not suitable to utilize the equipment effectively, and it was decided that any future institutions would be selected only after inspection by NCERT field staff.

It was decided to try out the NCERT material in a number of experimental schools. Consequently some 1,200 primary and 700 middle schools were selected throughout the country representing 30 states of the union.

Responsibility for providing the science kits needed for the pilot project was taken by the Workshop Department of NCERT. As only limited funds were available for the project, it was decided to concentrate on the demonstration kits rather than the pupils' kits. The workshop was strengthened in various sections to meet the demands to be made on it, and the toal number of kits provided up to the middle of 1975 was:

	69/70	70/71	71/72	72/73	73/74	74/75	75/76
Primary Science	-	760	188	155	61	110	47*
Physics 1	69	426	130	116	40	68	25
" 2	-	-	351	213	57	124	67
" 3	-	-	-	175	437	44	35
Biology 1	-	468	129	108	4	-	-
Biology Dem.	-	-	350	211	56	129	65
Chemistry Dem.	-	-	350	214	57	129	65
Physics Class	-	-	467	1,571	-	480	-

* 1,500 Primary Science Kits have been produced for the Republic of Afghanistan, and a further 800 for direct purchase by two states.

It is anticipated that some 8,000 primary kits will be produced for UNICEF during 1976.

The project plan was envisaged as having three phases - the pilot phase, the wider introduction phase, and universalization. The degree of progress through these phases has varied from state to state. UNICEF assistance at the wider introduction phase has been limited to primary education only, which in turn has affected its implementation in some states.

Workshop Department

The Workshop Department is in a purpose-built building in close proximity to the Science and Mathematics Department and is a single-storey building for the most part with a small first-floor area over part of the building.

The components of the Workshop Department are: main workshop; prototype design workshop; dies and sheet metal workshop; optics glass workshop; wood workshop; plastic workshop; foundry; electroplating shop; paint shop; welding bay; electrical repair/maintenance shop; design/development office; display laboratory; main stores (material); stores (spares, stock and inspection); completed kit stores; assembly area; reproduction/duplicating area; general office and administration section.

The Department has approximately 100 members of staff and, depending on demand, it also employs a daily labour force. Diagram 2 outlines the staff structure, but it should be noted that a particular title does not necessarily reflect the actual duties of an individual. For example, of the Technical Officers, one is responsible for office administration, and, in the Fine Mechanic grade, two are in the packaging section.

Diagram 3 on page 9 indicates the layout of the Workshop Department (not to scale).

Staff are recruited through national advertising, and the successful applicants are appointed to their appropriate grade. A system exists whereby any individual who shows aptitude can apply for the relevant trade test and be up-graded. (Such a system promotes staff improvement and encourages harmonious working relationships.)

The policy of the workshop has apparently been towards flexibility of staffing. Besides each individual having his specific duties, personnel can also be co-opted to other duties as the demand necessitates. This enables the NCERT to supplement demand areas and remove bottlenecks when they look like occurring. Such a policy, although often written into civil service conditions of employment, is not always effectively enforceable and often rests on good employer/staff relations.

HEAD OF WORKSHOP DEPARTMENT

- Principal Assistant

TECHNICAL

- Technical Officers (5)
- Foreman (1)
- Junior Foreman (4)
- Senior Draughtsman (1)
- Junior Draughtsman (2)
- Senior Laboratory Technician (1)
- Junior Laboratory Technician (2)
- Fine Mechanics (15)
- Mechanics (42)

STORES

- Assistant Stores Officer (1)
- Senior Store-Keeper (1)
- Junior Store-Keeper (2)

ADMINISTRATION

- Office Superintendent (1)
- Assistant Superintendent (1)
- Upper Division Clerk (1)
- Lower Division Clerk (2)

Peons (General Staff, e.g. Messengers) (17)

Daily Labour Force

Diagram 2. Staff Structure of the Workshop Department

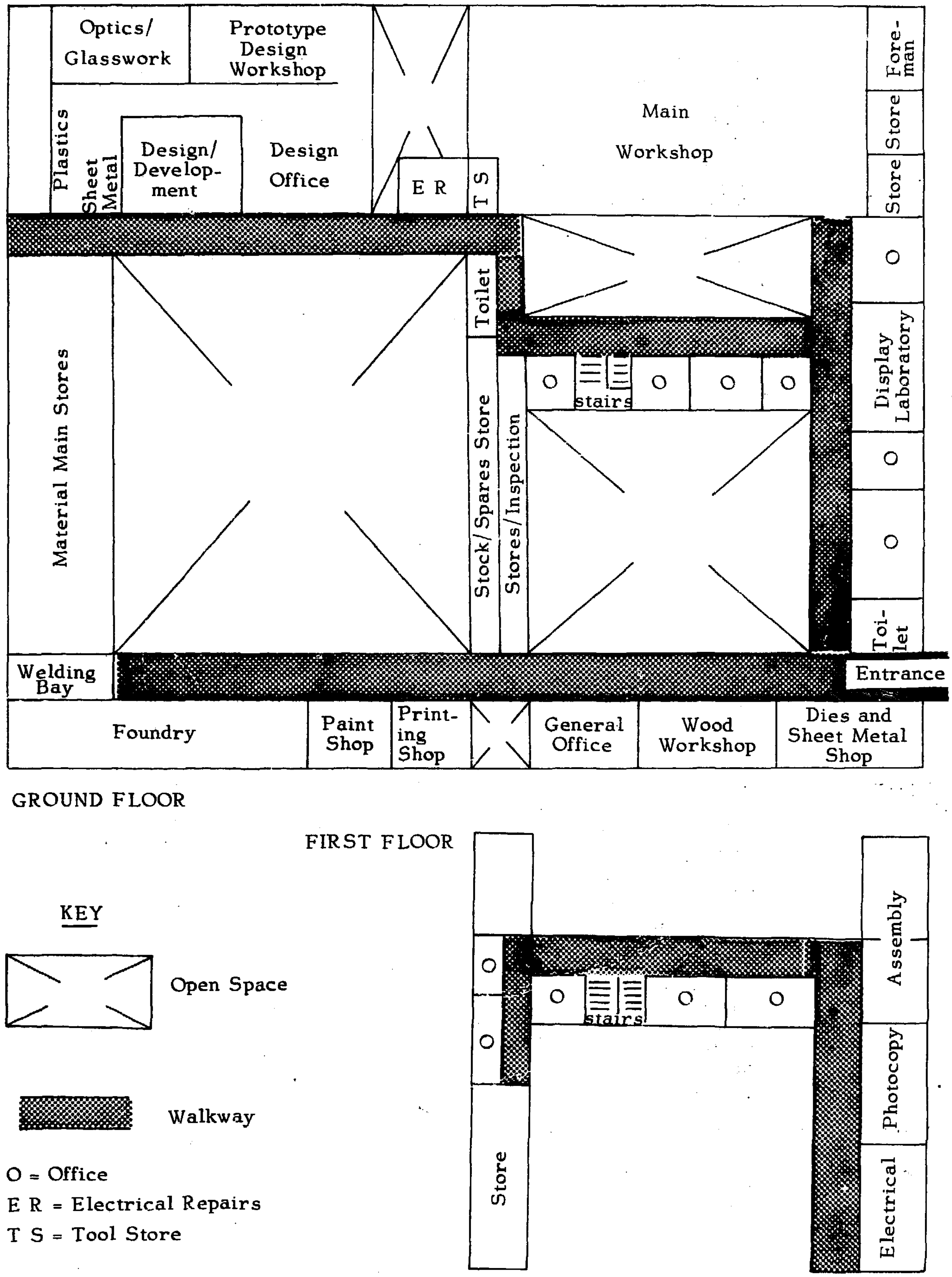

Diagram 3. Sketch of the Workshop Department (not to scale)

Financing

The NCERT is wholly financed by the Government of India. From the budget the workshop has been allocated 500,000 rupees for 1975/76 fiscal year, with a further 50,000 rupees for research and development. Of the 500,000 rupees, 60% is spent on the purchasing of raw materials, and the sale of the kits is normally expected to replace this expenditure. It is expected that the workshop will eventually be self-supporting financially, selling its products on a no-profit no-loss basis, which is not the case at present. A 'labour cost' figure is included in the price of the kits and this amount is reckoned at 60% of the staff costs. (Full staff costs are not included since the workshop also undertakes maintenance for the whole of the NCERT.)

Kits are purchased through each State Ministry of Education. Direct purchases cannot be made by schools, nor is it possible for them to obtain spare parts or replacement items at the moment.

The cost in rupees of the kit was quoted as being :

Primary Science Kit	210
Physics Kit 1	206
Physics Kit 2	250
Physics Kit 3	350
Chemistry Kit	420
" " (pupils)	224
Biology Kit	350

(Pupils' Kits have been discontinued due to the emphasis on primary work.)

(January 1976, £1 = 17.9 rupees.)

Development of Science Kits

In general the kits were developed by close liaison with the staff groups of the Science and Mathematics Department, as well as with the UNESCO specialists supplied under the UNDP/UNESCO assistance to the NCERT. From the workshop design staff's point of view, interchange of staff took place when developing a piece of apparatus, thereby allowing more than one individual to participate in the design at various stages. Materials were tried out in a local school, and, where necessary, modified prior to inclusion in the kits.

During the process of development, the production aspect of the apparatus was kept in mind, thereby facilitating a minimum of change between the form of the prototype and the form of the finished production item. On completion of development of the item, workshop production drawings were produced. They are available for anyone wishing to construct the apparatus.

Production of Kits

In addition to the facilities for constructing apparatus provided in the Workshop Department, a number of items are constructed by local manufacturers. Currently there are some twelve commercial manufacturers who tender for the batch requirements of the kits. The system is to request tenders for a fixed number of items with the suppliers working to the strict requirements of the Department. Poor quality control has been experienced in the past, and all items submitted to the workshop are inspected by selected members of the workshop staff prior to acceptance.

By maintaining their own quality control standards, the reliability of the manufacturers has improved, particularly since each manufacturer's tender rests heavily on the quality of his past product. New tender companies have to supply sample products prior to approval for tender. In addition to supplying the needs of the Department, these companies also offer their products on the open market for purchase by schools, etc. The Department supplies a list of such suppliers to all schools who write to the NCERT for information on the availability of the kits (see page 13).

Under the course work activities of the Science and Mathematics Department the workshop has held two courses on quality control. These have been for members of state Ministries of Education who have provided Quality Control Officers to specifically monitor the quality of products when purchased from commercial suppliers. The participants have been instructed in the requirements of their duties and have been provided with a kit of instruments and with samples purchased out of UNICEF funds.

AN EXAMPLE OF MATERIAL RELATED TO PRIMARY SCIENCE

REFERENCE BOOKS PUBLISHED (NCERT)

Textbooks

"Science is Doing" for Class III
"Science is Doing" for Class IV
"Science is Doing" for Class V

Teacher's Guides

Teacher's Guide to "Science is Doing" for Class III
Teacher's Guide to "Science is Doing" for Class IV
Teacher's Guide to "Science is Doing" for Class V

Teacher's Handbooks of Activities

General Science - A Handbook of Activities for Primary Schools Vol. 1
General Science - A Handbook of Activities for Primary Schools Vol. 2
General Science - A Handbook of Activities for Primary Schools Vol. 3

Kit Guide

SCIENTIFIC TOPICS COVERED UNDER NEW CURRICULUM

1. Our Universe. 2. Air, Water and Weather. 3. Rocks, Soils and Minerals. 4. Forces and Work. 5. Matter and Materials. 6. Housing and Clothing. 7. Living Things. 8. Plant Life. 9. Animal Life, including a separate chapter on Birds in Class III. 10. Man and His World (In Class V only). 11. Human Body Health and Hygiene.

LIST OF THE KIT CONTENTS

General Items

1. Aluminium Katori (a cup without handle) 100 mm. dia. - 2
2. Balls (rubber) 80 mm. and 50 mm. dia. - 1 each
3. Beaker 150 ml. and 100 ml. - 1 each
4. Hard glass test tube - 1
5. Compass needle - 1
6. Electric circuit-board with battery, bulb and switch - 1
7. Enamelled copper wire 24 gauge - 2 metres
8. Football pump - 1
9. Glass marbles - 50
10. Glass jar or empty jam bottle - 1
11. Glass rod 15 mm. dia. x 150 mm. long - 1
12. Hand fan - 1
13. Hand lens (mag. 4X) with plastic frame - 1

14. Hard board 200 x 200 x 3 mm. with rectangular slot of 80 x 80 mm. in centre - 1

15. Hollow polythene rectangular containers of same capacity but different sizes - 1 each

(a) 120 x 60 x 30 mm. height (red)
(b) 90 x 30 x 80 mm. height (blue)

16. Kitchen strainer (wire-net) - 1

17. Bar magnet - 1 pair

18. Measuring cylinder 100 ml. - 1

19. Aluminium tube 60 mm. dia. x 125 mm. long - 3

20. Soft iron nails 6 mm. dia. x 130 mm. long - 2

21. Mountirg needles - 2

22. Plane mirror mounted on wooden base 100 mm. x 61 mm. - 1

23. Plastic comb - 1

24. Plastic funnel 75 mm. dia. - 1

25. Tubing 7.5 mm. dia. (Polytene) - 1 metre

26. Plastic tumbler 100 mm. high - 2

27. Plastic syringe - 1

28. Polythene bags assorted - 6

29. Pulley - 1

30. Rubber stoppers assorted for item number 4 - 2

31. Rubber stoppers assorted for item number 36 - 3

32. Scale half-metre with five holes - 1

33. Sieve 125 mm. dia. - 1

34. Lamp (kerosene) - 1

35. Spring balance - 1

36. Test tubes 15 mm. dia. x 125 mm. long - 6

37. Thermometer 0-110° C on wooden base - 1

38. Thermometer clinical - 1

39. Torch with 2 cells - 1

40. Tripod stand with wire gauze - 1 each

41. Water wheel - 1

42. Wedge - 1

43. Wind-vane - 1

44. 1 kg. weight - 1

45. M. S. Wire 3 mm. dia. 200 mm. long - 1

46. Glider - 1

47. Top pan spring balance 2 kg. - 1

48. Model of lift pump - 1

49. Toy electric motor - 1

50. Kit box

Hand Tools

1. File triangular (100 mm.) - 1
2. Hammer with claw (250 gms.) - 1
3. Hand drill (6 mm. dia. capacity) with drill bits - 1

COMMERCIAL SUPPLIERS OF SCIENCE KITS

M/s. Delta Laboratory Equipments, 6438 Bagichi Ishwari Pershad, Bara Hindu Rao, Delhi 110006	Primary Science	III to V
M/s. Gaupad Chemicals, Kaithal Gate, Chandausi, UP	Primary Science	III to V
M/s. Optika & Chemico, 28-B Industrial Estate, Gwalior, MP	Physics I/Physics III	VI/VIII
M/s. Hargolal & Sons, Hargolal Building, Hargolal Road, Ambala Cantt.	Physics II/Physics III	VII/VIII
M/s. Metro Scientific Industries, Mori Gate, Delhi 110006	Physics I	VI
M/s. Dynam Engineering Corporation, 6 Haudin Road, Bangalore 560042	Physics I	VI
M/s. Arun Chemicals & Scientific Industries, 11/5495 Basti Harphool Singh, Sadar Thana Road, Delhi 110006	Chemistry	VII to VIII
M/s. Sisbro Scientific Industries, (New) 47, UA Lawahar Magar, Delhi 110006	Biology Composite/ Biology Non-Composite	VI to VIII/ VII to VIII
M/s. Mittal Sales Corporation, Chand Tara Building, G. T. Road, Shahdara	Biology Composite/ Biology Non-Composite	VI to VIII/ VII to VIII
M/s. Gadget House, Bhagat Ki Kothi, Jodhpur, Rajasthan	Biology Composite	VI to VIII
M/s. The Haryana State Small Industries & Export Corporation Ltd., Bank of India Building, (2nd Floor) Sector 17-B, Chandigarh	Biology I	VI
M/s. Educational Kit Manufactuer, 255/300 Mangal Pass Building, Kitchen Garden Lane, Bombay 400002	Biology Non-Composite	VII to VIII

Section 2

THE SCIENCE EQUIPMENT PRODUCTION UNIT: KENYA

Background

Primary education in Kenya is of seven years duration (standard one to standard seven) with the first four years being free. Education at this level covers a wide range of subjects including science and mathematics. Successful completion of primary education is marked by the award of a Certificate of Primary Education (CPE).

Secondary education takes place in Government-maintained schools, Harambee (self-help community) schools, or private schools. The private schools which are run by a person or organization (including religious societies) receive no assistance from the Government. Some Harambee schools receive Government help in the form of one or two teachers, and they may also obtain grants to help in the construction of classrooms, laboratories, and other school buildings. It is of interest to note that Harambee schools are gradually being phased out or being taken over as maintained schools by the Ministry of Education.

Entry into secondary schools is based on the performance of children at the CPE Examination. Entrants are generally those pupils with good marks who are at the same time able to pay fees, but scholarships and bursaries are available for very able pupils.

Secondary education is divided into two phases of four and two years' duration. At the end of the second year of the first phase of the basic secondary school course, there is an optional external examination which is normally taken by students in Harambee and private schools. This leads to the awards of the Kenya Junior Secondary Education Certificate. Students who successfully complete the four years of secondary schooling obtain the East African Certificate of Education (EACE)* which provides a basis for entry to the second phase of secondary education. The successful completion of these two years is marked by the award of the East African Advanced Certificate in Education (EAACE). This provides the basis for university selection.

Pre-service teacher education takes place in primary teacher training colleges, Kenya Science Teachers College (KSTC) and universities. There are three classes of teachers at the primary school level. Grade 3 teachers have pursued a two-year teacher training course after primary standard 7; Grade 2 teachers have completed a two-year teacher training course after secondary form

*To obtain a division 1 or 2 EACE, a candidate must obtain credit pass in maths and science.

2 or 4; and Grade 1 teachers have completed a two-year teacher training course after secondary form 4*. S1 teachers are lower secondary school teachers who after obtaining an EACE have pursued a three-year course at KSTC or who after obtaining an EAACE have completed a one-year course at KSTC. Senior secondary level teachers are normally expected to possess a university degree.

Table 1 gives some relevant educational statistics for the period 1972-76.

TABLE 1: SELECTED EDUCATIONAL STATISTICS: KENYA

	1972	1973	1974	1975	1976
Number of Primary Schools	6,657	6,932	8,000	8,049	8,500
Total Primary School Population	1,675,919	1,816,017	2,734,398	3,016,000	3,476,000
Number of Primary Teachers Colleges	17	17	17	17	17
Kenya Science Teachers College	1	1	1	1	1
Number of Polytechnics	2	2	2	2	2
Kenya Technical Teachers College	-	-	-	-	-
Number of Maintained and Assisted Secondary Schools	363	380	404	404	407
Number of Harambee and Private Secondary Schools	585	650	796	796	796
Number of Universities	1	1	2	2	2

Source: Ministry of Education Annual Report for 1972, 1973 and 1974
Unpublished data for 1975 and 1976

The Kenya Institute of Education (KIE)

As a result of a conference on educational institutes held under the aegis of the University of East Africa and the Ministries of Education in Kenya, Uganda and Tanzania, the KIE was established in April 1964. It was originally set up to administer a scheme of examinations on the behalf of the Kenya Ministry of Education and to act as a centre of professional activity for teachers. However, in 1968 it absorbed the former Curriculum Development and Research Centre (an amalgamation of the English Special Centre, the Mathematics Centre and the Nairobi Science Training Centre) and added to its list of duties the function of preparing educational materials.

*As from the 1976/77 academic year, all entrants to primary teacher training colleges must possess credit pass in maths and science in the EACE.

The work of the various sections of KIE is done through a system of subject panels. These panels consist of personnel drawn from the KIE, the Inspectorate Division of the Ministry of Education, the Kenya Science Teachers College (KSTC), the Education Department of the University of Nairobi and practising teachers.

The science panel played a central role in the development of the East African School Science Project, and has, since the early days of the Science Equipment Unit, provided professional advice to the work in the field of local production of equipment. Also, in addition to organizing in-service courses for teachers, the panel, from time to time, produces information sheets for schools, giving advice on science teaching materials. By mid-1975, over 500 publications had been produced by the KIE in conjunction with the Jomo Kenyatta Foundation, a non-profit making publishing organization.

The progress and evaluation of the materials produced are monitored by KIE. The necessary information is gathered through questionnaires, visits to schools, correspondence with the staff of teacher training colleges and at teachers' in-service courses.

All sections of the KIE are either broadcasting programmes to teachers and pupils or are planning to do so. The programmes in use and those envisaged are of three types: background materials for teachers, demonstration of how specific lessons should be taught, and specific help to teachers on how to teach individual lessons. It is hoped that increasing use of radio will be required as new materials are produced.

THE KENYA PRIMARY SCIENCE PROGRAMME

Overview

The Programme was initiated in the mid sixties. Aided by funds and personnel from the African Primary Science Programme (APSP), its first emphasis lay in the production of films and written materials. These materials were primarily in the form of guides for teachers, though a smaller number of science readers for children were also produced. Some 50 to 60 booklets, and five films, were produced, all of which received extensive fields trials in typical classroom situations.

Early on in the programme two subcentres for development were established, one at Kagumo Teachers College, and the other at Siriba Teachers College. Their basic purpose was to explore mechanisms for supporting teachers professionallly in primary schools. Both have subsequently been incorporated into the programme of Teachers Advisory Centres (TACs).

Recently the programme has produced a new set of Guidelines For Teaching Science in Primary Schools which will replace the former syllabus. These Guidelines outline the goals to be achieved through science education at each level in the primary school. The APSP booklets, as well as other materials, are referred to as resource materials to accompany the Guidelines. Research is being carried out to find suitable ways of evaluating the progress of children using the Guidelines. This includes consideration of the problem of writing questions for the primary school leaving examination which are both relevant to the new course and fair to the pupils and teachers in the schools.

Work is also going on which seeks to identify the most effective ways of giving professional support to personnel working in the field. In this connection KIE staff have co-operated closely with the Inspectorate in organizing workshops for Primary School Inspectors, TAC tutors and Assistant Education Officers. KIE staff also assist with in-service courses at the district level in an attempt to help to build up a core of local resource personnnel who can in turn assist in the task of in-service training. Curriculum materials are being developed for use by students and tutors in teachers colleges. Finally, the staff of the Primary Science Section of KIE are from time to time making professional contribution to the primary science education programme at the University of Nairobi.

Aims and Approach

The Programme has three basic aims: namely to encourage and assist children to: (a) develop the manual and intellectual skills that are necessary to solve problems in a scientific way; (b) preserve and acquire the attitudes that are necessary to apply those skills effectively; and (c) acquire a deep understanding of the natural phenomena that take place in their environment. In order to achieve these aims, activities in the classroom are made to relate directly to the pupils' environment. This is accomplished by helping children first to acquire problem-solving skills and than to apply the skills in solving problems based on their immediate environment.

In recognition of some of the complexities of the intellectual and emotional development of chilren, three stages in the programme are given special attention in the development of programme materials. In the first stage - that is for the first three years of schooling - children are presented with a variety of opportunities to preserve, strengthen and develop those attitudes and skills which will enable them to approach and solve problems rationally and effectively. They are encouraged to continue to develop their natural curiosity and their willingness to explore and ask questions, and to gain as much direct experience as possible of their natural surroundings. During the two years that follow, children are introduced to the process of solving specific problems. However, the application of the process of scientific problem solving is at this stage restricted to relatively simple and concrete situations. Finally, in the last two years of primary school, the children carry out a series of investigations, each of which covers a range of scientific topics, concepts and skills that were previously treated as separate entities.

This attempt to integrate the various scientific disciplines and use them to solve problems represents a significant change from the former approach which mainly consisted of learning unrelated pieces of information and repeating them in an examination. Moreover, this unified approach tends to bring the pupils' classroom experiences closer in line with real-life situations they will meet in the future.

Materials Available

No equipment is provided specifically for teaching science in primary schools. Teachers therefore make much use of ordinary things around them in the environment. In addition, some general equipment provided to schools can be used for science teaching. This equipment is purchased through the Ministry of Education Kenya School Equipment Scheme. Purchase is via the tender system, and deliveries take place to a central warehouse in Nairobi. Distribution is then to divisional warehouses located in 39 districts and seven municipalities, where Divisional Education Officers arrange distribution to the individual schools. Equipment lists are supplied by the Ministry, and schools make out their own requirements which are sent to the appropriate District Education Officer who submits lists to the Ministry for action.

Written material for the whole seven years of primary school and for teachers colleges can be summarized as follows:

Lower primary (standards I, II, III). About a dozen booklets have been produced which give suggestions to teachers on how to create opportunities for young children to gain the kinds of experience envisaged in the programme. The titles of some of these booklets reflect the close relationship of the suggested activities with the natural surroundings of the children: Plants in The Classroom; Water; Dry Sand; Woodwork; Exploring The Local Community; Construction. In all these booklets suggestions are given about using local materials that are available around typical primary schools. The use of locally available materials is important, not only in the name of economy and feasibility, but to help to prevent young children becoming alienated from their home community and background. Currently a group is at work preparing a guide to help teachers to use these booklets and other resource material in as integrated a style as possible. Additional materials are planned specifically for the transition period for children in standard three.

Middle primary (standards IV and V). The Guidelines Programme is introduced in Standard IV. Guidelines for standards IV and V have been prepared, and several reference units are being printed by the Jomo Kenyatta Foundation in 1976.

Upper primary (standards VI and VII). The first draft version of the Guidelines for Standard VI has been tested. The Guidelines and supporting resource books are being prepared to help teachers with such topics as people around us; the shamba; ourselves; and metals.

It is intended that the materials for Standard VII will follow a similar approach. However, the topics for investigation will be concerned with applied science and technology with the expectation that pupils will identify and solve problems of real and practical significance in areas such as agriculture, health and village technology.

Teachers Colleges are supplied with all the materials undergoing trial within the programme. In addition to the Guidelines and associated reference materials, a document called "Handbook for Teacher" has been developed as part of an international effort, sponsored by the Science Education programme for Africa. This Handbook has been designed specifically for use in teachers colleges to help prepare teachers in the effective implementation of new approach to primary science education. A further document "A Sourcebook For Tutors" is also being developed.

A number of films have been produced as part of APSP, both from Kenyan primary schools and from other African countries. These films have been found to be extremely useful when introducing the programme to teachers and other educators who have not yet experienced this kind of approach to science education.

SECONDARY SCHOOL SCIENCE

Science is taught in secondary schools either as general science or as physics, chemistry and biology. Because the separate subjects are generally regarded as bing academically superior, they tend to be more popular than general science.

In 1965, a move for reforms in secondary school science curricula in East Africa was initiated in Tanzania. Subsequently a series of conferences, held in Nairobi, Dar es Salaam and Kampala, led to the inauguration of the East Africa School Science Project (SSP) in 1966.

Originally the SSP aimed at adapting the Nuffield science materials for use in East Africa. Later, however, a more imaginative approach was adopted "to produce the right courses for the first four years of the secondary school programme".* By drawing upon the Nuffield project material as well as material from the UNESCO Pilot Project for Africa, subject panels in chemistry, physics, and biology were able to develop the required courses. Membership of these panels included university professors and lecturers, practising school

*SSP Physics Panel, SSP Physics: Introductory Statement, Dar es Salaam, April, 1970, p.3.

teachers, and representatives of the various Ministries of Education and the UNESCO Science Teaching Project for Africa.

The courses were first tested at the East African Certificate of Education level in 1970 (chemistry) and 1971 (biology and physics). They seek to promote in pupils, understanding, lively enquiry, and interest in science. Emphasis is placed on scientific concepts and principles, and on course content that has obvious relevance and interest to East African countries.

Materials developed for the SSP course include pupils' books, teachers' guides, background readers, filmstrips, film data book, photographs and other teaching and learning aids. It is noteworthy that the teachers' guides include, for the many teachers with limited qualifications and experience, advice on ways of introducing certain individual topics, on getting apparatus to work, on making-do with local resources when equipment fails to arrive on time, and on how to keep a whole class mentally active.

KENYA SCIENCE EQUIPMENT PRODUCTION UNIT (SEPU)

Background

In the early 60s almost all the science equipment used in schools in Kenya was imported from overseas. The high cost of apparatus precluded all but a small number of schools from buying the necessary quantity. Other problems were that imported equipment often failed to arrive on time, and that many items tended to be inappropriate to the conditions in Kenya.

With the growing interest in Kenya of science programmes such as Nuffield, SSP, and PSSC that emphasised individual student experimentation, the shortage of equipment became increasingly acute. Efforts therefore got underway to make cheap, readily-available equipment.

Two of these were unfortunately unsuccessful. The first of these was undertaken at a technically-biased secondary school - Starehe Boys Centre. Simple items of equipment suitable for the first year of the SSP course were produced. However, neither development work nor large-scale production was envisaged. The other was undertaken by the Engineering Faculty of the University of Nairobi where a few school science equipment items made from wood and metal were produced during a period of two summer vacations. The summer courses were aimed primarily at giving technical skills to the university's first year engineering students and to giving students in the faculty experience of production problems and planning.

Though efforts at these two production centres lapsed, it is hoped that in the near future the Faculty of Engineering will set up an Industrial Consultancy Unit similar to that based in the Engineering Faculty at the Universtiy of Science and Technology, Kumasi, Ghana.

Another venture, however, proved very successful. In establishing the Swedish-financed KSTC in 1965, the Agreement between the Kenyan and Swedish Governments made provision for setting up facilities for the production of science teaching materials and for running workshop courses. Three years later, KSTC accepted a Kenyan Government request to set up an Industrial Arts Department, and in March 1968 this Department began to run workshop courses for students. A small beginning was also made in the design and production of low-cost teaching materials for secondary schools. This early production effort was pioneered by the senior technical physicist, and the kit was therefore essentially a physics one. A special characteristic of this physics kit was that it was not linked with any particular teaching philosophy. In other words, the kit system was as such that it could be adapted easily to any of the "learning by doing" programmes mentioned above.

To make the efforts more successful, a production unit was set up within the College. It aimed at being both independent and economically self-supporting. A workshop occupying an area of $265m^2$ was completed in 1970. Since then it has been expanded and it now occupies an area of $960m^2$.

The principal machine tools supplied for the KSTC Production Unit are:

Metal Work: three lathes, one milling machine, one pillar drill, one band saw, one hack saw, two grinders, one oxyacetylene welding set, one arc welding set, one sheet metal roller, one manual guillotine, one bending machine.

Wood work: one circular saw, one band saw, one planer (3m), one thicknesser, one large belt sander, one spindle moulder, one bench mounted drill.

General: Compressor (a recent addition).

Science Equipment Production Unit Subscribers

Towards the end of 1971 a KSTC Policy decision led to the expansion of staff and the appointment of a full-time head of the Production Unit.

In 1972, a production unit Executive Committee was formed to help the understaffed unit in its management and design work. The five man committee comprised of the principal and administrative secretary of KSTC, the head of the unit (the SEPU Manager), a representative of the Kenya Institute of Education (KIE) and a representative of the Ministry of Education. The head of the unit left in July 1973, and due to difficulties with recruiting staff, the unit did not start functioning again until December 1973. During the period of closure, the unit was run as part of the Industrial Arts Department. In January 1975, SEPU became fully staffed and consequently the Committee was dissolved.

Currently SEPU is run as a company under a seven-man trusteeship. The trustees are the Director of Education, Ministry of Education; the Permanent Secretary, Ministry of Finance and Planning; the Kenya Science Teachers College; the Kenya Institute of Education; the National Council for Science and Technology, the Jomo Kenyatta Foundation; and the Kenya Technical Teachers College.

According to a Kenya/Sweden agreement signed in June 1976, the Swedish government will continue to provide financial aid and technical know-how to the company until 30 June 1979 when it is hoped that SEPU will be completely self-supporting.

Production Strategy

In developing the various items in the physics kit, no special strategy was adopted. However, to ensure economic viability and efficiency of the project the following approach has been followed, as far as possible, in the production of the chemistry and biology kits. To begin with, a list of the most acute apparatus needs of schools was produced by the Manager and the Designer in consultation with the chemistry and biology panels of the KIE. A questionnaire was used to probe the apparatus market prior to embarking on the development of the kits. It appears as Appendix 1 on page 26. The needs were then matched to the availability of raw materials, the amount of design work needed and the difficulty of production. At this stage an order of production priorities was agreed.

For each item the Designer produced one or more prototypes and calculated an order of magnitude cost. The costing procedure adopted was as follows: Cost of materials + 10%; cost of labour + 20%; running cost of machines + 40%. (The additions to the raw costs were to account for the cost of materials lying on shelf awaiting use or of finished items awaiting sale, the higher salaries paid to supervising and development staff, sales costs, and the wear and tear of machines.)

When the prototype was ready, it was vetted by the Manager who then determined the size of the batch, taking into account the relevance of the item to current syllabuses and likely sales. The Designer prepared the jigs needed for production with the help of the Manager, and arranged the sequence in which operations should occur. Once production started, continuity and quality remained in the hands of the Manager. At various stages in the production of a batch, items were subjected to tests devised by the Manager and the Designer. Any items failing these tests were either reworked or thrown away. In the early stages of 1972, the initial failure rate was sometimes as high as 80% although the final wastage in a batch, after reworking, was usually of the order of 7%.*

Prices: Local versus imported items

Table 2 below shows the prices in K.Sh. of some of the SEPU physics items and those of imported equivalents as of August 1973:

TABLE 2: COMPARATIVE PRICES

Item	Local Price	Imported Price	Type of Design
A. C. tuner	45	160	Local
Dynamics trolley	90 (per pair)	165 (per pair)	Local
Wheatstone bridge	80	202	Conventional
3-d Kinetic model	85	430	Local
Ray optics kit (including cylindrical lenses)	53	110	Local
Optics lamps	30	84	Local

SEPU Science Kits

Kits have been developed to allow students to have experience in as much individual practical work as possible in physics, chemistry and biology.

The items contained in each kit are accompanied by materials for students and teachers written by teachers with teaching experience in Kenyan Schools. Recently these have been strengthened by slides and tapes supported by leaflets. Still more recently radio programmes have been prepared to support the biology kit.

Whereas formerly most items (including electrical meters and lenses) were imported and assembled as part of the kit system, now the majority of the items in the kits have been developed locally. Since the three spearate kits have certain items in common, schools are able to cut down costs by buying a box containing, say, a physics/chemistry kit.

The chemistry kit can be used to illustrate the usefulness of the kits in teaching. The basis of the kit is the pegboard stand. This is a board drilled with small holes at regular intervals and supported

*These details were obtained from J.M.S. Whittell's article "Local Production: Principles and Practice", in The School Science Review, June 1975, pp. 675-76.

stand by means of a special stainless steel clip. The clip has a base which can be fastened on a stand with a screw and nut, and its diameter can be adjusted to hold all the pieces of glassware from the thermometer up to the beaker. Compared to the more conventional retort stand, the pegboard is stable and light. Moreover it possesses many features which allow flexibility. For instance it is possible to mount apparatus anywhere on the stand and at the same time see where one piece of apparatus is in relation to one another. More important for work in chemistry, the apparatus can be mounted away from the stand when heating is required.

About 50% of the kit consists of items of glassware. These are bought mainly from local companies, most of which represent foreign firms. The Ministry of Education lists local companies in the Inspectorate Circular Letter No. INS/76/3 of 10 January 1976 as: Instrumentation Limited, Nairobi; Westco Limited, Nairobi; Howse and McGeorge Limited, Nairobi; E.T.: Monks & Company Limited, Nairobi; Anant Limited, Nairobi; Philip Harris Limited, Nairobi; Sciex (East Africa) Limited, Nairobi; Achelis Limited, Nairobi; Cross Chemist Limited, Kisumu; and Anpi Pharma, Nairobi.

A notable characteristic of the kit is that there is no bent glass tubing. When collecting a gas over water (an exercise that is done frequently) the gas is led into the collecting test-tube through flexible plastic tubing. This type of arrangement does away with the rather cumbersome process involving the use of beehive shelves, gas jars, and thistle funnels. Further, despite the standard nature of the glassware involved, each component of the kit has been designated to be compatible with as many other items in the kit as possible. Thus the rigid plastic tube used as the electrolysis cell can be converted into a drying chamber for gases. With many other items fulfilling more than one function, it is estimated that at least 100 simple experiments can be performed with the set of apparatus contained in the kit.

When not in use the apparatus can be stored in a plastic mould or inside a cardboard box but there is also a wooden box designed to store the apparatus of several kits.

In terms of the cost and approach, the kit has considerable advantages. However, a few problems have been noted in connection with its use. One of these is that the kit is relatively small and therefore not suitable for demonstration purposes. Another is that because many of the items in the kit are small, they are easily lost. Practical work has therefore to be carefully organized. A further problem is that although the chemicals required for the experiments are listed, they are not provided. It is hoped, however, that in the near future a "chemical kit" will be developed containing all the chemicals required for the experiments in the EACE Course. Finally, the pupils' sheets do not contain any reading materials other than that directly related to the experiments. Consequently pupils need additional support in the form of a text or other suitable background reading materials.

Production Figures and Sales

As early as 1972, it was found that sales promotion based on distribution leaflets alone was unlikely to prove successful. So a KSTC graduate who was then teaching in a secondary school was seconded by the Ministry of Education to SEPU and given responsibility for promoting sales and arranging demonstrations to schools. The result was immediate: during the first six months of this new appointment, sales were six times the estimated figure.*

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*J.M.S. Whittell, op. cit. p.677.

Table 3 below shows numbers of kits that had been delivered to schools in Kenya up to April 1976.

TABLE 3: KITS DELIVERED TO SCHOOLS

Period	Physics	Chemistry	Biology
1969-1972	547		
Jan-Dec 1973	443		
Jan-Dec 1974	381	162	
Jan-Dec 1975	436	353	13
Jan-April 1976	159	152	112
TOTAL	1,966	667	125

Prices of kits as at 1 May 1976 are as shown in Appendix 2.

Future Plans

With the completion of the new building, plans are under way to make use of the increased storage facilities to buy chemicals in bulk and repack them in smaller packages for distribution to schools. Lecture room facilities in the new building will also allow SEPU to hold in-service courses for teachers in the use of the kits.

SEPU is considering the possibility of designing a special kit in science for primary schools, and hopes to begin exporting equipment in the near future. A detailed evaluation of the kits is expected to be carried out soon. It is hoped that, among other things, this evaluation will find out the extent to which the SEPU project has affected student attitudes to science and the style of science teaching in secondary schools in Kenya.

TEACHER ADVISORY CENTRES (TACs) IN KENYA

Following the establishment of the Primary School Inspectorate Service in 1969, it became clear that local centres were needed in various parts of the country where short courses could be provided for groups of teachers or individual teachers seeking advice or help. Thus in 1970, 20 Teacher Advisory Centres (TACs) were established and equipped with basic constructional tools for making audio-visual teaching aids, books and other printed materials for reference purposes.

There are at present 43 TACs of which eleven are situated in primary teacher training colleges, (these tend to be better equipped), 15 in primary schools, four in secondary schools, and twelve in other community centres. These TACs are distributed throughout the country with at least one in each of the 39 districts in the country. In addition there are sub-centres situated among a cluster of schools in an area where teachers can easily get together for a meeting.

Siting of TACs in teachers colleges allows college tutors and tutors of Centres to interact in pre-service and in-service courses. Again when residential in-service courses are held for practising teachers, existing college facilities are an asset.

The Centres are currently manned by tutors who also work closely with a number of "example schools", usually to be found within a radious of 8 km of the Centre. In these schools the TAC tutor acts as a supervisor, encouraging teachers, assisting them to improve their competence, keeping a progress report of each teacher, and informing KIE of work in the field.

Teachers for the position of TAC tutor are carefully selected. Once appointed they collaborate with the area assistant primary school inspectors and principals of the primary teachers colleges where the Centres are situated. These personnel provide the Ministry of Education with a record and an evaluation of the tutors' work.

KENYA SCIENCE TEACHERS ASSOCIATION

The Kenya Science Teachers Association (KSTA) was inaugurated in Nairobi on 7 April 1952. The idea to establish a professional body of science teachers was conceived by a group of expatriate teachers who, being scattered all over the country, hoped that such a body would help promote communication among them.

The Association which is exempt from registration by the Registrar of Societies, exists (a) to promote good teaching of science at all levels of the educational system, and (b) to afford means of communication among members and also between the Association and other bodies. Membership is open to all teachers and any person interested in the teaching of science. Thus it includes primary and secondary school teachers, science student teachers, tutors of teacher training colleges, inspectors of science, and university lecturers and professors.

The Association enjoys good working relations with the Ministry of Education, the Kenya Institute of Education, Science Equipment Production Unit and other bodies. Its activities are restricted to matters concerning the teaching of science. These include organizing conferences, seminars, workshops and student science congresses, and publishing a journal. The student science congresses have been held at the national level since 1964 and continue to be popular. Of the many conferences dealing with various themes, one which deserves particular mention is the School Science Apparatus Conference held at the University of Nairobi in August 1973. The conference looked critically at the problems of equipping school science laboratories in Kenyan schools and explored ways of easing some of the frustration experienced by science teachers.

APPENDIX 1: QUESTIONNAIRE FOR PROBE OF APPARATUS MARKET

Part 1

1. Name of school:
2. Name of person to whom correspondence should be addressed:
3. Telephone number:
4. Type of school:
5. Number of pupils in school:
6. Level to which pupils are taught:
7. Number of parallel streams:
8. Are the following subjects taught separately? physics; chemistry; biology:
9. Is general science taught as well as, or instead of, above separate subjects?
10. Average number of pupils per class:

Part 2

11. How much money, if any, is spent at present on apparatus annually for (a) physical sciences? (separate into physics and chemistry, if possible) (b) biology sciences? (c) general science?
12. Are you interested in the samples of apparatus shown?
13. At the prices aksed, how much would you buy?
14. How much would you spend annually if told/shown what was available?
15. Is there any particular time of year when it is easier to buy apparatus because of availability of funds?
16. If there were an apparatus fair at some accessible centre once a year, would you (a) find it useful? (b) attend?
17. Could you, under any conditions, pay cash on delivery? If not, what period would be needed for payment?
18. Would you welcome, and use, a periodical pamphlet saying what apparatus is available and outlining its uses, and giving prices and availabilities?
19. For expensive apparatus which is beyond your financial reach, would you welcome the establishment of a pool of apparatus at some local centre from which you could borrow?
20. For the use of the pool outlined in 19, would you be willing to pay a small annual charge to cover the cost of maintenance?

Part 3

Comments and additional information:

APPENDIX 2: PRICE LIST

Kits	Shs.
1. One physics kit in one box	395.00

2.	Two physics kit in one box	745.00
3.	One chemistry kit in one box	295.00
4.	Two chemistry kit in one box	545.00
5.	One supplementary chemistry kit in one box	235.00
6.	One physics and one supplementary chemistry kit in one box	585.00
7.	One empty box	45.00
8.	Biology kit	210.00

Manuals

9.	Science kit manual	5.00
10.	Mechanics and general physics	5.50
11.	Heat	5.50
12.	Chemistry kit pupils sheet yr. I & II	10.00
13.	Chemistry kit pupils sheet yr. III & IV	8.00
14.	Chemistry kit teachers guide yr. I & II	10.00
15.	Chemistry kit teachers guide yr. III & IV	8.00
16.	Biology manual	8.00

Physics Slides

17.	High voltage electric fields	66.50
18.	Difference between sounds	66.50
19.	Electric charge and electrons	66.50
20.	Cassette tape for the physics slides	16.00

Chemistry Slides

21.	Making soap in Kenya	47.50
22.	Soda ash from Lake Magadi	47.50
23.	Making salt in Kenya	47.50

Biology Slides

24.	Sorting out living organisms	66.50
25.	Savannah ecosystem	47.50
26.	Man and nature	47.50

Geography Slides

27.	Physical geography slides	167.50

Others

28.	Friction drums	250.00
29.	Min-Max thermometer	40.00
30.	3-D Model	120.00
31.	Ammeter	110.00
32.	Voltmeter	110.00
33.	Galvanometer	110.00

34.	Meter bridge	120.00
35.	Trolley	80.00
36.	Timer	80.00
37.	Ticker tape	1.20
38.	Stroboscope	15.00
39.	Optic lamp	35.00
40.	Statistics board	25.00
41.	Wall thermometer	15.00
42.	Test-tube racks	13.00
43.	20 ml syringes	10.00
44.	50 ml syringes	15.00

*£1 = Shs. 14.50

Section 3

CENTRE FOR THE MANUFACTURE OF TEACHING AIDS AND EQUIPMENT : TURKEY

Background

Primary education in Turkey is free and compulsory for a period of five years in the six to 14 age-bracket. Three-year regional primary boarding schools exist in addition to the usual day schools, especially in rural areas. Turkish is the medium of instruction. Class sizes average about 45.

Up to the end of the 1974/75 academic year, successful completion of primary education was marked with the award of a certificate. This practice has ceased with the coming into effect in 1976 of the new eight-year minimum basic education.

Secondary education lasts for six years, three of which are spent in middle school (orta) and three in high school (lycee). There are no specialized courses in middle schools: the programmes offered are career-oriented. Middle schools are either independent or are attached to high schools.

The high school prepares students for higher education, for the professions, and for the necessities of life. In the first year, termed a career-selection grade, general education, professional and technical courses are offered. At this grade, students sample different kinds of courses to find out the type of career that suits their aptitudes and inclinations. In different sections of the second year of high schooling, two kinds of programmes - literature and science - are offered to prepare students for higher education. There are four different kinds of programme in the third year of high school; literature, social science/economics, math/physics, and natural science. In each of these programmes, there are common, compulsory, special and elective courses. Turkish is the medium of instruction, but foreign languages like English, French and German are taught. The normal class size in middle and high schools is 40, though class sizes of 75 and 80 are not unknown.

A few experimental schools (nine as at present) exist. These make the introduction of innovations into the school system relatively easy.

Table 4 of educational statistics for Turkey, showing the number of pupils in the country who attend state, private and minority schools at the primary, middle, and high-school levels, appears at the foot of page 28. It should be noted that the private schools in Turkey usually exist to serve the need of foreigners.

The Science Lycee

In 1964, the Ministry of Education established, with assistance from the Ford Foundation, a high school called the Science Lycee to provide a three-year course with a bias towards science and mathematics. The school began with very well-equipped laboratories, high staff-student ratio, and highly qualified staff. Its highly selective nature was evident from the fact that out of at least 10,000 applicants only about 300 were admitted. Its science programmes were adaptations of current American materials in the separate subjects of biology, chemistry and physics (i.e. the BSCS for biology, CHEM study for chemistry, and PSSC for physics). However, the Science Lycee is no longer the model school it was proposed to be. R.H. Maybury in his book Technical Assistance and Innovation in Science Education (John Wiley & Sons, New York, 1975) describes it as being now "an ordinary secondary school, struggling against the same problems of niggardly budgets, inadequate equipment, and indifference among teachers that afflict most secondary schools in most economically-deprived countries".

The Science Project (Fen Projesi)

In 1966, the Ministry of Education decided that the Science Lycee materials should be placed into other schools in Turkey. The first pilot effort began in Behceliever School during the 1966/67 academic year. In this exercise the Science Lycee staff assisted the Behceliever School teachers to use the course materials in all their science materials. This experience at Behceliever School led to the initial outlines of the framework for the large-scale extension of the Science Lycee materials that is described next.

In March 1967, the Ministry of Education set up a body called the Science Education Development Commission (SEDC) whose members were drawn from the Ministry of Education and Turkey's scientific community. The Commission gave priority attention to a pilot programme for extending the Science Lycee materials into other schools

TABLE 4: SCHOOLS AND PUPILS IN TURKEY

	1971/72		1972/73	
	No. of Schools	No. of Pupils	No. of Schools	No. of Pupils
State Primary School	39,100	5,076,166	40,154	5,268,811
Private Primary School	79	15,990	78	16,842
Minority Primary School	76	7,272	72	6,734
State Middle School	1,734	786,486	1,909	906,187
Private Middle School	87	18,031	67	15,856
Minority Middle School	17	2,231	17	1,945
State High School	423	235,525	490	257,068
Private High School	78	13,816	61	15,856
Minority High School	12	1,044	12	969

The Science Lycee

In 1964, the Ministry of Education established, with assistance from the Ford Foundation, a high school called the Science Lycee to provide a three-year course with a bias towards science and mathematics. The school began with very well-equipped laboratories, high staff-student ratio, and highly qualified staff. Its highly selective nature was evident from the fact that out of at least 10,000 applicants only about 300 were admitted. Its science programmes were adaptations of current American materials in the separate subjects of biology, chemistry and physics (i.e. the BSCS for biology, CHEM study for chemistry, and PSSC for physics). However, the Science Lycee is no longer the model school it was proposed to be. R.H. Maybury in his book Technical Assistance and Innovation in Science Education (John Wiley & Sons, New York, 1975) describes it as being now "an ordinary secondary school, struggling against the same problems of niggardly budgets, inadequate equipment, and indifference among teachers that afflict most secondary schools in most economically-deprived countries".

The Science Project (Fen Projesi)

In 1966, the Ministry of Education decided that the Science Lycee materials should be placed into other schools in Turkey. The first pilot effort began in Behceliever School during the 1966/67 academic year. In this exercise the Science Lycee staff assisted the Behceliever School teachers to use the course materials in all their science materials. This experience at Behceliever School led to the initial outlines of the framework for the large-scale extension of the Science Lycee materials that is described next.

In March 1967, the Ministry of Education set up a body called the Science Education Development Commission (SEDC) whose members were drawn from the Ministry of Education and Turkey's scientific community. The Commission gave priority attention to a pilot programme for extending the Science Lycee materials into other schools

TABLE 4: SCHOOLS AND PUPILS IN TURKEY

	1971/72		1972/73	
	No. of Schools	No. of Pupils	No. of Schools	No. of Pupils
State Primary School	39,100	5,076,166	40,154	5,268,811
Private Primary School	79	15,990	78	16,842
Minority Primary School	76	7,272	72	6,734
State Middle School	1,734	786,486	1,909	906,187
Private Middle School	87	18,031	67	15,856
Minority Middle School	17	2,231	17	1,945
State High School	423	235,525	490	257,068
Private High School	78	13,816	61	15,856
Minority High School	12	1,044	12	969

in Turkey. Schools drawn from Ankara, Istanbul, Aydiu, Erzurum and Izmir cities were designated as lycees participating in this pilot project. TUBITAK (Turkey's Scientific and Technical Research Council) agreed to act as sponsor of this pilot programme under a project entitled: "Research on the possibility of conducting Science Education at other Turkish Lycees using the courses developed by the Science Lycee Project."

The original project involved nine lycees including Bahceliever School and about 100 teachers and 8,000 students. It consisted of trying out the Turkish adaptations of the American materials in use in the Science Lycee.

In June 1970 a SEDC-commissioned evaluation study of the performance of teachers and students of the nine pilot lycees in this project over the three-year period 1968 to 1970, showed that the materials were not as successful in other Turkish lycees as they had been in the Science Lycee. However, with the recorded positive attitude of the pilot lycee teachers, apparent failure was attributed to a number of causes including such factors as insufficient time to complete the ccurses, heavy workload on both students and teachers, lack of motivation of some of the students, and teachers' lack of experience in taking full advantage of modern teaching methods.

According to the new school system, the curriculum at first year high school was to be a general diagnostic one. It was then to be followed by a system of specialized options in which students chose to pursue literature or science stream courses.

With the first year general science course based on a Turkish adaptation of the American Introductory Physical Science (IPS) programme, the SEDC enlarged the scope of its outreach by launching a three-year experiment at the beginning of the 1971/72 academic year. This new project, in which all the existing American adapted texts were revised, involved 100 regular lycees and 89 lycee-level teacher training colleges. (The latter offer a four-year course including education and the general curriculum.)

The 100 high schools were selected from all over the country according to the following criteria: (a) the number of students in classes should not exceed 40; (b) there should be sufficient laboratory and classroom space for the teaching of science classes; (c) classroom-laboratories should be equipped with chairs and flat-top tables on which groups of four students could work; and (d) in case of an increase in the number of students, there must be a suitable place around the school building for construction of new buildings.

With this experiment over, the SEDC has begun introducing the following revised materials printed at the Science Project Centre into all state high schools in Turkey:

(a) Textbooks prepared by the Commission and printed by the Ministry of Education. These books are normally sold to students at cost but are generally given to poor students without charge.

(b) Teachers' guide books. These are distributed free to teachers who need to use them.

(c) Translations of a variety of source books for teachers and students.

(d) Tests and evaluation materials.

(e) "News Bulletin of Modern Science Education" published by the Scientific Commission.

In addition to these printed materials, films and film strips related to the modern science programmes are being procured. Reproducing these films for use in schools is the task of the Film Centre of the Ministry of Education, but purchasing them and meeting their costs in foreign currency are the responsibility of the Centre for Science Project.

Science Project Staff

The six professional staff, with supporting administrative and clerical staff, are housed in the new building of the Ministry of Education headquarters. These professional staff are all former teachers in lycees, and most have already been on training courses in the U.S.A. The current head of the team is Mr. Nihat Gurpinar. The SEDC is an advisory body to this team.

In-service Training of Teachers

The teacher training implications for the Lycee Science Projects have been met in part, at least by a series of summer institutes. A considerable budget from TUBITAK has been made available to these institutes which have been staffed by university professors and members of the Project. These summer courses are being conducted all over Turkey. It is worth noting that in the early years of the Lycee Science Project, a number of American tutors participated in these courses, and it is no surprise that the institutes seem to have been modelled on the extensive National Science Foundation summer institutes that were a feature of the U.S. curriculum science during the 1960s.

SCHOOL MATERIALS MANUFACTURING CENTRE (DAYM)

Establishment and Functions

With the aid of expert assistance and cash for machinery and equipment from the Organization for Economic Co-operation and Development (OECD), the Ministry of Education set up the School Materials Manufacturing Centre (DAYM) in Ankara in 1961.

The main function of DAYM is to provide teaching materials for schools in Turkey. This it does by producing the bulk of the equipment and aids and by purchasing the remainder for distribution from local or foreign markets.

The Centre also serves two other functions. The first of these is to hold in-service courses during summer months for science teachers in order to train them to use and to repair laboratory equipment. For this purpose, mobile units are used. They are based in a few centres, and generally consist of a van, science equipment, tools and small machines for repair work, and audio-visual aids. They are staffed by able science teachers who travel around a province (particularly in deprived areas) helping science teachers with their teaching problems, introducing them to new mehtods and techniques in science education, repairing broken equipment, and giving demonstrations in practical lessons in rural schools where adequate facilities for such work are at present non-existent.

The second function of the Centre is to run day and/or evening courses for apprentices as well as evening courses for people who intend to learn a trade. The students involved are adults and out-of-school youths. The courses include machine tool operation, metal turning, die making, electricity, electronics, glassblowing, technical drawing and woodworking. Over 2,300 workers have received satisfactory training through this scheme over the past ten years.

Structure

Though the Center started with only 25 workers and four teachers in what was originally a day technical school, the DAYM now has a new building in addition to the old one, 580 workers and 18 workshops (soon to be increased to 30), manned by 34 teachers. The administrative staff are all ex-classroom teachers and still belong to the teaching service. Of the 34 teachers, four are qualified engineers and four are Higher Education Technicians. The administrative set up includes: chiefs of various workshops (at present 18), a director, a deputy director, the head of the research development unit, the laboratory chief, five assistant directors responsible for personnel, education, public relations, commercial matters, and production, and 18 workshop chiefs.

Finance and Methods

DAYM is regarded as a Department and it is therefore financed as such by the Central Ministry of Education. Each year the Department of Education Aids within the Ministry of Education receives lists of schools' requirements from the Secondary and Elementary Education Departments. These requests are processed and passed on to the DAYM which then produces and sends the equipment to schools through private transport companies. A school's responsibility is simply to report receipt of equipment by writing to the Centre and to the particular Department under which it functions. If schools need supplementary equipment, they are expected to make direct contact with DAYM or local companies for supplies and pay out of their own school science vote. Records reveal that school requests are dealt with promptly by the Centre.

School Science Equipment

Science equipment for primary, secondary and teacher training levels in all types of materials (wood, plastics, steel and glass) are produced. In fact, apart from certain sophisticated equipment like microscopes and thermometers which are imported from Germany, the U.S.A., Israel and Japan, most of the school science equipment is produced by DAYM. It is estimated, for instance, that over 80% of the equipment required for teaching the Turkish PSSC-Physics is produced at the Centre.

To produce these instructional tools, the main raw materials that have to be imported are optical glasses; chemicals for metal plating; resistance wires (chrome oxide); magnets (horse shoe and bar types); Fe, Ni, A, Cu, components; and semi-manufactured musical instruments components.

The machines available at the DAYM for producing the instrumental tools are shown in the following table 5.

TABLE 5 : DAYM MACHINES

Machines	Quantity	Machines	Quantity
Automatic coil winding machine	4	Spring winding machine	2
Diffusion pump (for glass blowing)	1	Plastic injection press (for 2 kg. capacity)	1
Machines for optical workshops	1 set	Plastic injection press (for 1 kg. capacity)	1
Checking and control devices for optics shop	1 set	Plastic injection press (for $\frac{1}{2}$ kg. capacity)	1
Work dies for optics shop	1 set	Plastic blowing press (for bottle making - 2 litres capacity)	1
Checking and control instruments for electric and electronic workshops	1 set	Lathe	3
Special machines for the production of musical instruments	1 set	Polyester spraying machine	1

Table 6 on page 34 indicates the number of sets of equipment and aids produced and supplied to schools by DAYM during the period 1970 to 1973.

TABLE 6: INSTRUCTIONAL TOOLS GIVEN TO SCHOOLS IN THE YEARS 1970-73

Type of Instructional Tool	Number of Sets Given				
	1970	1971	1972	1973	Total
Lycee Modern Physics	88	94	105	100	387
Lycee Modern Chemistry	88	94	105	100	387
Lycee Modern Biology	70	76	90	100	336
Lycee Mathematics	125	126	150	100	501
Lycee Social Studies	115	445	200	100	860
General Science (Lycee + middle school)	60	670	220	500	1,450
Middle School Physics	100	40	340	-	480
Middle School Chemistry	120	40	340	-	500
Middle School Natural Science	100	40	340	-	480
Middle School Social Studies	100	210	350	500	1,160
Middle School Mathematics	125	152	300	500	1,007
Middle School Handicrafts	-	50	-	200	250
Primary School General Science and Natural Science	3,000	3,600	4,000	4,000	14,600
Primary School Social Studies	-	3,500	4,000	4,000	11,500
Primary School Handicrafts	350	-	400	400	1,150
Pre-School Education Instructional Tools	100	100	100	100	400
Middle School-Lycee, Lycee Level College Language Laboratory	-	9	10	10	29
Vocational - Technical Schools General Science	-	75	50	-	125
Grand Total	4,541	9,321	11,100	10,710	35,672

Section 4

REGIONAL CENTRE FOR
EDUCATION IN SCIENCE AND MATHEMATICS (Malaysia)

Background

The Southeast Asian Ministers of Education Organization (SEAMEO) was established in 1965 to foster regional co-operation in education, science and culture. The eight member countries are Indonesia, the Khmer Republic, Laos, Malaysia, the Philippines, Singapore, Thailand, and the Republic of Vietnam. In addition there are three associate member countries, namely Australia, France and New Zealand.

The policy-making body of the Organization is the Southeast Asian Ministers of Education Council (SEAMEC) composed of the Ministers of Education of the member countries. The executive arm of the Council is the Southeast Asian Ministers of Education Secretariat (SEAMES), located in Bangkok, Thailand. Programme activities are mainly carried out through a series of Regional Centres/Projects located in various member countries. The Regional Centres/Projects are:

1. The Regional Centre for Tropical Biology (BIOTROP) located in Bogor, Indonesia.

2. Regional Centre for Educational Innovation and Technology (INNOTECH), temporarily located in Bangkok, Thailand (previously in Saigon, Vietnam).

3. Regional Centre for Education in Science and Mathematics (RECSAM) located in Penang, Malaysia.

4. Regional English Language Centre (RELC) located in Singapore.

5. Regional Centre for Graduate Study and Research in Agriculture (SEARCA) located in Los Banos, Philippines.

6. Central Office of the Governing Board of the Regional Tropical Medicine and Public Health Project (TROPMED) located in Bangkok, Thailand.

A further Centre, the Applied Research Centre for Archaelogy and Fine Arts (ARCAFA) is under consideration, and was originally planned to be located in Phnom Penh, Khmer Republic.

The Regional centres conduct a wide range of training courses. BIOTROP, INNOTECH, RECSAM and RELC award certificates and diplomas to their participants on completion of the courses, whilst SEARCA and TROPMED award master's and doctorate degrees and postgraduate diplomas.

Structure of RECSAM

RECSAM was established by SEAMEO as an autonomous institution in May 1967, with the main purpose of assisting member states in the improvement of science and mathematics teaching and thereby providing the firm foundation necessary for meeting the scientific and technical manpower requirements of Southeast Asian countries in the future. The Centre is hosted by the Government of Malaysia as her contribution to regional co-operation, and administered by a Director under the guiding policy of SEAMEC which channels its policy decisions through a governing board. The Director is guided by an International Advisory Council in the development of the Centre's programme.

The Centre is organized under four broad headings, namely Training, Research, Information and Special Services, and Administration.

The Training Division operates courses aimed at training key personnel in modern techniques of teaching and evaluation in science and mathematics.

The Research Division operates courses aimed at developing complete prototype units or modules in science and mathematics as well as conducting some pilot studies on child learning. The two most important projects are the Southeast Asian Science and Mathematics Experiment (SEASAME) and the Science and Mathematics Concept Learning of Southeast Asian Children.

The Information and Special Services Division produces and disseminates the various reports and other RECSAM publications, as well as maintaining contact with appropriate institutions and bodies both within and external to the SEAMEO region.

The Administration Division handles the organization and running of the Centre.

Location of RECSAM

RECSAM is located on the Malayan Teachers' College campus, near Georgetown, Penang. It began limited operations in 1968 in borrowed accommodation from the college, and occupied its own premises on the completion of the first building phase in 1972. This phase involved the construction of hostel accommodation and the recreational block (the latter being temporarily used as the teaching/administrative block pending the completion of phase two). The phase two building will contain two laboratory/workshop blocks, a library/information block, a conference hall and an administrative/teaching block. Details are shown in the drawing on page 37.

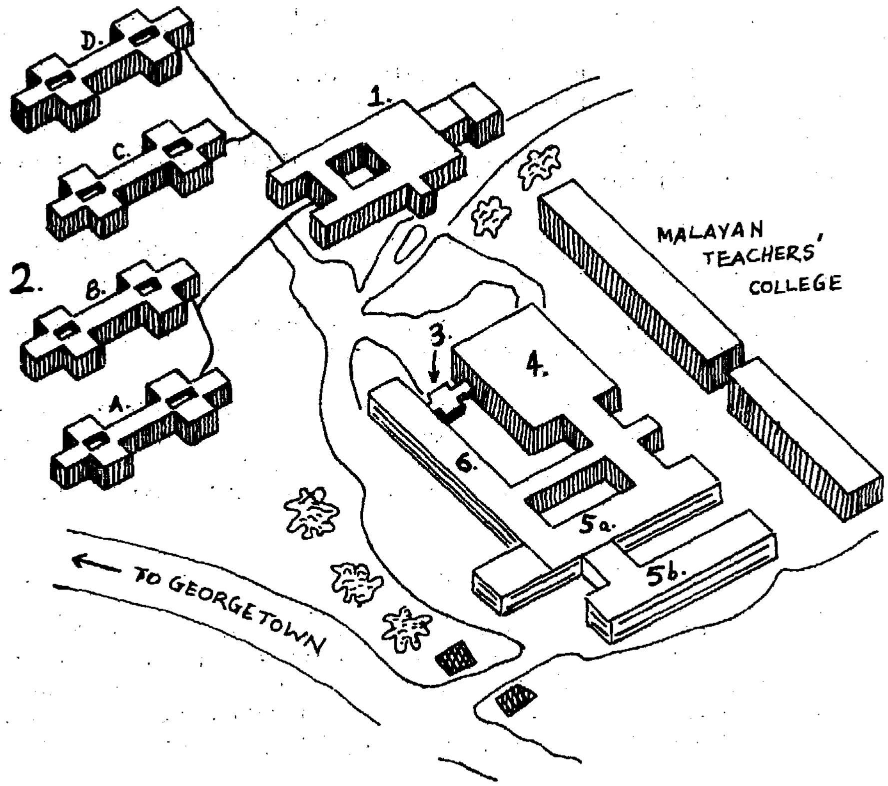
The building priorities were based on the provision of satisfactory accommodation for the course participants together with adequate teaching facilities, followed by purpose-built teaching facilities. By using such a plan, course participants suffered minimum interference to their work. (Accommodation is often a source of discontent on residential courses.)

Facilities

The building currently being used to house the activities of RECSAM is the recreational block, which will revert to this function when phase 2 is completed. The block contains classroom/laboratory space, a small workshop, stores, printing/duplication space, a small resource area (the main library is located in the Malayan Teacher's' College building) and a small darkroom for photographic work. In addition, office space for staff, the administrative offices and the dining room are located in the building.

The new building is scheduled to have an administrative and teaching wing, two wings containing science laboratories and workshops, a library and information block, and a conference block. It is envisaged that the workshop facilities will be able to cater for course work by the participants, whilst a separate workshop will be concerned with prototype production of science and mathematics apparatus.

SKETCH PLAN OF THE RECSAM SITE



KEY

1. Recreational Block
2. Hostel Blocks (A, B, C, D)
3. Conference Room
4. Library and Information Block
5a. Science Laboratory/Workshop Block
5b. Science Laboratory/Workshop Block
6. Administration and Teaching Block

At present these two functions are carried out with some difficulty in the one small workshop in the recreational block. Basic hand tools are used for the construction of apparatus: machine tools are not used.

The hostel accommodation is located near the teaching area and consists of some 100 units of single/double accommodation, some of which are air conditioned. There are common rooms and laundry facilities in each of the four hostel blocks. A large dining room/ recreation room is located in the recreational block, which at the moment is also used as a general purpose hall.

Functions of RECSAM

To achieve the purpose for which it was established, RECSAM undertakes the following activities:

1. Training programmes for key educators in modern methods of teaching science and mathematics.

2. Development of action-research techniques.

3. Critical study of selected pilot project materials.

4. Development of specific studies and instructional materials to be carried out as pilot projects.

5. Critical examination of research on curriculum materials and methodology.

6. Development of simple techniques in apparatus-making using low-cost materials.

7. Organization and conduct of professional seminars and workshops for educators in the region.

8. Gathering information and acting as a clearing house for science and mathematics education.

9. Consultation and special services for SEAMEO member countries.

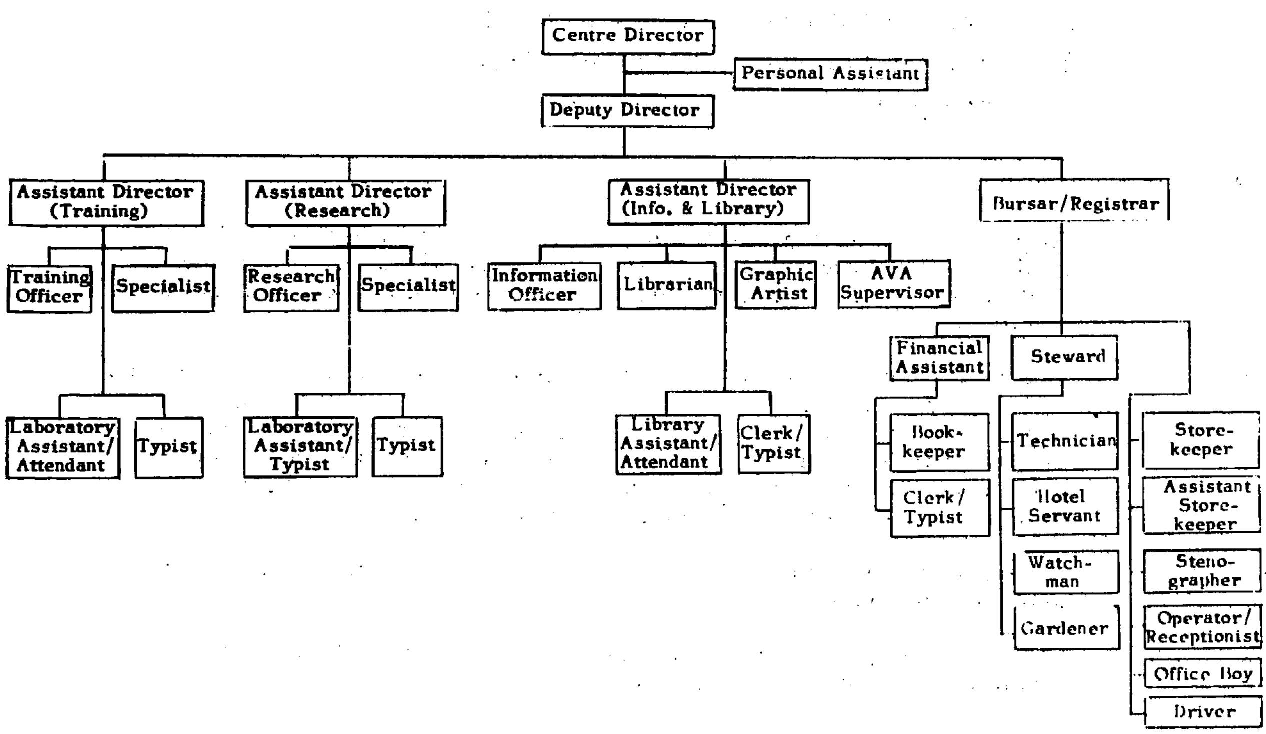
10. Promotion of indigenous efforts in curriculum development.

Formal relations have been established with UNESCO, thereby providing mutual-co-operation in matters and activities related to science and mathematics education in Southeast Asian countries. This link will also enable the Centre to benefit from the provision of specialists, consultants, etc. when required.

Staffing of RECSAM

RECSAM is staffed by tutors recruited from within the SEAMEO region and by specialists from elsewhere. In addition, the services of short-term consultants are utilized when required. Often these are generously provided by governments throughout the world. The organizational structure of RECSAM is shown in this diagram:

RECSAM ORGANIZATIONAL CHART



The actual staff and posts for 1975-76 are as follows.

ADMINISTRATION

Academic Staff

Centre Director (1)
Deputy Centre Director (1)

Non-Academic Staff

Registrar/Bursar (1)
Financial Assistant (1)
Personal Assistant to Director (1)
Stenographers (2)
Book-keeper (1)
Clerical Officers (4)
Clerical Assitants (2)
Typists (2)
Store-Keeper (1)
Assistant Store-Keeper (1)
Van Driver (2)
Office Boys (3)
Maintenance Technician (1)
House Servants (10)
Gardners (6)
Watchmen (4)
Steward (1)
Security Officer (1)
Receptionist/Telephone Operator (1)

TRAINING DIVISION

Academic Staff

Assistant Director (1)
Training Officer (Science) (1)
Biology Officer (1)
Chemistry Officer (1)
Mathematics Officer (1)
Physics Officer (1)

Non-Academic Staff

Laboratory Assistant (1)
Laboratory Attendants (4)
Typists (2)

RESEARCH, DEVELOPMENT AND EVALUATION DIVISIONS

Academic Staff

Assistant Director (1)
Biology Officer (1)
Mathematics Officer (1)

Non-Academic Staff

Laboratory Assistant (1)
Workshop Technician (2)
Laboratory Attendants (2)
Typists (2)

INFORMATION/SPECIAL SERVICES DIVISION

Academic Staff

Assistant Director (1)
Information Officer (1)
Librarian (1)
Library Assistants (2)
A.V.A. Supervisor (1)
Graphic Artist (1)

Non-Academic Staff

Clerical Officer (1)
Clerical Assistant (1)
Typists (2)
Library Attendants (2)

Financing of RECSAM

In mid 1970, RECSAM became semi-operational with the first phase of its building programme, and this commenced the first five-year operational plan for the Centre. The total cost of the plan was projected as being US $ 8.7 million, of which the U.S.A. contributed 50%. The Government of Malaysia, as the host country, assumed responsibility for the capital and operating costs of the Centre whilst

SEAMES had the responsibility for raising the funds required for the Centre's activities. The latter are generally raised from grants and donations, in either cash or kind, from interested governments and other organizations and institutions. The second phase of the building programme is being financed jointly by the U.S.A. and the Malaysian Government. Work on this phase commenced in 1975, and occupation of the premises is expected in late 1976.

The second five-year development plan commenced in July 1975, and for this RECSAM is completely responsible for obtaining its own finances.

The responsibility for the total operational costs for the second five-year development plan was taken over by the Government of Malaysia in June 1975. The amount allocated was about M$ 4.6 million, with an additional M$ 3,150,000 for the construction of additional facilities in the building programme and for awarding scholarships and fellowships.

The breakdown of financing for the second five-year plan is as follows:

SECOND FIVE-YEAR FUNDING PLAN (1975-1980)

OPERATIONAL COST ESTIMATES

		Total for 5 years
Personnel emoluments for SEAMEO staff, including other personnel costs and benefits		M$ 4,092,500
Services and Supplies		1,655,900
Grants and Subsidies		145,000
	Total	M$ 5,893,400

SPECIAL FUND ESTIMATES

		Total for 5 years
Training and Research Scholarships		M$ 2,516,800
Seminars/Conferences/Workshops		137,500
Governing Board Meetings		96,250
Personnel Exchange		15,000
	Total	M$ 2,765,550

(M$ 1.00 = £S 0.20 approx. in January 1976)

ACTIVITIES

The Training Division and the Research Division are responsible for the courses conducted at the Centre and work closely together. The courses run by the Training Division aim at training key personnel in modern techniques of teaching and evaluation, whereas those run by the Research Division deal with the development of complete prototype units or modules and with conducting pilot studies on child learning. The range comprises elementary science, elementary and secondary mathematics, integrated science, biology, physics, chemistry, and elementary and secondary science apparatus. Up to June 1975 some 900 participants had attended training courses at the Centre. Depending on the nature of the course/seminar/workshop, participants spent from two weeks to twelve weeks there.

In the second five-year plan, some streamlining of courses has been introduced to reflect more clearly the intentions of the activity and distinguish more clearly the expected outcomes. Table 7 indicates the types of courses and the numbers of participants for the second five-year plan 1975-1980.

TABLE 7: PROPOSED PROGRAMMES FOR 2½ MONTHS EACH

	NUMBER OF SCHOLARS				
TRAINING COURSES	1975/6	1976/7	1977/8	1978/9	1979/80
TC-S1 Modern Methods of Teaching Primary Science	16	16	16	16	16
TC-M1 Modern Methods of Teaching Primary Maths	16	16	16	16	16
TC-C Modern Methods of Teaching Chemistry	16		8		8
TC-B Modern Methods of Teaching Biology	8		16		16
TC-P Modern Methods of Teaching Physics	16		8		8
TC-M2 Modern Methods of Teaching Secondary Maths	16		8		8
TC-E1 Modern Methods of Primary Science and Maths Evaluation/DP-SM	16	16	16	16	16
TC-E2 Modern Methods of Secondary Science and Mathematics Evaluation		8		8	
TC-1 Modern Methods of Teaching Integrated Science	16		16		16
TC-Q1 Training in Development of Primary Science/Mathematics Apparatus	8	8	8	8	8
DEVELOPMENT					
DP-SM Development of Teaching Modules for SEASAME Project	16	16	16	16	16
DW-02 Development of Secondary Science/Maths Apparatus (Production and Design)					
DW-LM Manual of Laboratory Management and Techniques	16	16			
DP-1 Development of Teaching Units in Integrated Science		8		8	
RESEARCH					
RP-SL Studies in Concept Learning - Primary Science	8	8	8	8	8
RR-M1 Studies in Concept Learning - Primary Maths	8	8	8	8	8
DEVELOPMENT					
DW-SIN Development of Pre-Service Teacher Training Modules in Primary Science		16		16	

Development (continued)					
DW-MIN Development of Pre-Service Teacher Training Modules in Primary Maths		16		16	
DW-SMR Development of In-Service Packaged Units in Primary Science and Maths		16		16	
DW-M2G Development of Maths Teaching Units for Secondary Students (General Curriculum)		16		16	
DW-S2V Development of Science Teaching Modules for Vocational Studies			8		8
DW-M2V Development of Mathematics Teaching Modules for Vocational Students			8		8
TOTAL	176	176	176	176	176

N.B. If more scholarship funds were available more courses per year could be mounted or more scholars could be accepted for any course approved for any year.

Some idea of the range of the courses listed in Table 7 may be obtained from the following outline of three of them.

1. MODERN METHODS OF TEACHING BIOLOGY (TC-B)

Objectives

To train key educators from participating countries in the principles of curriculum development, their implementation and evaluation.

To acquaint participants with modern curricular projects in Biology (e.g. BSCS and Nuffield Biology).

To introduce participants to modern methods employed in teaching Population Biology with emphasis in field exercises and laboratory studies relevant to Population Education Studies.

To make use of readily-available resources in SEAMEO countries to introduce Population Education into their Secondary School Biology Curriculum.

To produce prototype instructional units in Population Education consisting of Pupils' Texts or Teachers' Guides.

Description

Under the guidance of specialist-consultants the participants will engage in the analysis of modern Biology curriculum projects from outside the SEAMEO Region (BSCS & Nuffield Biology). The course will also involve the participants in actual laboratory experiences as well as field exercises which have been planned to develop concepts which could then be presented to and understood by secondary students.

The participants will be acquainted with basic skills in: (a) planning and writing their units; (b) teaching techniques; (c) examination techniques; and (d) evaluation techniques. At the end of their term at RECSAM they will be required to produce prototype instructional units in Population Education. These units may be in the form of a teachers' guide or pupils' text. Participants will also evaluate their product in the classroom situation when they return to their home countries and send some feedback to RECSAM.

Participants Two or three educators who are involved in or are likely to be involved in curriculum development and/or teacher training programmes on returning to their own countries.

Duration A ten- to eleven-week course offered annually.

2. SECONDARY SCIENCE/MATHEMATICS APPARATUS (DW-02)

Objectives These workshops are aimed at the variety of problems of design and production of secondary science/mathematics equipment in SEAMEO countries.

Given the various national priorities for secondary level equipment, participants will:

(a) Design and produce industrial prototype (hand-made) for selected priority items of equipment.

(b) Produce small quantities of selected items for tryout in their countries' curricula.

(c) Produce plans for in-country testing and evaluation of these items.

(d) Produce a set of guidelines for co-operation (liaison) between curriculum development centres (educationists) and equipment design and production units (engineering personnel).

Description These workshops will be product-oriented, but on a small scale in order to ensure that the work of the participants will provide them realistic exposure and training in the techniques of mass production in the light of the equipment situation in their own countries. To some degree the workshops will be future-oriented.

Participants' work and training will include the following concerns: designing for small-scale mass-production from a tested educational prototype; making industrial prototypes; making inexpensive dies; properties of raw materials; manufacturing methods (small-scale); quality control (educational and industrial specifications); evaluating equipment in the classroom; and the nature of working relationships in the development of educational equipment.

Participants Two to four (depending on details of workshop's structure and duration).

Duration Ten to 20 weeks. The length of the workshop will depend on its implementation. If design and production are separated into two sequential workshops, both could extend for ten weeks. If design and production are not separated, but run simultaneously, the duration could be ten weeks.

3. STUDIES IN CONCEPT LEARNING - PRIMARY SCIENCE (RP-SL)

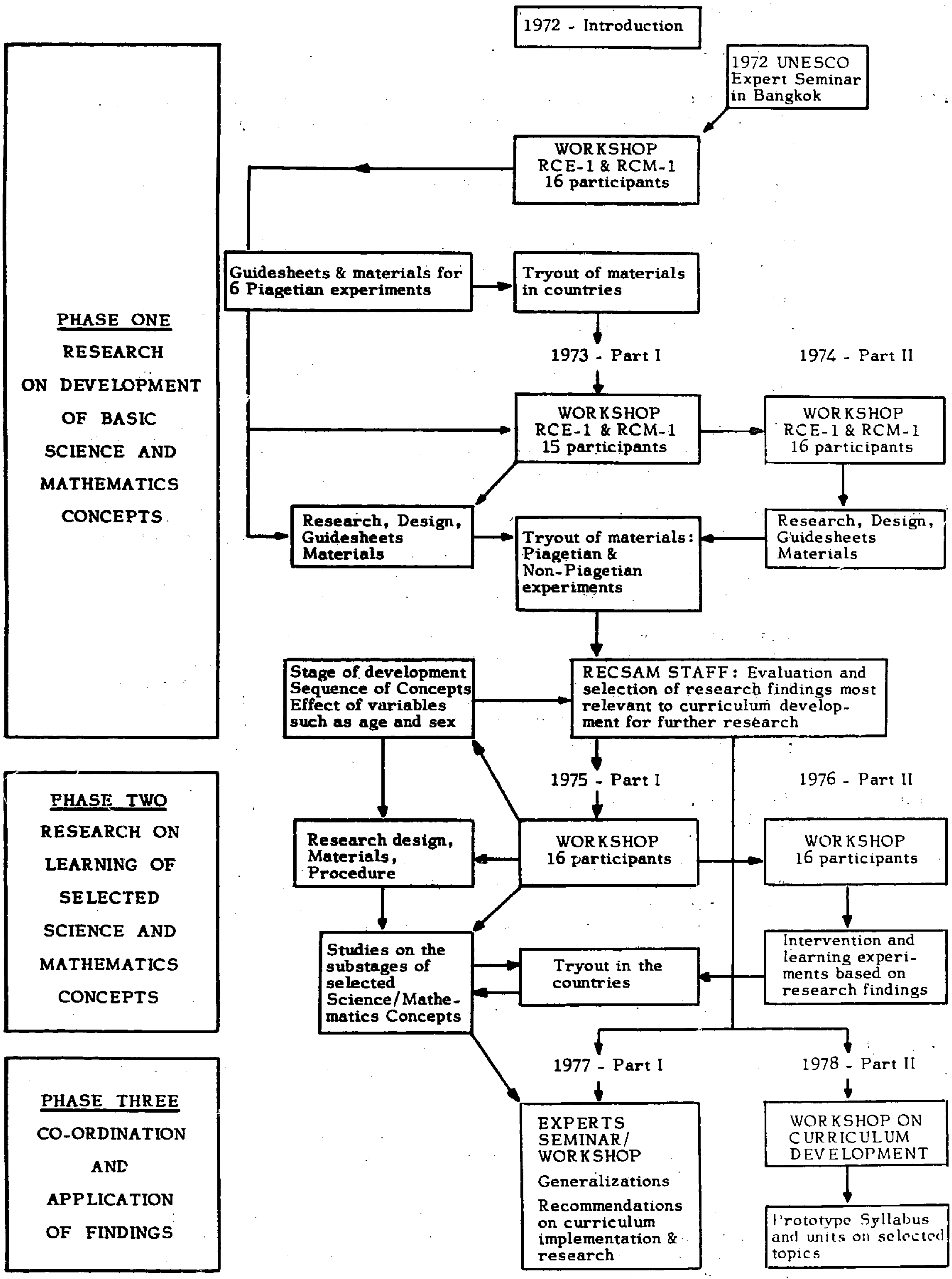
Objectives and Benefits This course is part of a series implementing RECSAM's Pilot Project on Science/Mathematics Concept Learning of Southeast Asian Children. The project aims to:

(a) Gain a better understanding through research, of how children in the region form science and mathematics concepts, and the variables influencing the process.

(b) Develop procedures, materials, research design and techniques for experimenting with children's thinking for possible use by member countries interested in conducting similar research or for diagnostic purposes in science classrooms.

PILOT PROJECT ON SCIENCE/MATHEMATICS CONCEPT LEARNING OF SOUTHEAST ASIAN CHILDREN

1973-1978



(c) Develop guidelines on how to teach primary science based on the findings of the research done by the participants and of similar research in the region.

(d) Design and test learning experiences which utilize the research results and which can be incorporated in the primary science curricula of member countries.

An added benefit is the training and experience gained by the participants in designing, conducting and evaluating research of this kind.

Description

The stages in the development of the project are shown in the flowchart on page 44. The 1976 course, which is now in progress, concentrates on the learning of science concepts. By the end of this phase of the programme, it is expected that participants will have devised or replicated intervention experiments for the basic science concepts and creative learning experiences for the various substages of certain concepts.

Phase 3 begins in 1977 when findings at RECSAM and those of other researchers will be co-ordinated. Tentative generalizations will be made about how Southeast Asian children develop and learn science/mathematics concepts. Recommendations for curriculum implementation and further research in the region are expected. The course will be in the form of an expert's seminar.

The last course in the project is that of 1978 wherein the participants, after examining the various primary science curricula in the region and the recommendations of the 1977 seminar, will co-ordinate with the SEASAME Project to develop a prototype syllabus and selected units for primary science.

Participants

These should be from one of the following groups:

(a) Researchers (graduate students or college lecturers) who have been involved in children's learning and/or the teaching of primary science.

(b) Senior teachers or educators connected with primary science teaching who, upon their return to their own countries, are likely to be involved in research or curriculum innovation.

(c) Classroom teachers or inspectors or supervisors of primary science who have shown active interest in children's thinking or the teaching of science.

Duration

Ten weeks.

RESEARCH PROJECTS

The Southeast Asian Science and Mathematics Project (SEASAME) aims to design, develop and produce relevant teaching and learning modules which include teachers' guides, pupils' worksheets, evaluation procedures and instruments, and appropriate apparatus and equipment. It is hoped that the modules will complement and supplement national efforts to innovate primary science and mathematics curricula.

The initial unit "Introduction to Systems", comprising twelve lessons as well as teaching aids and evaluation instruments, was developed early in 1973 and tried out in Penang. Some 600 primary children were involved in the trials. The materials were developed and tested by course participants in the first half of 1973. At the same time a course for senior national administrators recommended that each member country should have a national co-ordinator in charge of the whole project at national level. This recommendation was accepted by the member countries, and a workshop for the national co-ordinators was held in March 1974 under local conditions. The workshop produced regional and individual country plans for trying out the materials.

Trials were carried out in the eight member countries and, as a result of the feedback, modifications were carried out in courses during 1975. In addition,new units were prepared and trial tested in Penang. The second phase of country tryout was prepared for testing in late 1975/early 1976.

Another research project on "Science and Mathematics Concept Learning of Southeast Asian Children" commenced in 1972 with two courses in which the participants were exposed to concept formation in general. From these courses guide sheets were developed, and selected Piagetian experiments were tried out in schools in Penang.

The 1973 courses again discussed general theories of learning and then critically examined the material prepared and used in the previous year. Further tests were developed as well as guide sheets, work sheets and summary sheets which were then tested in seven Penang schools. RECSAM requested the national Ministries of Education to release the participants from regular duties so as to carry out the field trials in their respective countries. In all, 2,860 tests were carried out on 847 seven- to twelve-year-olds using the eight experiments so far developed.

The 1974 courses built on the previously-developed material, and field trials were again carried out in the participants' home countries with three additional experiments. Twelve participants returned their results containing 6,460 tests involving 1,086 children.

At the 1975 course, which included five participants who had been on the 1974 course, the activities involved analysis of the 1974 field trials as well as the preparation of further material and its trial in schools. A longitudinal study also commenced in 1975 using twelve children from near-by areas. Equipment to suit the study was constructed both by the participants and the technical staff at RECSAM and all the experiments developed on previous courses were used.

A third project, on self-instructional materials, is related to the functioning of RECSAM. Basically, the eight member countries can be divided into English speaking or French speaking, although each country has its own language and regional variations. This presents a problem for RECSAM in that participants on courses have different levels of understanding. To overcome the problem of language, and other possible areas of weakness, a programme has been implemented on preparing self-instructional, self-paced materials in defined areas. Four areas have been chosen, namely: instructional goals and objectives; how children learn; evaluation; and science/mathematics topics.

The material prepared so far has been translated into Lao, Indonesian and French. It has been tested, and is currently being revised. The development of this project is being undertaken by members of the RECSAM staff. The provision of research fellowships is another component of the RECSAM research programme.

Equipment Unit

In October 1973, RECSAM hosted a regional workshop on the "Production of Low-cost Teaching Materials for Primary Science and Mathematics" which was sponsored jointly by SEAMEO and Deutsche Stiftung Fur Internationale Entwicklung (German Foundation for International Development). Amongst the recommendations of that workshop were:

SEAMEO Regional Programmes

1. There should be established a regional equipment unit at the SEAMEO Regional Centre for Education in Science and Mathematics, with the following functions:

(i) Designing and fabrication of prototype equipment for science and mathematics.

(ii) Training of key personnel from the SEAMEO countries for designing and production of prototype materials.

(iii) Acting as a clearing house for collection and dissemination of information regarding materials for science and mathematics.

(iv) Exploring ways and means by which the science and mathematics equipment needs of the region can be met.

National Programmes

1. Each member country examines the feasibility of establishing a national design and prototype production unit as a component of its curriculum development centre or similar institutions. Multilateral and/or bi-lateral assistance in establishing such a centre should be explored.

2. Countries should decide on their own priorities for prototype equipment development which should cater for the present curricula in mathematics as well as science.

The Fifth Governing Board Meeting of RECSAM, held in September 1974 decided "that the Centre in its attempts to implement some of the recommendations of the Workshop, should develop the necessary materials only to the stage of educational prototypes, and that the emphasis should be on the training of personnel who would be likely to be employed as designers in national equipment workshops."

One member of the academic staff, namely the Training Officer (Science), is responsible for the technical component of the course work as well as arranging the specialist courses on laboratory management/equipment, etc. In addition, he is involved in other duties related to his own academic discipline, and he is assisted by one workshop technician, two laboratory assistants and a laboratory attendant. Technical staff are trained by the RECSAM staff. The workshop facilities consist of a laboratory area equipped with hand tools and workbenches (see photo). The new building will have two workshops - one for course work etc, and one for prototype design and development.

Those courses that relate specifically to equipment offered at RECSAM are perhaps best described in the following extract from a paper entitled "RECSAM's Programmes and Courses for Development and Production of Prototype Science Equipment" presented at the aforementioned workshop:

To assist each member country build up a core of equipment key personnel who could develop prototype equipment and produce design plans for dissemination, as well as organize in-service training of teachers and laboratory personnel in equipment production, RECSAM has successfully implemented the course 'Development of Primary Science Apparatus' code titled RMI-1 in 1972 and again in 1973. This intensive course of about ten weeks' duration is specially designed for SEAMEO key peronnel who are actively involved in equipment design, development and manufacture in their respective countries, or who are in positions which make them likely to be so. So far, fourteen SEAMEO key personnel have undergone this course, namely, two each from Indonesia, Khmer Republic, Malaysia, Philippines, Singapore, Thailand, and one each from Laos and Vietnam.

The terminal behavioural capabilities expected of participants on completion of the RME-1 course are that they should be able to:

(a) improvise simple science and mathematics equipment for use in the primary grades.

(b) carry out routine maintenance and minor repairs on simple equipment.

(c) transform new ideas for simple equipment into reality through designing, constructing and testing of such.

(d) produce an equipment design plan acceptable for publication with the necessary technical drawings and parts specification included.

(e) provide sound advice for the procurement of equipment from commercial sources.

(f) carry out refinements on prototype equipment for possible mass production.

(g) advise on plans for mass production of prototypes by government and non-government agencies.

(h) assist in development of curriculum materials through design, and development of equipment hardware for these materials.

(i) organize and conduct in-service courses for teacher trainers, teachers and laboratory personnel, to train them in the basic skills for equipment production leading to actual production of urgently needed equipment.

(j) play leadership role in science/mathematics exhibitions and in school science/mathematics activities.

The course work described above has been continuing, and the Centre has a display area for apparatus developed. In addition, the workshop staff have been constructing apparatus for the Concept Learning Project.

Audio Visual Aids

The Centre has a specialist in audio-visual aids on its staff, and this topic is a constituent part of the majority of courses offered at RECSAM. A small darkroom is available where course participants are able to receive instruction in the use of photographic materials and techniques, and a small amount of resource-centre space is available for using a range of audio and visual apparatus and for receiving instruction in the operating techniques and the preparation of material. It is expected that, along with the expansion of the workshop facilities in the new building, an expansion of the audio-visual facilities will also take place.

Curriculum Development Centre - Kuala Lumpur, Malaysia

This is an example of a national centre established by a member country of RECSAM. It is a division of the Ministry of Education and was established in January 1973 with assistance from UNESCO. The activities of the centre include: (a) curriculum development at primary and secondary school levels with an emphasis on science and mathematics; (b) research in conjunction with a Malaysian university on problems related to linguistics in education; (c) pre-school education and compensatory education; and (d) prototype equipment research and production.

The curriculum development projects are related to an integrated approach to learning and also reflect some of the materials developed at RECSAM.

The workshop unit of the centre constructs apparatus in wood, metal and plastics, and has workshop capacity for developing prototypes. Once a design is accepted, the designs are made available to local commercial manufacturers who construct and market the approved article.

Course work is carried out at the centre and is particularly related to key personnel from the Federation, who in turn are in a position to further expand the "multiplying effect" in their own states.

The centre has a comprehensive resource area containing a range of audio-visual aids as well as the Library and a printing/publication section for producing its own materials. In addition, a number of vans, located at selected establishments (often teacher training colleges or higher secondary schools), serve schools within their area. They carry a kit of tools developed at the centre and other equipment, and they act both as repair units and as in-service training centres.

The centre has received assistance from UNESCO, UNICEF and other donor agencies. It will be moving into its own purpose-built facilities late in 1976. Besides having workshop and teaching facilities it will have hostel accommodation for some 140 persons.

Section 5

GENERAL CONSIDERATIONS

"Local production" and "improvisation" are not synonymous with one another, although they are often used in the same context. Teachers can readily improvise, using local materials, for their own requirements, and they are increasingly being encouraged to do so during their pre-service training. Local production, which implies a sophistication over and above local improvisation, is related to producing apparatus for the needs of the whole school system rather than for the needs of the individual school.

Local production is being implemented by many countries for basically two reasons: the lack of financial resources to supply the whole school system with equipment which has to be imported, and the development of curricula related closely to the local environment.

To reconcile local production with improvisation we can say that the local production unit provides the teacher with his basic requirements. The teacher then extends his teaching resources by improvisation. Whittell summarizes this distinction quite ably*. The NCERT publication, Improvising Science Teaching Kits for Schools is an example of the mis-use of the word "improvisation" since it really relates to the development of kits for the whole school system.

The foregoing chapters deal with centres developing school science equipment. Apart from DAYM these centres could also be classified as assisting with improvisation through their in-service course work. In this section it is perhaps worthwhile to indicate some of the less evident areas of concern which became apparent during the case studies, and which may be of help to a country when it considers establishing a production unit.

DEVELOPMENT OF APPARATUS

Kit Development Two centres are concerned with developing kits for teaching science. These kits are basically demonstration kits, although one centre has also developed pupils' kits. The lack of adequate finance for school equipment often limits the purchase of apparatus to one-off demonstration items. In India for example, with some 460,000 primary schools,

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* Whittell, J.M.S., "Local Production: Principles and Practice", School Science Review, Vol. 56, No. 197, June 1975, pp.669-84.

the development of a demonstration kit is probably the only way of getting practical science introduced into the schools. Naturally such introduction is also coupled to teacher competence. If the teacher education system does not orientate teachers towards practical science, then the teacher demonstration kit, rather than the kit for pupil involvement, is likely to be the norm. The project operated by the Educational Technology Department of the NCERT to investigate the use of satellite television to provide in-service training to rural teachers would be worthy of closer examination as a means of orientating serving teachers towards practical science teaching.

The development of a kit pre-supposes that it is to be an integral part of the teaching syllabus (although this is not necessarily so). Consequently curriculum and equipment development should proceed together. In India the two units are part of the same Department which work together to produce the whole. In Kenya the production unit is remote from the curriculum development unit. Hence the production of kits was only undertaken after the production unit had made a survey of the needs of the schools and the availability of teaching apparatus from local commercial suppliers. It is obvious therefore that before a kit is developed a thorough identification of the role of the kit must be made, particularly its relationship to the curriculum.

Non-Kit Equipment

The DAYM production unit in Turkey is an example of a production unit which concerns itself with producing some 80% of the school science equipment requirements, as compared to India and Kenya which produce only kits. Because such a production unit produces apparatus for use in many learning environments, it can operate independently from curriculum development. One of the dangers of this isolation is that too little innovation may take place, and the items produced may be stereotyped year after year. To prevent this from happening the design and development section of such a production unit needs to have close links with curriculum developers so that changing curriculum requirements can be reflected in their products.

Quality of Products

There is quite a difference between a good idea and a quality-produced piece of science equipment, and appropriate staff are necessary for all stages of development. Many factors have to be taken into account before a good idea reaches the classroom. This is best illustrated by an example from NCERT. The primary science kit was originally designed to be wall-mounted and at the same time to provide a safe storage for the apparatus. So the container had to be sturdy. With village schools having mud walls, the fixing of this robust container proved difficult or even impossible, and when mounted the demonstration surface was not always at a suitable height for the children. The kit went through a series of containers before one was found suitable to meet the requirements of the village schools.

A further example from NCERT relates to the quality of product. Under its component of assistance, UNICEF provided kits of apparatus which, though based on the workshop designs, had to be purchased from commercial suppliers (due to the production load on the workshop). Considerable quality control problems existed, and the workshop department held three courses in 1974 to train key personnel from each State in the inspection and quality control of science kits. The courses included introduction to engineering instruments and materials, particularly related to the kits developed. An inspection kit was developed during the course and supplied to each key institution in the States. Since the kits include items manufactured by local industrial concerns, the department has its own quality control unit. In addition, by implementing the tender requirements on a batch number basis, no supplier is able to become complacent in the belief that he will automatically receive an order. Nor is the lowest tender bound to be accepted, although reasons have to be given to justify any action taken. Where the department finds sub-standard quality it refers the items to the National Standards Institute. The Institute on its part occasionally requests the department to supply specifications for certain items. Hence a close co-operation exists in an attempt to maintain standards.

IN-SERVICE TEACHER TRAINING/CURRICULUM DEVELOPMENT

NCERT in India and RECSAM in South-East Asia are two centres which provide course work. RECSAM in particular is concerned with curriculum activities and is not a production unit as such, though eventually it will have workshop facilities for developing and producing prototypes which member countries can then reproduce in their own centres. (The Curriculum Development Centre in Kuala Lumpur is an example of one such centre in one of the member countries.)

At NCERT, most course work has been related to the primary science project, with selected State institutions providing facilities for the in-service training of teachers. The choice of such institutions needs to be carefully made so as to ensure that they are all able to support the duties required of them. The successful running of courses requires the timely provision of the necessary finance and materials.

It is important that courses should be provided over as wide a geographical area as possible and not only in the Centre. This not only helps the teachers in their own environment but assists the public relations that are needed to establish the credibility of the Centre. It also provides the basis for the multiplier effect whereby the Centre's activities can reach persons who themselves are not directly involved but who nevertheless may be required to make a decision affecting the implementation of the Centre's activities.

RECSAM, as a regional centre, relies on the multiplier effect in operating its courses. On returning to their countries, participants are expected to be in a position to train others and influence local developments. Ideally, this pre-supposes that course participants should be selected from those (such as senior teacher educators, curriculum developers, and administrators) who can wield some influence. In practice, it is unlikely that such individuals can be released for extended periods of some twelve weeks duration and course participants are therefore generally chosen from the teacher or teacher educator level. Nevertheless, this does not necessarily negate the multiplier effect as long as courses for the senior educational administrators are provided so as to orientate them towards the effective use of the course participants within the national system.

At RECSAM a procedure exists for providing an overlap to courses, and for enabling some participants from a previous course to return to participate in later courses. In this way feedback is obtained, and continuity in the development of curriculum materials and equipment is ensured. In India a similar process has been tried. In 1975, a seminar for participants from selected teacher training institutions was held to deal with the use of local resources to supplement the developed kits. Such a seminar was found necessary to overcome the immediate impracticality of providing every primary school with a kit. A UNICEF consultant specializing in local resources related to the child's environment assisted with this course. A second workshop was held early in 1976 using previous participants who presented and discussed their prepared materials. The workshop then considered further possibilities in the use of local resources as well as media of instruction. Workshop assignments were related to the use of pictorial posters as a medium of instruction for primary school children. The results of this approach will be analysed at a further workshop to be held at a later date. (The UNICEF consultant was again present at this workshop.)

ESTABLISHMENT OF LOCAL PRODUCTION CENTRES

It is worth noting the efforts referred to on page 20 to produce school science equipment in Kenya prior to the existence of SEPU. These were made at educational institutions which either utilized the services of school-aged children or university students and teachers in training who did not have the necessary technical training or skills to produce the required items. In addition to this problem, it was found that a term-based programme was not conducive to effective continuous development or quality production. Only when SEPU came into existence as a separate entity with its own autonomy could it really be said that a production unit existed to serve the needs of the school system. In Turkey DAYM started as a component of a technical/vocational teaching establishment which rapidly developed an autonomy of its own (i.e. not tied to term-time operating). In practice this autonomy was brought about by employing craftsmen and others to provide the continuous operation while at the same time, the students in training participated in the activities during their teaching programmes. NCERT and RECSAM were established as continuous-operation educational establishments.

Physical Facilities

If the Centre is to be of a multi-purpose nature (i.e. equipment development/curriculum development/course work/repair maintenance), considerable care is necessary in providing adequate facilities to meet the demands. If course work is to be a regular component hostel accommodation as at NCERT and RECSAM needs to be provided. In the RECSAM development, priority was given to hostel accommodation with the purpose-built facilities for course work and administration following as a second phase. In practice, the planned dining and recreational building was used for teaching purposes, and will revert to its intended function on completion of phase 2. Phase 2 will have prototype production workshop facilities as well as a small practical area for course work (improvisation). This highlights the need to separate the design and production component of a centre from the course work component. A workshop trying to cater for production as well as training is not usually successful at either. NCERT was developed as a whole, but its course work activities are carried out separately from the production workshop area. DAYM and SEPU are not directly involved in course work but at SEPU the facilities of the teacher training college could be utilized for course work.

Finance

A centre must be provided with enough money to enable it to operate properly. The amount will depend upon the manner in which the centre is going to work. For example, it was envisaged that after its initial establishment, SEPU would become a self-financing operation, and in actual fact it has a sales manager concerned with the marketing of its products. DAYM is a Ministry establishment, and its products are ordered directly by the Ministry and distributed accordingly by them. Similarly, NCERT has its own budget with State Ministries of Education purchasing directly from NCERT. The production of kits at NCERT is mainly related to a primary education project which is supported largely by UNICEF.

Staffing

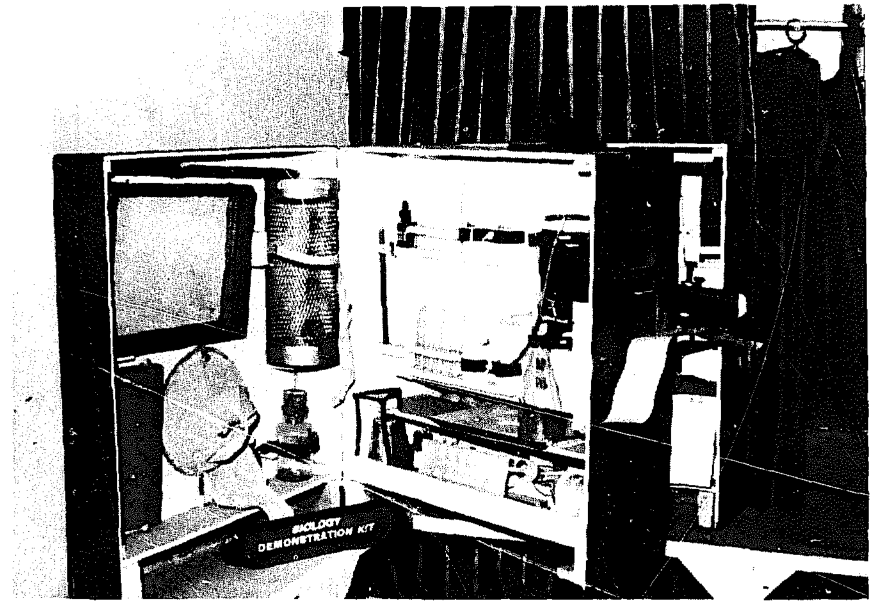
The staff of a centre must have the right type and level of training. For example it is not realistic to expect a science teacher to be competent in the design, development and production techniques of school equipment. RECSAM, for example, will need to consider this problem when the section dealing with the development of prototypes comes into existence because this operation requires personnel with an engineering background who can liaise and interpret the requirements of the educationist. The other centres have met these requirements, as can be seen from the example of the personnel involved at NCERT.

Components

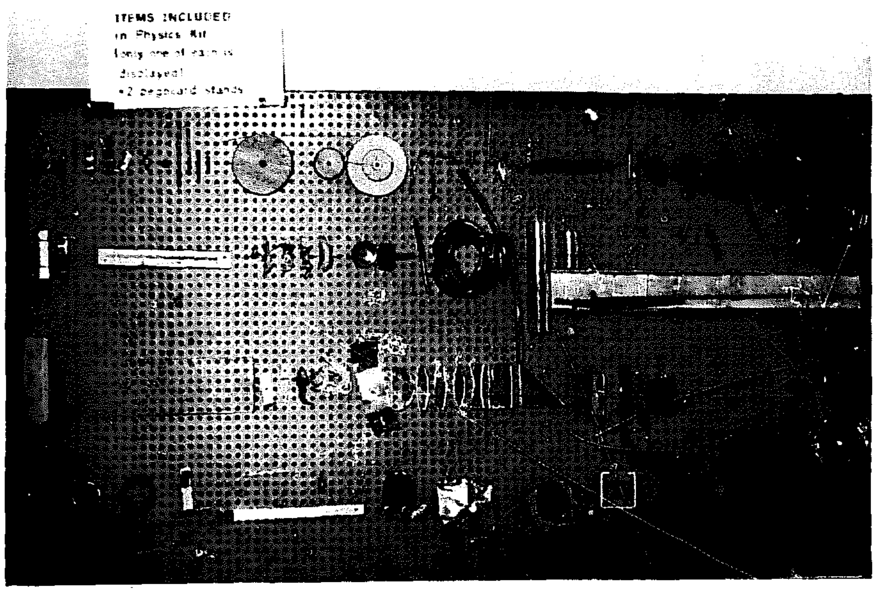
Mention has already been made of the multi-purpose nature of a centre concerned with the development and production of school science equipment. Not only is it necessary to produce the equipment and get it into the schools but it is also necessary to consider that the equipment will need some follow-up replacement of parts. Consequently, the requirements of staff and facilities for repair and maintenance should be considered when establishing such a centre. Trained laboratory technicians may also be needed in the schools. It is worth noting that of the four production centres only one was concerned with this aspect of equipment care.

SECTION 6: ILLUSTRATIONS OF SOME OF THE APPARATUS AT THE CENTRES

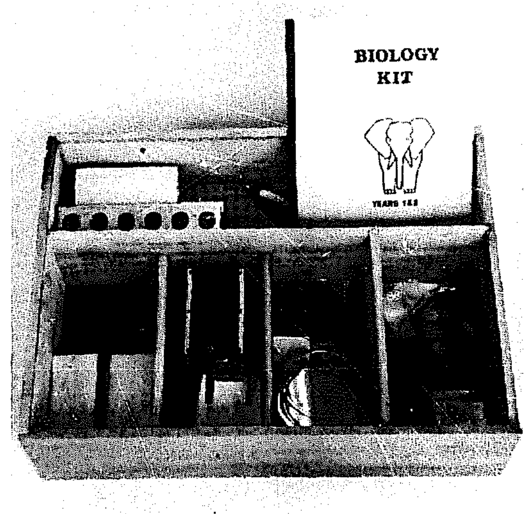
NCERT: 1. Secondary School Chemistry Demonstration Kit



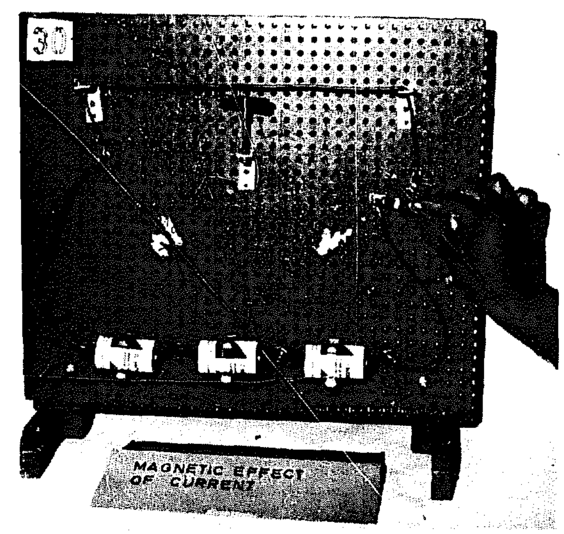
2. Secondary School Biology Demonstration Kit



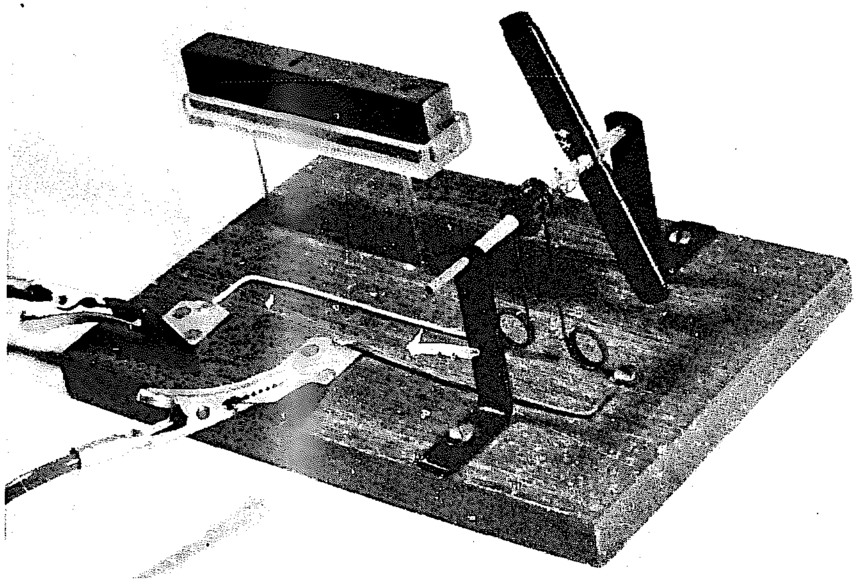
SEPU: 3. Physics Kit



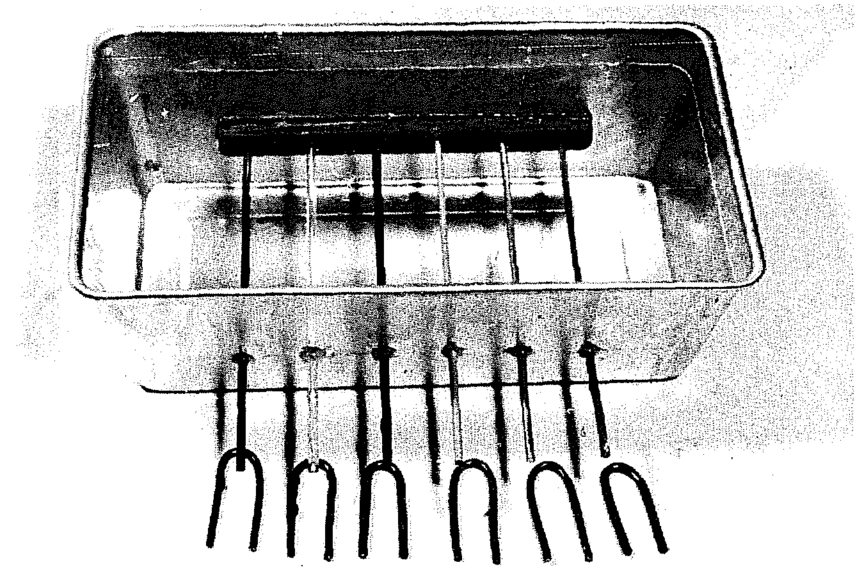
4. Biology Kit



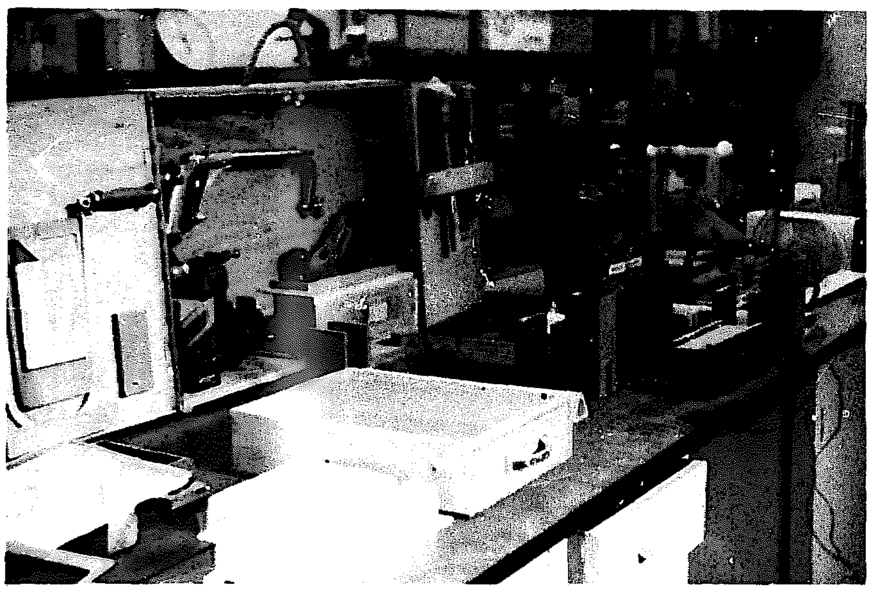
5. Part of the Physics Kit
(mounted ready for use)



RECSAM: 6. Single pole electric motor



7. Heat conduction set
(the rods are of copper, iron, wood etc.)



8. Tools for schools and resource centres

9. A praparium (for investigation into ecosystems)