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Report on Teaching of Technical and Science Subjects in Sri Lanka

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Alan Dock & Soren Salomonson

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REPORT ON THE TEACHING OF TECHNICAL AND SCIENCE SUBJECTS IN SRI LANKA

0. SUMMARY AND RECOMMENDATIONS

The Report gives a brief description of the present general education system in Sri Lanka and the changes which will ensue from the "White Paper" (Education Proposals for Reforms), with special reference to Technical and Science subjects.

Furthermore the Report makes quantitative analyses of provisions for the study of technical and science subjects and gives the O-level examination performance for 1981 and 1982. It also briefly describes the teacher training structure and the administration of education with regard to technical and science subjects.

From the field study, which was confined to Kandy and Matari districts, the Report makes the following observations:

Technical Subjects:

a) Only a limited number of the 13 subjects are offered, varying from school to school.

b) The distribution of students in the different technical subjects varies considerably.

c) the teaching methods are confined to demonstrations and "dralk and talk" lessons. Hence the number of practical lessons is limited.

d) The amount and quality of tools and equipment are very uneven as well as storage facilities and maintenance of the equipment.

e) There are no text books in technical subjects.

f) The utilization of the aid provided by SIDA does not correspond to the observed needs of the country with regard to woodwork.

Science Subjects:

a) The teaching method most commonly used is the lecture assisted by blackboard diagrams, followed by the dictation or copying from the blackboard of formal notes.

b) There is therefore a very large gap between what is taught in theory and what can be related to reality.

c) There is an insufficient quantity of apparatus to allow the students to work in small groups.

d) The science subjects in the teacher training colleges are taught as separate subjects, which is also reflected in the limited integration of the subjects on Junior Secondary level.

e) The majority of classes observed appeared to have access to student text books. On the Senior Secondary level, however, the number of appropriate text books in Sinhala is a major limiting factor in providing additional study and reference materials for students.

f) Underutilization of laboratory space and facilities is common and could easily be rectified by improved timetabling and improved maintenance of equipment.

g) Safety precautions must be emphasized with regard to science equipment and consumables.

The Report strongly emphasizes the need for improvisation and simple apparatus and tool construction/production in order to move the reality into the workshops/laboratories, and make the lessons more practically oriented.

The Report also fully supports the idea of implementing the new Life Skills subject on a nationwide scale as laid out in the "White Paper" and introduced by the UNDP/UNESCO Project for Quality Improvement of General Education.

Based on the findings of the study the Report finally gives the following recommendations.

RECOMMENDATIONS

In order to strengthen the technical and science subjects the following recommendations are made:

Policy and planning:

1. There be a clear policy statement from the Government regarding the implementation of the proposed new educational structure.

2. A plan be drawn up regarding the implementation of the new educational structure.

3. There be a clear policy statement regarding the nationwide implementation of Life Skills subject regarding to what extent Life Skills will be taught on the new Junior Secondary level.

4. There be a clear policy statement regarding the technical subjects in regard to the new Senior Secondary level.

5. The technical subjects on the new secondary level be ordered into clusters as follows:

New Subject	Subjects included
Agriculture	Agriculture Home gardening Fishery
Handicraft	Wood work Metalwork Pottery Masonry
Home Science	Home Science Needlework Weaving

The new subjects be taught under the concept of Life Skills.

6. The new technical subjects be taught 1/3 of a school year each thereby giving all students training in all subjects.

7. Motor mechanism be taught in G.C.E. Technical stream under T.E.A.

8. Radio mechanism be taught in the G.C.E. Technical stream under T.E.A.

9. Life Skills and Technical subjects be taught in groups of 20 students in order to maximise the utilization of workshop space, tools, and equipment as well as to promote good teaching conditions in practical work.

10. A plan be developed for the inservice training of teachers.

11. Guidelines be developed on the procurement of consumables for the technical subjects.

12. A plan be developed to reorientate the teaching of science on the Junior Secondary level to the use of student centred low cost apparatus.

13. The concept of 'Field Study Centres' be extended to include centres whose main themes would lie in the fields of technology, industry and agriculture.

Administration and Organisation

1. A record system be established for each of the new technical subjects including projects made, list of students, attendance records and assessments.

2. A head of section be appointed in each school responsible for the Life Skill subject on Junior Secondary level.

3. Headmasters be responsible for funds for the purchase of consumables for Life Skills and technical subjects.

4. A routine be worked out in the schools in order to protect the crops from being stolen.

5. A structure be established in all secondary schools or schools with secondary classes for the overall administration, development and maintenance of science teaching.

6. In small schools of less than 6 classes at G.C.E. and 4 classes at A-level we recommend there be a teacher in charge of science. At larger schools there would be a teacher in charge of Science Department with teachers in charge of subjects (integrated science, Physics, Chemistry, Botany, Zoology) under him.

7. A sub-committee of C.D.C. be appointed to consider the administration structure of science teaching and draw up a list of duties and responsibilities for the various categories of responsibility.

8. The teachers appointed to positions of specific responsibility in science be paid an annual responsibility allowance established on a sliding scale linked to the number of classes involved. The allowance to be paid against the range of duties and responsibilities and not according to the qualifications or experience of the teacher assuming them.

9. Guidelines be laid down by the C.D.C. sub-committee as to appropriate reductions in science teaching load, for the various levels of responsibility.

10. Science departments be required to establish and maintain a stock record system for all apparatus, glassware and consumable stores.

11. An annual stock take be done of all science equipment and consumables at the end of each school year.

12. A post of Curriculum Evaluation Officer be established. The officer to be part of the Curriculum Development staff with the responsibility for assessing the efficacy of curriculum innovation and change as required by the subject panels.

13. A system be established for the maintenance and repair of science equipment beyond the resources of the science teacher and school facilities.

14. Further development of SEPU be discontinued and the existing facility be put out to 5 year lease by tender. (see para. 8.2.9. for responsibilities of contractor and functions of the Unit).

Curriculum Development and Methodology

1. A curriculum be developed for the new educational structure. This new curriculum should be founded on the "Educational Proposals for Reform" referred to as the "White Paper".

2. A syllabus be developed for the Life Skills subject.

3. A syllabus be developed for each of the new technical subjects on the Senior Secondary level. (see 10.1.5).

4. The new syllabuses be flexible in order to take into account the needs of the community.

5. New syllabuses be developed for technical and vocational training institutions taking into

account the needs of the country regarding production of low cost tools and science equipment. production thus being part of training.

6. Maintenance of tools and equipment be included in the new syllabuses for Senior Secondary level.

7. During training useful projects and articles be produced rather than training pieces.

8. The integrated science be reviewed and the teaching materials revised to encourage student experimental work using low cost apparatus.

9. A list of required practical work be prepared for the integrated science syllabus.

10. The integrated science text books be revised to include investigative experimental work.

Technical Tools and Equipment

1. Tools and equipment be as much as possible produced locally either by local manufacturers or in training institutions as part of training.

2. No electrical equipment be purchased for technical subjects until all schools have received a minimum number of simple equipment such as hand tools.

3. Maintenance of tools and equipment be carried out by all teachers involved in teaching technical subjects, and students as part of their training.

4. Tool racking and proper tool storage be carried out by teachers, and students as part of their training.

Proper storage facilities be developed in each school by teachers, and students as part of their training.

. New tool and equipment lists be developed for the Life Skills subject in Junior Secondary Schools and the new technical subjects in Senior Secondary Schools.

7. Each handicraft workshop be equipped with hand-operated revolving grindstones for proper sharpening of tools.

8. All electric operated tools and machines be transferred to the new Technical Stream under TEA.

9. Improved clamping facilities be produced and implemented (see appendix 3.).

Science Equipment and Laboratories

1.(a) A policy of supplying low cost functional equipment in sufficient quantities for G.C.E. pupils to use in pairs, replace the current policy of supplying single or small numbers of items of conventional equipment.

(b) The initiation of this policy to be accompanied by the preparation of a full range of revised texts, teachers guides.

2. Urgent consideration be given to the conversion of one laboratory in every school to be refurnished to accommodate classes of forty pupils for use by the grade 9 - 10 science classes.

3. Serious consideration be given to the improvement of safety procedures in school science laboratories storage areas and science rooms.

4. The standard equipment list for chemicals be revised with the aim of removing materials which constitute a major health hazard.

5. The C.D.C. prepare a safety booklet for issue to schools which would outline appropriate safety procedures, list chemicals of a hazardous and injurious nature, and list experiments in physics, chemistry and biology which require specific care.

6. Simple fire fighting equipment be placed in all science activity areas with instructions ot teachers for its usage.

7. Laboratory safety rules be drawn up and a chart prepared and issued to all schools for prominent display in every laboratory and science room.

8. Schools be encouraged to establish a bottled gas supply for laboratories. Where laboratories are in one block a bulk supply (eg. 45 kg cylinders) is recommended.

9. For small schools and widely spaced laboratories small 2.5. kg. cylinders are recommended for portable use.

10. Encouragement be given to schools to convert laboratory gas service to bottled gas by the

offer of a 'once only' grant for this purpose.

11. The practice of supplying schools with chemical 'beam' balances be phased out.

12. The provision of electronic or semi-automatic balances to A-level schools be adopted as an alternative.

13. A 'per-capita' allocation be established at Junior Secondary level for the purchase of consumable materials used in science classes along the same lines as presently allocated at A-level.

14. The possibility be investigated of repackaging chemicals into standardised resupply kits for distribution to schools on an annual basis.

Workshop Space and Land

1. Each school be equipped with one workshop for agriculture, home science and handicraft allowing practical training of 20 students at a time.

2. Each school be allocated land for school gardens sufficient for demonstration of crop production on a small scale.

Text books

1. Textbooks and teaching manuals be developed in the new technical subjects on the new Senior Secondary level.

2. A committee be appointed under the C.D.C. for the development and production of text books and teachers guides for the Life Skills subject and the new technical subjects on the new Senior Secondary level.

3. Consideration be given to the issue of standard reference texts in each science subject to schools offering A-level science.

4. A committee be appointed for the revision of existing integrated science pupil texts and teacher's guides to accommodate the low cost equipment and pupil activities methods.

5. Consideration be given to the provision of science books and magazines in English to

broaden the knowledge and perspective of teachers and students.

Teacher Training

1. New teacher training syllabus be developed for the Life Skills subject.

2. New teacher training syllabuses be developed for teacher training of the new technical subjects on the new Senior Secondary level.

3. The syllabuses for 2 above include production of low cost tools and equipment for the Life Skills subject as well as the new technical subjects on the new Senior Secondary level.

4. Maintenance of tools and equipment be part of teacher training.

5. Tool racking and proper storing be part of teacher training.

6. Teacher training colleges for training of technical teachers be equipped with the same tools and equipment as an ordinary school for the new technical subjects on the Senior Secondary level.

7. All electric operated tools and machinery in handicraft workshops in teacher training colleges be transferred to the new technical stream under T.E.A.

8. Inservice courses be organised for technical teachers in regard to:

   a) teaching methods

   b) tool and equipment production

   c) maintenance of tools and equipment

   d) racking of tools and equipment

   e) storage of tools and equipment

   f) assessment of students.

9. (a) Teacher training science courses be restructured on an integrated basis.

   (b) A course on low cost equipment be included in the curriculum.

(c) A practical activity based course on simple workshop skills, maintenance of equipment and the improvisation of simple apparatus be included in the curriculum.

(d) Science students be required to undertake one major project involving a scientific investigation. The completion of this project to be one of the pre-requisites for qualification.

(e) A course in laboratory hazards and safety procedures be included in the curriculum.;

10. Science Inservice Courses

(a) A series of inservice workshops be organised to effect re-orientation of teachers to the large scale use of low cost equipment.

(b) Inservice courses be organised to create in teachers an awareness of the need for appropriate care when conducting practical work with students.

(c) An inservice course be organised to sensitize teachers to the need for safety procedures in science teaching.

Examination and Assessment

1. Assessment procedures for Life Skills be developed taking into account participation in the subjects only for a pass mark from Junior Secondary schools.

2. Pass mark from Junior Secondary school in Life Skills be required for entry into the Senior Secondary level.

3. Examination of technical subjects be introduced at the end of the new Senior Secondary cycle based on assessment of practical work as well as examinations which include questions to the practical experience of the student.

4. Impetus be given to the stated aims of involving pupils as participants in practical work by assigning at least one quarter of all examination questions at G.C.E. to the testing of the pupils' practical work experience.

5. An Integrated Science sub-committee be established to prepare and maintain question banks for this purpose.

6. Sets of questions involving science practical experience be issued as specimens to emphasise the importance of this aspect in the examinations.

7. Workshops be organised on a regional basis to follow up the above exercise.

Study Visits

1. A study visit be undertaken in order to study the low cost local production of tools in the Village Polytechnic Programme under Ministry of Culture and Social Services, Kenya, and the ILO/SIDA Skill Develoment for Self- Reliance Project, P.O. Box 60598, Nairobi, Kenya. Contact person can be Chief Technical Advisor G D Green in the SDSR-Project.

2. A study visit be undertaken in order to study the use of low cost equipment and associated teaching methodology in the Zimbabwe Integrated Science Programme under the Zimbabwe Ministry of Education at the University of Zimbabwe.

   Contact person: The Project Leader Zim-Sci Project University of Zimbabwe, Po Box Mp 167, Mount Pleasant, Harare, Zimbabwe.

3. A study visit be undertaken to visit Sweden in order to study the three subjects SLÖJD (Handicraft) HEMKUNSKAP (Home Science) and TEKNIK PA GRUNSKOLANS MELLAN-STADIUM (Technical education on the upper primary level) as well as the way assessments are made in these subjects.

1. INTRODUCTION

Since 1977 SIDA has provided funds for the procurement of tools and equipment to SRI LANKA to be used in technical and science subjects. The purpose of the support is to strengthen the non-academic subjects in the development of pre-vocational skills, and to improve the capability for practical work in the science subjects. Most of the equipment is purchased centrally by the Ministry of Educational Services which also distributes it. Funds are also allocated to the Regional Education Offices for purchase and distribution.

At the annual consultations between SIDA and the Ministry of Education in March 1983 it was agreed to review the support.

As a result two consultants were called upon to make an evaluation of the ongoing programmes.

The study was carried out during 18 March - 6 April 1984. The objectives of the study in regard to the programme were:

to describe and review the administration at

(a) the central level - Ministry of Education (including the Curriculum Development Centre and the Ministry of Educational Services,)

(b) the regional level - the Regional Education Offices,

(c) the local level - the school,

- to give a description of the curricula and syllabus for the two subject areas including linkages to the equipment.

- to describe and review the training given in the teacher training colleges and in in-service training courses to teachers of the relevant subjects.

- to collect data and describe to what extent the practical subjects and science have been introduced - number of schools, students etc.

- to describe and review how the equipment is used in regard to frequency, the various levels, etc.

- to describe and analyze the administrative routines for purchase, distribution and maintenance of the equipment.

- to give recommendations in regard to the utilization of the Swedish support based on the findings.

For terms of reference see appendix 1.

2. METHODOLOGY

The study is based mainly on the following sources of information:

- records from the Ministry of Education and the Ministry of Educational Services.
- interviews with officials in the two Ministries.
- visits to 17 schools in Kandy and Matara districts.
- visits to teacher training colleges.
- visit to UNDP/UNESCO Project for Quality Improvement of General Education.
- visit to Naiwela Training Centre for Life Skills.
- reports and books listed in the bibliography as appendix 9.

The interviews were directed towards the following individuals and groups involved in the programme:

- Secretary, Ministry of Education
- Secretary, Ministry of Educational Services
- Regional Directors of Education
- Chief Education Officers
- Education Officers
- Circuit Education Officers
- Principals
- Headmasters
- Master Teachers
- Teachers
- Teacher Trainees
- Students

The study plan was as follows:

1) Preliminary reading of reports and other relevant literature.

2) Discussions with officials of the Curriculum Development Centre and the Ministry of Educational Services.

3) Visits to a group of rural and urban schools in order to collect data.

4) Further discussions with Ministry officials focused on the impressions and data collected.

5) Visits to a second group of rural and urban schools in order to test tentative assessments made and to collect data on questions raised during 3 and 4 above.

6) During the field study visits were also made to other institutions relevant to the terms of reference. This included teacher training colleges and the Life Skills Training Centre.

For a complete list of schools and institutions visited see appendix 2.

3. PRESENT GENERAL EDUCATION IN SRI LANKA

The present structure of the general education at primary and secondary level is:

Level	Age	Grades
Primary	5 - 10	1 - 5
Junior Secondary	11 - 15	6 - 10
Senior Secondary	16 - 17	11 - 12

3.1. Primary Education

There are approximately 8600 primary schools. An integrated curriculum is used and the teaching is focussed on the project or thematic approach. Subjects are grouped into areas. A foreign language is introduced in Grade 3. The medium of teaching is the mother tongue.

Subjects in Primary Grades

Religion
First language
Mathematics
Environmental studies
Aesthetic studies
Constructional activities
English (from Grade 3)

3.2. Junior Secondary Education

After primary education approximately 60% of a cohort of children proceed to the junior secondary level (grades 6-11).
There are 5554 schools providing junior secondary education in the country.

In the junior secondary school a common curriculum is used. Integrated science and social studies replace the environmental studies. A technical subject is also introduced by giving the students a choice of 13 technical subjects from which the student can choose one.

Ordinary level of the General Certificate of Education (GCE O-Level) is awarded on satisfactory completion if the junior secondary school examination taking place at the end of grade 10.

3.3. Subjects in Junior Secondary Grades

Religion
First language
International language (English)
Mathematics
Integrated science
Social studies
Health science
An aesthetic subject
A technical subject

The technical subjects consist of:

1. Agriculture
2. Home gardening
3. Home economics
4. Needlework
5. Wood work
6. Metal work
7. Weaving
8. Ceramics
9. Motor mechanism
10. Radio mechanism
11. Marine fisheries
12. Inland fisheries
13. Masonry

All these subjects are included in the syllabuses for grades 6 to 10 leading to the G.C.E. O-level examination. Only two of them, namely agriculture and home economics may be taught in grades 11 and 12 and offered for the G.C.E. A-level examination. Commerce may be taught in grades 9 to 12, and shorthand and typing in grades 9 and 10. Commerce may be offered for the G.C.E. O-level and A-level examinations, but shorthand and typing may be offered only for the G.C.E. O-level examination.

3.4. Senior Secondary Education

Approximately 25% of the students from Grade 10 enter the Senior Secondary Education.

> " Senior secondary education is divided into three streams: science, commerce and arts. Depending on the facilities the secondary schools are categorized as 1A, 1B, 1C and 1D schools. 1A means a school with three streams and a science laboratory. 1B schools have three streams bot no science laboratory. The 1C category has no science stream and 1D schools lack both the science and the commerce streams.
>
> Students study their first language and English as compulsory subjects plus four out of fifty subjects. Advanced level of the General Certificate of Education (GCE A-level) is awarded on satisfactory completion of the senior secondary school examinations. " (1)

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(1) Engquist, O. et al, Education and Training in Sri Lanka, SIDA, 1981

3.5. Vocational and technical education

"Within the formal education system there are two types of technical institutes under the Ministry of Higher Education. The number of institutes is twenty. Of those, twelve are classified as Junior Technical Institutes and the remaining eight have been designated Polytechnic Institutes. There is also a technical unit at Polgolla, affiliated to the Polytechnic Institute of Kandy.

Junior Technical Institutes provide full-time and part-time courses up to certificate level and Polytechnic Institutes courses up to diploma level. Courses are offered in the fields of engineering, commerce and agriculture of craftsman, technician and technological levels.

Professional and Higher National Diploma Courses at the Polytechnics are comparable to those for a university degree. At present, higher national diploma courses only exist in the field of commerce. National Diploma Courses aim at training middle level technical personnel in various branches of engineering and commerce. Ordinary level is the basis for admission to engineering courses. In other cases Advanced level is required.

National Certificate Courses are part-time for persons in employment. The certificate is of a lower academic standard than the diploma.

Craft Level Courses provide training of craftsmen mainly in the engineering trades. Minimum entry requirement for admission to these courses is a pass at grade 6."(1)

3.6. Examinations

"All examinations are set and administered by the Examination Branch of the Ministry of Education." (1)

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(1) Engquist, O. et al, op.cit.

4. PROPOSED CHANGES IN THE GENERAL EDUCATION SYSTEM

In the "Education Proposal for Reform" the "White Paper" the main weaknesses of the present school systems have been summerized as follows:

i. State schools numbering over 9500 cover a very wide range both in pupil numbers as well as the facilities they make available. They compete as separate, individual institutions firstly, for the limited resources provided by the State and secondly, for a clientele among the parents. In this situation in spite of various regulations on school admission a few large and rich schools continue to grow larger and richer while the small and poor schools become poorer. This is harmful to both groups as well as to the total school system.

ii. Schools have become more a medium for competition than institutions imparting sound all-round education. Excessive emphasis on examinations has led to an impoverishment of the content of learning inside the classroom and dimunition of the importance of those most valuable outcomes that accrue from co-curricular activities. In serving primarily the scramble to reach the top, the needs of the majority who cannot get there are neglected.

iii. What gets most attention is subject matter that can be tested at national-level written examinations. What tends to be neglected are other, equally if not more important aspects of the curriculum such as content of local relevance and practical subjects.

iv. The Teaching Service is influenced by a number of factors which tend to lower performance levels. Recruitment of teachers based solely on paper qualifications without any pre-service training; the low salary scales that they obtain and the resulting discontent in the profession; and an all-island transferable service that fails to engender in teachers a sense of loyalty and commitment to the school are some of them.

The objectives of the changes are stated:

1. The changes that will be introduced in the scheme of general education, in particular the re-structuring of the span of schooling, the revision of the curriculum, text books and examinations are all intended to promote more effectively the harmonious growth of the child and to prepare him

more purposively than before for life and work in society. Each of the three phases of general education span - Primary, Junior Secondary and Senior Secondary has been so structured and its curriculum and text books will be so devised as to optimise the assistance which the school system can give the child at each stage of his development.

The new structure will be:

Primary Education, Grades 1 - 5

Junior Secondary Education Grades 6 - 8

Senior Secondary Education Grades 9 - 11.
The Ministry proposes absorbing the old K.G. year ("Grade 0") with the Primary school, but will keep the same number of years in this phase of education.
The old Secondary phase will be extended by one year at the top to Grade 11 and will terminate in the General Certificate of Education.
The division between Junior Secondary and Senior Secondary will be moved to the end of Grade 8.

Grade 12 and the new year 13 will be called Collegiate level and will end in the University Entrance examinations.
The effects of these changes are as follows:

(i) the period of open access education will be extended by one year (Grades 1 - 11).

(ii) the senior secondary level during which separate subjects are studied for the General Certificate in Education will be 3 years in length instead of two as in the old 'upper' end of Junior Secondary.

(iii) pupils will be retained in the school system for an additional 'maturing year', leaving at 15+ after G.C.E., and 17+ for University or other higher education.

Timetable for Introduction of Changes

While this is not completely finalised some decisions have been made:

(i) the new Grade 1 and Grade 6 will be introduced in 1986

(ii) the new Grade 7 and Grade 9 will be introduced in 1987

(iii) this will enable the new Life Skills course replacing technical subjects in Grades 6, 7 and 8 to be phased in from 1986 on a national scale.

(iv) the introduction of the new G.C.E. curriculum in 1987 will mean the first examination will be taken in 1989 and the first Collegiate graduates will emerge from the system in 1991.

Table 4(1) Diagram of system

Old system:

Pupils age	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	
School year	1	2	3	4	5	6	7	8	9	10	11	12	
K G													
	Primary School					Junior Secondary					Advanced Level		

New system:

Pupils age	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	16+	17+	
School year	1	2	3	4	5	6	7	8	9	10	11	12	13	
	Primary School					Junior Secondary			Senior Secondary			Collegiate		

The primary education will not change very much but on the junior secondary level the introduction of a new subject Life Skills will replace the different technical subjects.

The main objectives of the Life Skill subject are:

- to introduce the child to the 'world of work' and inculcate in him a positive attitude towards it.
- to provide for domestic skills, graded as appropriate for the age-group to help the pupil acquire some familiarity and proficiency in the use of common tools and appliances.
- to provide for certain pre-vocational skills and make pupils proficient in simple skills relevant to a range of vocations.
- to provide for an activity-based subject to give the the non-academically-oriented pupil meaningful learning activities in which he can excel.

A UNDP/UNESCO programme "Quality Improvement of General Education" in operation since 1983 are focussed on the introduction of Life Skills in the Secondary schools.

For more details on Life Skills subject see Chapter 9.

4.1. The curriculum and syllabuses of the technical subjects

As mentioned earlier the student has to take one out of thirteen technical subjects as compulsory from Grade 6 to 10.

The complete list of the technical subjects offered is presented under section 3.3. in this paper.

The time allocation in the timetable is 3 periods a week with 1 period theory and 2 periods practical work. After completion of the 10th year the student can sit for G.C.E. O-level examination. The subject is however optional for the examination.

All the syllabuses are written in Sinhala and it has therefore not been possible to make a first hand observation. In a report "The Teaching of Technical Subjects in Secondary Schools in Sri Lanka" these matters have been examined and reference is therefore made to that study.
The report deals extensively with the context of the different syllabuses and gives three recommendations in regard to the syllabuses:

a) as a matter of the greatest urgency a circular should be issued clarifying points of difficulty in teaching the syllabuses in agriculture.

b) suitable clarifications and minor adjustments be made in the syllabuses for home economics wood work, metal work and weaving to make them more easily teachable, and that circulars should be issued accordingly to schools.

c) committees be appointed to review all syllabuses and recommend new syllabuses, the implementation of which could commence in certain grades in 1984 and others in 1985 or 1986." (J.P. Jayasuriya, 1983).

The situation in regard to the implementation of the proposed new structure in general education of course implies that completely new syllabuses will be prepared for the technical subjects as they are only to be taught in Senior Secondary Grades 10 - 11 and with a strong emphasis on Life Skill. There will also be a more specialized G.C.E. Technical stream under the Technical Education Authorities (TEA) for those seeking early vocational training. Hence a more specialized syllabus must be prepared for that stream.

In view of the above it is therefore, as we see it, better to give priority to the preparation of the new syllabuses than to make clarifications on the old.

4.2. The Science curriculum and Syllabuses

4.2.1. Introduction: A Description of the curriculum and syllabuses for science subjects in the Sri Lanka education system cannot begin without emphasising that

science in schools has been a major preoccupation of policy makers since the early seventies.
The Minister of Education in a public statement (1) during 1971 expressed the intention of designing a curriculum which would be "geared to developing a scientific attitude in the mind of the child".
He went on to compare this aim unfavourably with current curricula which he said

> "are heavily burdened with irrelevant facts. Children are encouraged to commit to memory a whole heap of unessentials. A stop should be put to this type of learning. The ability to reason and think are vital. An inquiring mind should be developed. The technique of learning rather than a whole heap of facts should be taught..."

Herath Fernando de Silva (2) quoted the President of Sri Lanka as stating in 1978 the National Science of Technology policy of the country to include

> "To provide equal and adequate opportunities for all to acquire a basic education in science.
> To ensure that our institutions of education and research will produce scientists and technologists of the highest calibre".

They also observed (3) that major provisions within the Ministry of Education to implement that policy have included

1. Education free of school fees at all levels (implemented 1945).

2. Issue of free school textbooks to all children at all levels of open access general education (introduced in 1980).

3. Implementation of a common curriculum, with science as an essential component, in all schools up to the end of open access general education (from 1972 onwards).

4. Availability of financial assistance under scholarship schemes to those children who qualify for such awards.

4.2.2. Structure of the Curriculum The curriculum is divided into two phases: junior secondary (Grades 6 - 10) terminating in the General Certificate O-level examination, and senior secondary (Grades 11 - 12) completing the school curriculum and terminating in the Advanced level examinations.

4.2.3. The Junior Secondary Curriculum: Since Grade 10 and the concommitant O-level examination is the end point for the open access general education, the science course is shaped to provide a broad education in science for all citizens and the foundation on which deeper study may be based for the minority of students proceeding to senior secondary and science oriented careers. These two aspects of the course are contained in the following objectives (4) for the student:

1. Understands the methods and the processes used by scientists in solving problems and be able to use the same in appropriate situations.

2. Acquires skills, attitudes and scientific knowledge relevant to the daily life of individuals engaged in various spheres of national activity.

3. Develops creativity needed for scientific inventiveness.

4. Acquires knowledge, skills and attitudes relevant to the maintenance of personal health.

5. Appreciates the contribution made by scientific institutions to national life, and be willing to assist their activities and seek their assistance in appropriate situations.

6. Understands the problems and perils of technological development and appreciates the need for choosing appropriate technology for Sri Lanka.

7. Acquires a knowledge of the natural resources and the skills necessary for exploiting them judiciously.

8. Develops the ability for critical evaluation of information disseminated through various media.

9. Develops an understanding of major unifying concepts and patterns of science.

10. Acquires the academic background necessary for further education in science.

A recent revision of these objectives (5) deletes number 5 and adds two further objectives. viz: "understands how man affects his environment

and appreciates the necessity for maintaining the balance of nature,
learns to apply science in profitable leisure-time activities",
thereby placing additional emphasis on the aim of producing citizens with a relevant knowledge and understanding of science applicable to their daily lives.

4.2.4. The Junior Secondary Science Syllabus: in order to meet these two-fold aims of general education and foundation studies for later specialisation, science is presented at this level as an integrated subject ie., attempts are made to link the various physics, chemistry and biology content areas through unifying themes. Efforts are also made to link the content areas with aspects of the students' experience in life outside school.
The Director of the programme which developed the syllabus described the integration as follows:

> "It was decided therefore, that since all pupils would follow a common curriculum including mathematics and science, social studies and the humanities, with emphasis on the application of these disciplines to the world of work, the new curriculum in science would be designed as an integrated course rather than one divided into specialist disciplines. This would have the advantage of introducing concepts across the sciences and would eliminate the kind of illiteracy in other science subjects which is displayed by many students who study one branch of science to the exclusion of the others." (6)

The concepts included in this integrated syllabus are developed through the 'spiral method' of revisiting major concepts at increasing levels of sophistication as the students' ability for abstraction matures. In accordance with the objectives stated above the intention is that most teaching will be activity based with concepts developing through the students own practical observations and experience.
Six periods per week are allocated for integrated science in Grades 6 - 8 and seven periods per week in Grades 9 - 10. (Each period is approximately 40 minutes). It is expected that approximately 25-30% of this allocation will be used for practical activities by the pupils and teacher demonstration work, taken when appropriate during each week.
The Teachers Guide to the Grade 6 material, ie., the first unit of the course, is quite clear on the teaching methodology to be employed:

"It should be noted that this is an integrated science course designed to give a broad view of the processes common to all the science disciplines ..... The course has been planned to demonstrate the main concepts which are the fundamental basis of science, the patterns by which we understand correctly the material world and the scientific procedures through which we do this."

"The course incorporates new methods of investigating facts, new techniques, new ideas and new subject matter with the objective of giving a feeling of how diverse, complex and deep science is ..... In order to achieve the objectives of the course pupils should be made to realise things through direct experience rather than telling them facts. Lessons should not be confined to the classroom or to books but experiences should be acquired from the many places where they are available. Through observations, activities, experiments and discussions the students should have the opportunity to think freely, enquire, put forward hypotheses and to design experiments to establish them and to criticise their teachers' views". (7)

A summary of the content of the syllabus is included in Appendix 5 to this report.
An analysis by Lewis (8) of the course unit objectives shows a serious discrepancy with the overall objectives:

Table 4(2) Distribution of I.S.S.L. objectives (after Lewis pp 356)

Type of objective	Year 1 %	Year 2 %	Year 3 %	Year 4 %	All Years % (Mean)
Knowledge	48	71	85	70	69
Comprehension	21	4	5	12	10
Application	8	5	3	11	7
Affective	3	7	1	4	4
Psychometer	21	13	6	3	10

This divergence from the main objectives has serious implications for the teaching methodology which have been reinforced by the field observations reported in Chapter 8.

4.2.5. The Senior Secondary Curriculum: at this selective level of secondary schooling, the science appears under its

traditional subject classification as physics, chemistry, botany and zoology. Each subject is viewed as complete in itself although certain content areas within each subject are complementary leading to preferred study combinations. While we do not feel that it is appropriate in a study of this nature to present detailed objectives for each subject, the following broad objectives give some indication of the treatment intended for each subject at this level:

the student

(a) acquires knowledge of the subject's framework, major concepts and underlying themes,

(b) develops intellectual experimental and manipulative skills related to science,

(c) is able to apply knowledge and skills to the technological, economic and social development of Sri Lanka,

(d) is aware of the balance which exists between conservation and exploitation of Sri Lanka's natural resources in the context of (c),

(e) is sensitised to the growth of the subject and significance of its probable lines of development in the future.

Eight periods per week are allocated in the timetable for each of the subjects. Of these periods two are intended for individual student practical work. A list of required practical experiments for each subject has been prepared by the syllabus committees of the Curriculum Development Centre, and a student is required to complete at least 60% of this list before entry to the theory examination in that subject will be accepted.

The extent to which these curriculum objectives for the Junior Secondary and Senior Secondary science course have been attained will be discussed as part of the findings from the field study in Chapter 8.

References Section 4.2.

1. Minister of Education : Ceylon Daily News June 5 and 9, 1971.

2. Herath J.R. et al : A study on the position of Science Education in Sri Lanka (Report for the U.N. June 1983) pp 2.

3. Ibid : pp 3 - 4.

4. Ibid : pp 21.

5. Ministry of Education : Proposed Senior Syllabus Grades 6 - 11 P.1.

6. Ranaweera M. : Science at the Junior Secondary Level Bulletin of the Curriculum Development Centre No. 1 (1975)

7. Curriculum Development Centre : Integrated Science Sri Lanka Teachers Guide Introduction Grade 6.

8. Lewis K. : Science Education in Malaysia and Sri Lanka, Curriculum Development and Course Evaluation (1970-78).

5. QUANTITATIVE ANALYSIS OF PROVISION FOR THE STUDY OF TECHNICAL AND SCIENCE SUBJECTS. (1)

5.1. Technical subjects

This analysis confines itself to agriculture, home economics, wood and metal work, weaving and pottery. Motor mechanism, radio mechanism, fisheries (marine and inland), and masonry are not dealt with as the scale on which they are taught is insignificant, and the requisite data are not available.

5.1.1. Agriculture

According to the data provided by the Ministry of Education, agriculture is taught in 4125 schools from grades 6 to 10. The number of agricultural units, as the buildings specially equipped for agriculture are called, number only 206. This means that only about one school in twenty teaching agriculture is equipped with agricultural units, and that the remaining schools function with marginal facilities. The situation in regard to teachers can also be regarded as unsatisfactory.

Teachers of agriculture classified by qualifications:

Qualification	No. of teachers
B.Sc. degree in Agriculture	41
Agriculture trained	1001
Diploma in Agriculture	93
Uncertified except for G.C.E. O/L or A/L	1393
	2528

A comparison of the number of teachers with the number of schools shows that only 61 per cent of the schools teaching agriculture have a teacher with any kind of qualification in agriculture. Hence, it would appear that in about 1600 schools, agriculture is being taught by teachers who do not possess a pass in agriculture even at the G.C.E. O/L. To state this is not to deny the possibility that all or most of them may be making a success of their teaching because of one or more factors such as practical experience, interest, self-learning, participation in in-service courses.

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1) Jayasuriya J.E. The Teaching of Technical subjects in Secondary Schools in Sri Lanka, 1983 is one of the sources of information for this section.

5.1.2. Home Economics

According to data provided by the Ministry of Education, 3750 schools have provision for the teaching of home economics from grades 6 to 10, and 311 of them for grades 11 and 12 as well, leading to the G.C.E. A/L examination. The teaching of home economics was started in schools without specially designed buildings, utilising such accommodation as was available with a few later additions in some schools. Consequently, the number of specially designed and equipped buildings is very small. The following Table shows the number of teachers and their qualifications.

Teachers of home economics classified by qualifications

Table 5(1)

Qualification	No. of teachers
Degree	61
Diploma	61
Specialist training	130
National diploma	997
G.C.E. A/L	316
G.C.E. O/L	679
	2244

5.1.3. Wood work and Metal work

Information provided by the Ministry of Education regarding wood work and metal work workshops indicates that there are 736 schools with wood work workshops and 345 schools with metal work workshops. There is a total of 771 teachers for wood work and metal work. The Ministry of Education indicates that the shortage of teachers is 500. This differs substantially from the shortage of teachers mentioned in the report by Jayasuriya but we have to take the figures given by the Ministry of Education as the correct figure, as Jayasuriya only made calculations based on certain assumptions.

5.1.4. Weaving and pottery

In regard to weaving and pottery there are 684 schools with weaving workshops and 223 with pottery workshops. The total number of teachers for the two subjects together being 788. There is a shortage of teachers of 119 assuming that the teachers are competent in both subjects. As the skills are so different for the two subjects that is probably not the case. This

figure is therefore not worth further consideration and a more detailed study must be done.

Existing provision for technical subjects

Agriculture	
No. of schools with relevant facilities	4125
No. of teachers	2528
Home economics	
No. of schools with relevant facilities	3750
No. of teachers	2244
Wood work	
No. of schools with workshops	736
Metal work	
No. of schools with workshops	345
No. of teachers for wood and metal work	771
Weaving	
No. of schools with workshops	684
Pottery	
No. of schools with workshops	223
No. of teachers for weaving and pottery	788

5.1.5. Performance in technical subjects at the G.C.E. O-level examination 1981 and 1982.

Table 5(2)

Subject	No: of candidates (1981)	No: as a percentage of total	No: of candidates (1982)	No: as a percentage of total
Agriculture	69,512	38.7	109,913	37.3
Home economics	44,184	24.6	70,486	23.9
Commerce	36,423	20.3	65,318	22.2
Needle work	6,934	3.9	9,027	3.1
Wood work	6,853	3.8	9,560	3.2
Weaving	4,848	2.7	6,380	2.2
Home gardening	3,446	1.9	3,655	1.2
Shorthand & Typing	2,765	1.5	12,151	4.1
Metal work	2,023	1.1	3,147	1.1
Ceramics	1,598	0.9	2,413	0.8
Motor mechanism	598	0.3	1,169	0.4
Radio mechanism	333	0.2	875	0.3
Marine fisheries	47)		172)	
Masonry	31)	0.1	160)	0.2
Inland fisheries	3)		2)	
Total	179,598		294,428	

Table 5(3)

Subject	No. of candidates	No. successful
Agriculture and home gardening	72,958	28,966
Home economics and needlework	51,118	37,556
Commerce	36,423	16,864
Wood work	6,853	3,262
Weaving	4,848	1,319
Shorthand and typing	2,765	583
Metal work	2,023	694
Ceramics	1,598	718
Motor mechanism	598	304
Radio mechanism	333	117
Marine fisheries	47	34
Masonry	31	23
Inland fisheries	3	0

Table 5(4) Percentage distribution of candidates, G.C.E. O/L

	1981	1982
Agriculture and home gardening	40.6	38.5
Home economics and needlework	28.5	27.0
Commerce, shorthand and typing	21.8	26.3
Others (Wood work, metal work, weaving, ceramics, masonry, motor mechanism, radio mechanism and fisheries)	9.1	8.2
	100.0	100.0

5.2. Quantitative analysis of provisions for the study of science

Figures quoted are drawn from the School census June 1982, Ministry of Education unless otherwise stated.

Number of schools offering science:

Schools offering only Junior Secondary Science	(Grades 6 - 10)	5084
Schools offering Junior Secondary science and Advanced level science	(Grades 6 - 12)	453
	Total	5537

Student enrolement in Science Classes

Since science is a component of the common curriculum for Grades 6 - 10 the figures quoted are for total student population in each grade.

Figures for the Senior Secondary are for students doing at least one science subject although the majority will be doing more than this.

Estimates of the 1984 populations are calculated from earlier grade populations in the 1981 census with the mean drop out rate calculated over the appropriate 3 years from the 1982 census. In calculating the post G.C.E. estimates, the assumption was made that the relative proportions remain constant.

Table 5(5)

GRADE	1982 census	Mean drop out rate over each of 3 years	1984 estimate	Students taking Science	
				1982 census	1984 estimates
6	273 266	6%	293 000	all	all
7	234 762	7%	269 000	all	all
8	203 684	7%	258 000	all	all
9	169 867	7%	220 000	all	all
10	133 452	7%	189 000	all	all
10 (repeat)	89 879	-	163 000	?	?
11	65 972	-	96 000	18 402	27 000
12	94 595	-	130 000	29 244	39 000
12 (repeat)	19 464	-		7 736	

Table 5(6) TOTALS, SCIENCE STUDENTS

	1982 census	1984 (estimates)	Estimated mean annual increase
Grades 6-10	1 104 910	1 392 000	8.7%
Grades 11-12	180 031	226 000	8.5%
GRAND TOTAL	1 284 941	1 618 000	8.6%

Laboratory facilities The total number of laboratories recorded in Table 4 of the 1982 census is 983. Since primary schools are not provided with laboratories, it must be assumed that these laboratories are in the 4203 secondary schools. It should be noted that according to the 1982 census there are 453 schools offering science subjects at advanced level. Since at least two laboratories are required in these schools the maximum number of laboratories available for integrated science in the 5537 schools is 77.

Table 5(7) Teachers

	TOTAL NO. OF TEACHERS	TOTAL NO. OF SCIENCE T.*	2 YR. TRAINED	GRADUATES BIO+PHY SCI
JUNIOR SECONDARY	54 182	12 152	4 091	-
SENIOR SECONDARY	13 836	3 026	-	2 133
	(1982 census)		(1982 census)	(1982 census)

* verbal communication Ministry of Education, 1984.

Laboratory Services (gas, water, electricity) No data is available on this aspect. Comment is made based upon the schools inspected under section 8.2. (findings from field study).

Laboratory Assistants Again, this heading is only included for the sake of completeness as no overall statistics are available.

Examination Results

Science candidates' performances at O-level and A-level.

Statistics are for the 1982 examinations unless otherwise stated.
Source: Ministry of Education Examinations Div.

Table 5(8) G.C.E. O-LEVEL CANDIDATES

Source of Candidates	Number of Candidates	Candidate pass in 6 or more subjects		Candidates qual. for A-level sciences	
			%	Number	%
Govt. Schools Grade 10					
Sinhalese	105 680	42 125	39.9	16 040	15.2
Tamil	19 616	8 658	44.1	4 054	20.7
Govt. Schools Grade 10(R)					
Sinhalese	65 573	22 022	32.6	4 509	6.7
Tamil	9 865	3 805	38.6	1 090	11.1
English	108	16	14.8	3	2.8
PVT. Candidates					
Sinhalese	135 106	34 884	25.8	7 315	5.4
Tamil	24 579	5 192	21.1	1 500	6.1
English	2 149	54	2.5	15	0.7
TOTALS					
Sinhalese	308 359	99 031	32.1	27 864	9.04
Tamil	54 060	17 655	32.7	66644	12.29
English	2 257	70	3.1	18	0.80
GRAND TOTAL	364 676	116 756	32.0	34 526	9.5

Table 5(9) : INTEGRATED SCIENCE CANDIDATES ACHIEVEMENT BY GRADE

MEDIUM	NO. OF CANDIDATES	NO. PASSED		GRADE D		GRADE C		GRADE S		FAIL	
		NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%
SINHALA	231 736	130 346	56.2	1 201	0.5	18 969	8.2	110 176	47.5	101 390	43.8
TAMIL	40 185	20 899	52.0	284	0.7	3 659	9.1	16 956	42.2	19 286	48.0
ENGLISH	233	89	38.2	0	0.0	12	5.2	77	33.0	144	61.8
All media (1982)	272 154	151 334	55.6	1 485	0.5	22 640	8.3	127 209	46.7	120 820	44.4
All media (1981)	186 937	60 540	32.4	106	0.1	4 355	2.3	56 079	30.0	126 397	67.6
All media (1980)	144 139	46262	32.1	1 056	0.7	13 961	9.7	31.245	21.7	97 877	67.9

Grade D = Distinction

Grade C = Credit

Grade S = Pass

Table 5(10) Advanced Level Performance in Sciences and Mathematics 1982.

Subject	Number of Candidates	Passed & % Obtaining Grade					
		Number	%	A	B	C	D
PHYSICS	29 150	6 833	23.4	0.2	0.7	3.6	19.0
CHEMISTRY	32 416	9 722	30.0	0.3	1.3	6.4	22.1
BOTANY	21 705	9 181	42.3	0.7	3.4	16.0	22.2
ZOOLOGY	22 448	7 199	32.1	0.2	1.9	11.4	18.6
AGRIC. SCI.	2 830	1 480	52.3	0.1	0.6	11.7	40.0
PURE MATHS	10 866	2 808	25.8	0.4	1.1	4.8	19.6
APP. MATHS	9 777	2 694	27.6	3.2	2.9	7.7	13.8

6. TEACHER TRAINING

This study will only deal with teacher training in regard to technical subjects and science.

6.1. Technical subjects

Teacher training in technical subjects is conducted in the following colleges:

Agriculture:

Pattalagedara Teacher Training College
Hingurabigoda Teacher Training College.

Handicraft:

Maharagama Teacher Training College
Palali Teacher Training College.

Home Science:

Maharagama Teacher Training College
Kalutara Museus Teacher Training College
Uyanwatta Teacher Training College
Alutgama Teacher Training College
Kopay Teacher Training College.

Entry into teacher training requires at least two years of teaching experience in a technical subject in addition to a credit pass in the technical subject concerned and three passes at A-level.

The course timetable allows for 6 periods a week in each of the technical subjects. The teacher trainees are out on 8 weeks of teaching practice under supervision of lecturers from the college during the two years of training.
The course consists of the following technical subjects:

Handicraft:
Woodwork, Metalwork, Masonry.

Home Science:
Home science and sewing.

Weaving and Pottery:
are combined with fine art.

Agriculture is taught as a single subject.

A Certificate is not issued until satisfactory teaching for one year after training has been completed.

The number of teacher trainees in 1983 are:

Handicraft	50
Homescience	300
Agriculture	60
Weaving and pottery	no figures obtained.

6.2. Teacher Training - Science Teachers fall into two main categories in the Sri Lanka system: 'graduates' and 'two year trained'. The graduate teachers mainly employed in teaching the advanced level subjects are trained at the Universities (under the Ministry of Higher Education), while the two year trained teachers receive their training at Teacher training colleges run by the Ministry of Education.
The University offers two professional training courses for the science graduates:

(a) The Post-Graduate Certificate in Education. (1 Year full time)

(b) the Diploma in Education of the Open University. (two years part-time by distance methods).

Only graduates qualify for these courses.
The Training College course taken over two years full time is not confined to the professional training of the teacher, but incorporates a significant component on subject competency.
Candidates with three good O-levels in appropriate subjects, Science, Mathematics and first language qualify for entry to the Training Colleges although many entrants also have A-level passes.
Applications for all three courses are only accepted for individuals who have already been teaching for at least two years, ie., all entrants have some initial teaching experience.

Summary of facilities for Science students 1983.
(Training College)

Medium	No. of colleges offering Science	No. of students Year II	Year I*
Sinhala	5	412	100
Tamil	4	155	85

* The number of Year 1 students has been dramatically reduced because five of the Colleges, 4 Sinhala (Unyanwatta, Maharagama, Pattalagedara and Museus) and 1 Tamil (Palaly) have stopped taking students for

science. This is in anticipation of the new course bringing an integrated approach to science and mathematics due to begin towards the end of 1984/ beginning of 1985.

The course time table allows 16 hours per week for science, four hours for science teaching methodology, and four hours each for the three separate disciplines, (Physics, Chemistry or Biology). No attempt has been made to integrate the content areas in either of the two colleges visited.

7. THE ADMINISTRATION OF EDUCATION IN REGARD TO TECHNICAL SUBJECTS AND SCIENCE

This chapter will deal with the curriculum development processes, the production of materials and equipment, the distribution to schools, and the regional/school administrative machinery.

7.1. The Curriculum Development Process: all syllabus design, development of locally produced teaching materials, and equipment design, is coordinated through the Ministry of Education Curriculum Development Centre.
The Centre has a permanent staff of Education Officers who are specialists in the different subjects which form the school curriculum. Each Education Officer is supported in his work by a subject committee drawn from other areas of the Ministry and which occasionally includes the services of an outside consultant.
The work of the Centre is supported by an administrative cadre of office staff with the appropriate facilities and a library containing copies of curriculum development projects in Sri Lanka, Ministry Reports, Reports and samples of curriculum material from other countries, relevant text books, and other reference materials.

The technical subjects are grouped into three clusters: Home Science, Handicraft and Agriculture with one curriculum committee for each cluster.
Science has five committees, one for each of the Advanced level subjects, (Physics, Chemistry, Botany, Zoology) and another for the Junior Secondary Integrated Science course.
Each committee consists of a 'core' of the Education Officer responsible for that subject, a full time seconded teacher appointed on the basis of qualifications and long experience in the schools, and a Teacher Training College Lecturer. To this core are added individuals of specific expertise as and when required in the development of materials.

7.1.1. Committee Responsibilities The comittees have the following specific areas of responsibility:

(a) Production of materials and equipment.
The committee is responsible for the writing of text books and teachers guides, coopting experts from the schools, other government departments, research institutes and industrial agencies where required. Equipment is recommended by the Committee to the Ministry of Educational Services which arranges its acquisition from local or overseas sources and eventual distribution to the schools.
Close liaison is sometimes required between

the subject committee and the Ministry of Educational Services if a new piece of apparatus is designed for local manufacture.

The science committees produce "Standard Lists of Science Equipment, perishables and chemicals which are updated at regular intervals. (See Appendix 7). These committees also produced lists of items of local manufacture and availability, which can be purchased out of the school grant with the approval of the Circuit Education Officer (C.E.O.). A supplementary list of miscellaneous consumable items, for which C.E.O. approval is not required, provides guidelines for the purchase of matches, candles, spirit, etc.
The technical committees have produced similar lists of equipment for the thirteen subjects within their areas of responsibility.

(b) In-service Training Each committee is responsible for the organisation of in-service training programmes and the teaching of in-service courses in its subject area. Such courses cover subject content, methodology and apparatus.
eg., a simple kit for the teaching of electricity was designed by a member of the science committee. Teachers on an inservice course each manufactured one of these kits, learned how to use it, and took it back to the school.
At the Junior Secondary level "Master Teachers" are trained through an initial course of five days at the Centre followed by twice termly visits to the Centre, each of 3 - 4 days.
To date two Master Teachers have been trained for each region in each subject area: Science, Mathematics, English, Technical (Life Skills) and Social Studies.
At the Senior Secondary level training is done on a regional basis involving C.D.C. staff and local teams of qualified teachers. These teams are also used for the writing of curriculum materials, eg., a Teachers Guide for the A-level Chemistry Practicals has recently been produced by such a team.

(c) Ten Science Education Support Centres have been established in the regions. These Centres are used as residential venues for Senior Secondary training, teacher reference and self improvement studies.

Technical Resource Centres are to be established in five regions as soon as equipment is available for them. These Centres will perform similar functions to those served by the Science Education Support Centres.

(d) Use of the Educational Television: limited use is made of this medium for the instruction of classes at the Advanced level in the Science subjects.
Of the four hundred and ninety schools offering A-level, 420 have electricity and have been issued with normal colour sets, and a further thirty have battery operated sets with solar panels for recharging. One hundred and thirty two of the schools have also been issued with a VHS video machine for the recording of programmes.
Two twenty minute programmes per week are transmitted on Science, Monday, Wednesday and Friday in Sinhala and Tuesdays and Thursdays in Tamil.
Teachers Guides are prepared in advance for each programme and distributed by the C.E.O. The preparation of these programmes and teachers' guides is the responsibility of the A-level subject committees.

(e) Evaluation: Reports are prepared on the basis of feedback from Master Teachers and Education Officers visiting schools. We were told that some formal evaluation work has been done but no reports were seen.

(f) Field study centres have been established in several regions to facilitate the study of ecosystems at advanced level. One centre has been established for the study of solar energy usage. Students come to these centres with their teachers for short periods of 2 - 5 days.

7.2. The Production and Distribution of Materials and Equipment:

Responsibility for stocking schools with materials and equipment for all subjects is vested in the Ministry of Educational Services.
The Ministry operates an order system, a record system, a central stores complex and a small transport fleet. Also included within this Ministry is the Schools equipment Production Unit (SEPU). Permanent links are maintained with the Ministry of Education

Curriculum Development Centre (CDC) and with regions and schools through the Regional Directors and Circuit Education Officers.
The Ministry is also responsible in the final analysis for the maintenance of all school equipment.

7.2.1. Sources of Equipment: Equipment comes form three main sources:

(i) overseas agencies
(ii) local commerical enterprise
(iii) SEPU (in case of science equipment).

Overseas orders are placed on catalogue information, local orders after consideration of samples, and SEPU orders in consultation with C.D.C.

Schools Equipment Production Unit (SEPU): this Unit was originally established "to design and pilot prototype low cost equipment for schools that could be manufactured on a large scale by local entrepreneurs. (Lewis PhD pp 344).
This concept was later broadened to include the mass production of such items for all schools.
The Unit is housed in three buildings.
There is a large 30m x 20m workshop which provides adequate room for its current range of power tools and benches.
The range of tools and equipment is considered sufficient for moderate levels of production involving sheet metal, bar metal, wood and plastic. Facilities exist for the cutting, shaping, drilling and joining of all these materials.
An oil fired smelting furnace forms part of the equipment but has never been installed.
Adjacent to the workshop is another large 20m x 10m storage room which is currently used for the assembly of manufactured components.
In addition to these working areas there is a third building which contains a large storeroom with steel racking and two small offices for administration.
The entire complex is security fenced.
The unit has a staff of about twenty-five men at present although none are qualified craftsmen or engineers.

7.2.2. Purchase of Equipment: is against the standard lists of equipment , perishables and consumable materials issued by the C.D.C. (See para. 7.1.1. (a).).
Equipment is ordered by the teacher through the school principal on standardised forms. Required information includes present stock levels and the number of students and classes to be taught.
Orders are verified by the regional subject Education Officer to prevent over-ordering.
On reception at the Head Office, Ministry of

Educational Services, orders are assessed and the numbers of each item adjusted to fit budget constraints and estimates of requirements in the opinion of the Education Officer in charge of orders.
Once a year these orders are consolidated, compared with current stock levels in Central Stores, and the difference (if any) ordered through the State Trading Board. The State Trading Board issues tenders on a world wide basis.
Tenders are considered and awarded by the Cabinet Tender Board Committee of which the Secretary for Educational Services is Chairman.
Samples which have been submitted by local commercial enterprises are assessed for functional quality by a sub-committee of this board.
Local tenders are taking an increasing proportion of equipment orders. In particular, "Vidya Silpa", a local science equipment manufacturing company took about 40% of the 1983 science equipment order.

Handtools for the technical subjects are also mostly purchased through local suppliers.
Funding for equipment purchase is from the Ministry of Education budget with the assistance of SIDA support.

7.2.3. Science Equipment funding: no clear distinction is made between the Ministry allocation and SIDA funding.
Accordingly it is not possible to estimate to what degree SIDA is contributing to the growth of local science equipment supply enterprises directly.

Table: Value of Science Equipment Purchases 1982 - 84.

Year	Total Cost (Rupees)	SIDA contribution (Rupees)
1982	20 million	4 million
1983	16.7 million	1.7 million
1984	20 million	-

Within this budget funds are also allocated to schools for local purchase of small items and miscellaneous consumables (See para. 7.1.1. (a).).
At the Junior Secondary Level this school allocation is currently set at the following flat rates:

Schools with up to 150 students	200 Rupees/year
Schools with more than 300 "	300 Rupees/year

At the Advanced level, allocation is made on a 'per-capita' basis at the following rates:

Zoology	8	Rupees/student/year
Botany	1	" " "
Chemistry	1	" " "
Physics	1	" " "

7.2.4. Technical Equipment Funding:

There are three sources from which funds are available for the purchase of tools and equipment. These are the Ministry of Education, SIDA and UNDP/UNESCO. Aid from SIDA is utilised by purchasing tools for standard kits which then will be delivered to the schools. The tools which the school already has will be distributed to other schools. Purchases during 1983 of tools and equipment for technical subjects amounted to 5 744 064 Rupees.

UNDP/UNESCO purchase tools and equipment related to the Life Skills pilot programme. The purchase of tools for UNDP/UNESCO amounted to approximately 1 000 000 Rupees in 1983.

7.2.5. Delivery and Storage: all equipment ordered is delivered to the Colombo Central Stores. Overseas deliveries are made via the State Shipping Board and take an average of one year from time of ordering.
All deliveries of equipment to Central Stores are recorded in a master register and stock records are updated on a regular basis.

7.2.6. Distribution: equipment is distributed by the Ministry of Educational Services using its own road transport fleet.
The fleet consists of seven large vehicles, one of which was purchased with SIDA funds.
Science equipment is delivered to the Regional Education Officer where it becomes the responsibility of the Circuit Education Officer to arrange transport to the schools.
Technical subject equipment, in kit form, is delivered by the fleet direct to the schools since it is considered too bulky for local transport.
Chemicals and other consumable materials required for science are distributed in bulk to the regions. Regional science Education Officers then arrange with schools for the division of the bulk supply into smaller lots for school use. Generally schools are asked to provide the containers for this purpose
Records are maintained in Central Stores of the issue of equipment and consumable materials to

regions on a "date of issue" basis.
These records are analysed and consolidated on a monthly basis by the Head Office, Ministry of Educational Services.
Central records of actual stock holdings by individual schools were discontinued when the number of secondary schools exceeded five hundred.
In general, deliveries are made to schools once a year although for urgent requests, if the items required are available 'ex stock', immediate delivery can be arranged.

8. FINDINGS FROM THE FIELD STUDY

The evaluation team visited 17 schools, rural as well as urban, in Kandy and Matara Districts.

The schools visited are of various sizes, with a population of approximately 500 - 3 000 students, offering Grades 1 - 10, 6 - 10, or 6 - 12. Some of the schools are pilot schools where Life Skills are taught in Grade 6.

Some schools are for boys and girls only while others are mixed.

8.1 Technical Subjects

Although some of the schools are very large, none offers all 13 technical subjects. All schools offer agriculture. Girls schools and mixed schools offer home science.

8.1.1 Distribution of students in subjects

The distribution of students in different subjects varies from 2 students taking woodwork in one class in grade 10, to 90% of the girls in one school taking home science.

The headmasters of the schools seem to play a main role in organising the time-table for technical subjects. Although all schools visited offer technical subjects, 3 periods a week, in some cases the time-table has the periods as only single periods (3 x 1). Most of the schools, however, have time-table arrangements which enable the teachers to teach the subject for a double period plus one single (2 x 1) + 1. In most of the schools the time-table is arranged to combine different classes in the same grade in order to make the group of students big enough for subjects which are less popular. The problem with such an arrangement is that when two or even three classes are combined in order to utilize the workshops for woodwork and metalwork or weaving and pottery, the groups in agriculture and home science become too big and therefore lack sufficient workshop space and tools.

The problem is very difficult to solve unless the school is big enough to have at least double the number of teachers and workshops in agriculture and home science as in woodwork andd metalwork, weaving and pottery. In schools where combined classes are not arranged, one teacher can have classes of 2 - 10 students in some subjects. A more careful study of the time allocated in the time-table is needed in order to find possible solution, but accord-

ing to many headmasters the only solution at present is more workshop space, land, tools and equipment in order to cater for the large number of students choosing agriculture and home science.

One possible solution is to arrange the technical subjects in clusters where woodwork, metalwork, masonry and pottery form one subject which can be called handicraft, while home science, needlework and weaving form a subject named home science. Agriculture, home gardening and pottery can all be included in a subject named agriculture.

These arrangements of course imply that a complete new curriculum is written as well as syllabuses for each of the new subjects. Radio mechanism can be referred to the new technical stream under T.E.A.

In schools where Life Skills are taught, this problem never arises, as an even distribution of students is made and groups of reasonable size can be arranged. Usually the teachers teach the Life Skills subject in half classes. In one school, however, the teachers complained that they have to teach Life Skills in full classes.

8.1.2. Teaching Methods

All teachers claim that both theory and practical work are taught. The normal time-table allocates 3 periods of 45 minutes a week with 1 period of theory and 2 periods of practical work. But no practical lessons were observed although it was evident that some practical work had been done by the projects displayed.

By looking at the state of the equipment and the projects, it is quite easy to establish if practical work is common or not. Most probably the interpretation of 'practical work' can also differ as some teachers claim that practical work is done, although the facilities apparently do not allow any practical work.

In one of the schools the teacher in woodwork said that he had not been able to get any wood for practical work for the last three years.

One obvious limitation in the study was that almost all interviews with the technical teachers were carried out with the C.E.O. as interpreter. Hence it was very difficult for the teacher to criticize anything concerning the C.E.O.

The school gardens were all cultivated and it is apparent

that agriculture is a subject which does involve some practical work. In most cases the schools also have small rooms used for storing equipment and as laboratories for agriculture.
Weaving and pottery are subjects which are taken by very few students and the teachers in those subjects have therefore very small groups of students.

From the lessons the evaluation team could observe, it is obvious that most of the teachers depend on dictating notes, and writing and drawing pictures on the blackboard as the students do not have any kind of textbooks.

The overall impression the evaluation team received is that there is very little practical work, in its real sense, going on in the technical subjects.

There are many reasons why the teacher does little or no practical work with students:

a) Lack of knowledge and experience from practical work.

b) The teacher training institutions also lack workshops, tools and equipment. Hence the teacher thinks that demonstrating is practical work, as that is the way practical work was done during his/her teacher training.

c) Practical work is much more difficult since the teacher does not have the class under the same control as when he/she teaches theory.

d) Practical work requires tools and equipment as well as workshop facilities. If these are not available the teacher can do nothing else than teach theory.

e) Lack of consumables due to lack of funds or an administrative network which is not functioning and does not deliver consumables to the school.

f) There is no examination in practical work. Hence the teacher trains the students to succeed in the examinations as set.

g) The tools and equipment are in very poor condition due to lack of maintenance and the result of their use will therefore be poor.

All these things can be rectified by:

a) improving the facilities

b) improved administration

c) improved teacher training

d) inservice training inteaching methods and maintenance

e) improved or different methods of assessment

8.1.3. Workshop/teaching space and land for practical work

The size of the workshops varied substantially. The workshop referred to earlier when the teacher had only 2 students in one class has at least 120m^2 for teaching woodwork, while other workshops only had 20m^2 where 24 students should be taught woodwork and metalwork.

To teach practical work under these latter conditions is most unsatisfactory and, as pointed out earlier, makes the teachers emphasize theory.

Home science workshops also vary in size. However, in most of the schools visited by the team, it is not the size of the workshops for home science which is the problem, but the number of workshops. Most of the workshops are big enough for teaching 20 - 30 students, but not 40 - 60. For that two workshops are needed.

As far as agriculture is concerned all schools visited have school gardens. The size of the school gardens varies. Most of the school gardens are fairly small and are used for growing the same sort of plants. It appears therefore necessary to improve the teaching method by introducing a variety of plants, rather than increasing the amount of land available as only demonstration plants should be grown in a school garden.

In all schools the school gardens were cultivated, but with the number of students the teachers have to teach the practica work in a school garden must be very limited. It is therefore necessary that all schools offering agriculture have laboratories in order to allow for practical experiments. Most of the schools visited lack proper laboratory facilities for agriculture and the teacher only has a storeroom for teaching and laboratory experiments.

Weaving and pottery are the only subjects where it can be stated that there is sufficient space. This is due to very small number of students taking these subjects.

Schools participating in the Life Skill Pilot Programme are using the ordinary facilities of the school and the even distribution of students in that subject makes it easier to find sufficient space at present.

8.1.4 Order in workshops

The order in the workshops is very bad. It is only in a very few isolated cases that it can be said the workshops are in good order. Two woodwork shops, one metal workshop, one home science workshop, two weaving workshops and one pottery workshop were in good order during the visits made by the team. All agriculture workshops lacked tool racks, although some of the schools have store rooms for agricultural equipment.

It can be stated that in general the workshops lack racking facilities for tools and other equipment as well as storage facilities for projects and work pieces. In most of the schools the tools and equipment are stacked in a cupboard which causes the tools to wear out quickly and makes it very difficcult to select the necessary tool for a specific purpose during practical work.

Thus it is absolutely essential that the teachers are trained, through teacher training and inservice courses, in the necessity of proper tool racking.

The lack of order in the workshops is an indication of theory-only lessons as then there is no need to keep tools and equipment in good order. But it can also be the cause of this situation. The lack of proper racking makes it so difficult for practical work that the teacher prefers to stick to theory and demonstration.

8.1.5 Amount and distribution of tools and equipment

From the observations made during the field study it was striking that:

a) Tools and equipment in many schools are insufficient in quantity for practical work.

b) Tools are unusable due to lack of maintenance.

c) According to the teachers several tools mentioned in the syllabus are not available.

d) Some schools have the most sophisticated tools and equipment while other schools do not have any tools at all.

Woodwork

In one of the schools visited the woodwork woodwork shop is equipped with two electric hand-planers. One of them had a short-circuit in the cable. That was the reason why the school had got the second one. To the question: "Do you know how to sharpen the blades for the electric hand plane?" the teacher looked surprised and replied that he did not think that sharpening of blades was necessary for an electric tool.

In one workshop we found one power saw, one electric sander, one electric grinding machine and one electric hand drill. In other schools there are not even the most essential handtools for woodwork.

It is our opinion therefore that no electric equipment should be purchased until all schools are equipped with the necessary handtools.

In no case did the woodwork benches have efficient arrangements for fastening the work-piece. Therefore most of the students are not able to do the most simple planing. A simple device made of 10 mm round steel bar, drilled holes in the side of the bench and a woodwedge could solve that problem very easily. The item is described in appendix 3.

Only in two schools visited were the tools in the workshop sharp and in good order. In all other schools the most essential maintenance was lacking.

Metalwork

Also in metal work the uneven distribution of tools is very striking. One of the schools visited has only one vice and almost no tools whatsoever. Another school has all the tools necessary for a fully equipped workshop for vocational training. The lack of maintenance in the metal workshops is not as severe as in woodwork, but there is still a lot to be done until it reaches a reasonable standard.

For many woodwork and metal workshops the design of the workshops and the arrangement of benches, tools and equipment must be improved if any kind of meaningful practical work is to be done.

Home science

Very few home science workshops have proper cooking facilities in terms of stoves. Lack of utensils was in many cases obvious and explains why meaningful practical work must be very difficult to achieve.

Some schools have electrical equipment which looks

out of place when the most essential utensils are missing.

Agriculture

Some schools visited have many tools while others have almost none. The extreme case is one school where only three hoes are available, and one of these has a broken handle! No school offering agriculture had any equipment for tests or other laboratory experiments.

Weaving

It would appear that the weaving syllabus is aiming too high as the weaving workshops the evaluation team visited had only big looms and no small frames for simple weaving.

Weaving should concentrate more on simple weaving with less complicated looms and leave the sophisticated techniques and the big looms for vocational training.

Pottery

All pottery workshops visited are equipped with potter's wheels but no workshop has firing facilities. In one workshop there is an electric oven which has been out of order for a long time. Repair was not planned for the near future.

8.1.6. Tools and equipment storage

Most of the schools visited have lockable cupboards for tools and equipment. Better facilities are definitely required for safe storage of equipment, especially the electrical equipment, as it is very costly and must be very attractive to thieves. In those schools where products produced by the students could be found, the storage facilities leave a lot to be desired. More shelves or cupboards are needed. These could be produced by the school during woodwork lessons.

8.1.7. Protection of crops

Some schools visited reported that thieves loot the school gardens when the plants and fruits ripen Not only fences but watchmen are needed in order to prevent this. The easiest solution might be to have students from the upper grades, who are taking agriculture, to guard the gardens when the fruits and plants are almost ripe.

8.1.8. Content of subjects taught

From the visits to the schools it appears that the emphasis in technical subjects is on names of tools and names of parts of tools where woodwork and metalwork are concerned.

As stated so many times earlier in this report, practical work seems to play a minor role. Even if the woodwork and metal workshop have all the facilities needed for practical work, the teacher tends to emphasise what he/she thinks will in in the examination. Therefore questions in the examination paper must be formulated in such a way they test knowledge which could only have been acquired through practical training.

Another way to achieve practical work in the schools could be to only give marks through continuous assessment.

A third way is suggested by J.E. Jayasuriya (1):

It is proposed that the students in any particular school 'A' should be examined and evaluated by the teachers in a neighbouring school 'B', the tests being conducted in the students' own school 'A' itself. A teacher from school 'C' will examine the students in school 'B' and so on, taking care to ensure that no two teachers X and Y would examine each other's pupils. If there are 30 students A1, A2, A3,.....A30 offering a particular technical subject in school 'A', the examiner will prepare an order of merit list without awarding grades, and this list will be sent to the Commissioner of Examinations who will assign grades on the basis of the distribution of grades among the same candidates in the written papers in the subject. If the distribution of grades in the theory papers is as follows:

Grade	Number of Candidates
D	2
C	9
S	15
F	4

the first two in order of merit in the practical test will be given the grade of D, the next nine will be given C, the next fifteen will be given S and the last four will be given F. These may in turn be converted into a numerical mark by awarding either a uniform mark for all D's and likewise for all C's etc. or a graduated scale of marks, and finally the marks for the written papers and the practical tests will be combined to award a final grade for the subject.

In agriculture and home science the content of the subjects transmitted to the students was more difficult to judge but theory must of necessity take a major part in those subjects. It was obvious that the lack of essential

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1) Jayasuriya J.E., op cit.

equipment made the subjects too theoretical.

In weaving and pottery, it is hard to say anything about the content. One remark made by an education officer indicated that weaving was too difficult for Grades 6-8.

Two of the schools visited offer motor mechanism but only theory is taught.

8.1.9. Textbooks

No technical textbooks could be found in the schools visited.

Introduction of simple textbooks could therefore reduce the time spent copying from the blackboard allowing more time thereby for practical work.

8.1.10. Teacher Training

The team visited three teacher training colleges in addition to the visit to Naiwela where inservice training for Life Skills was going on at the time of the visit.

At Pattalagedera the lecturers and the students were all out on teaching practice. Consequently, very little information was obtained but J.E. Jayasuriya makes the following remarks in his report:

'The present provision at Pattalagedera for the training of teachers of agriculture is in urgent need of review. The institution lacks the basic facilities to have a sufficient variety of crops under cultivation or to practise animal husbandry with adequate care and protection. Moreover, the time table is not structured to accommodate the special needs of trainees in agriculture such as devoting the morning hours to practical activities in agriculture and animal husbandry. Above all, residential facilities for all trainees in agriculture are essential if training is to be carried out successfully, and this is not possible at present at Pattalagedera. Much regret is expressed at the closure of the agricultural training college at Kuliyapitiya which had provided the right kind of agriculture environment necessary for the satisfactory training of teachers of agriculture. Contrasts are also drawn between the superior quality of the training provided in the past at Peradeniya, Kundasale, and even in practical farm schools and the meagre provision currently obtaining at Pattalagedera. Agriculture occupies a pre-eminent place in the development plans of the government, and if the schools are to make the contribution they ought to make in this regard, serious note should be taken of shortcomings in the training of teachers of agriculture, and every effort should be taken to place the training on a sounder basis than at present.'

Jayasuriya, J.E., op cit.

During the visit to Unawatuna where home science teachers are trained the Principal informed the team that no lecturer in home science is employed byt a home science teacher from a school nearby teaches home science 10 periods a week at the college.

The team could observe that the facilities are very poor with only a few utensils and poor cooking facilities.

In Maharagama however, the home science section is very well equipped and seems to function very well.

The weaving section has only big looms and no training in simple frame weaving is given.

The woodwork and metalwork sections were at the time of the visit in very bad order as far as racking of tools is concerned. It is no wonder that the teachers cannot keep good order in the school workshops when the situation is as unsatisfactory as found at Maharagama. Tools and equipment were stacked in piles both on shelves and in cupboards although racking facilities were available.

The college was built during the 1950's and almost no maintenance of the buildings has been carried out since then. The machines and tools are worn out.

According to the Principal, the students in technical subjects complain that they have to do practical work in Maharagama which they felt was unfair as students in other colleges, according to them, do not have to do practical work. Practical work is not needed for the examinations and therefore the students wanted to concentrate on theory.

During the visit to Naiwela, the evaluation team found that all the students were engaged in practical work. Naiwela can serve as a very good example on how good training can result in good attitudes as the team only met teachers full of enthusiasm teaching Life Skills out in the pilot schools. It also shows the value of good teaching guides, as all the projects observed in the schools were of a high standard and all the students were engaged in practical work. Both boys and girls out in the schools were engaged in practical work as traditionally related to male or female work. That deserves all encouragement.

8.1.11. SIDA-Aid Utilization

In a letter to SIDA from the Ministry of Education dated 28 September 1983, justification for the purchase of tools and equipment can be found.

In home science and agriculture the justification coincides with the observations made by the team during

the field study. There is a need for further aid in this direction even if the Life Skills programme is implemented.

In handicraft, however, the justification does not correspond to the needs observed by the team during their field visits. Although the idea of raising the standard of one workshop in each region to the absolute top level can look good, it will, in the opinion of the evaluation team, destroy the positive attitudes of the teachers. With these resource centres the teachers out in the schools will feel most unsatisfied and the possibility of supplying them with the same equipment in the future must be almost nil.

Low cost tools and equipment evenly spread, together with inservice training on tool-production, maintenance and teaching methods should be amphasized instead in order to improve the quality of education in technical subjects.

8.1.12. Conclusions

During 1983 SIDA aid was, among other things, utilized for buying 32 electric planing machines amounting to 1 383 224 Rupees. For that amount many workshops could have been equipped with the necessary hand-tools. Even more workshops could have been equipped if tools could be produced locally.

Through the Skill Development for Self-Reliance Project ILO/SIDA, based in Nairobi, Kenya, local production of tools has been introduced into the 300 Village Polytechnics monitored by the Ministry of Culture and Social Services. The production is done by the students as part of their training.

The cost of a set of tools for a carpenter has thereby been reduced by 90% compared with tools purchased from the manufacturer.

More than 60 different tools have been designed by the project. The tools are aimed for carpenters, metalworkers, blacksmiths and masons. A study visit to that project is therefore to be recommended.

It must be unnecessarily costly for the Government of Sri Lanka to keep so many different specialised technical subjects in the junior secondary schools. It is therefore with deep satisfaction that the evaluation team has learned about the plans for the future with the introduction of Life Skills and the proposed new educational structure.

What is stated regarding the technical subjects on the proposed new senior secondary level is also very worthy of admiration. It must however be noted that the technical subjects should be ordered into clusters as suggested under 8.2. in order to minimize the cost for national implementation. The way the technical subjects are arranged and taught today has proved to be most unsatisfactory and should be changed to what is suggested in the "White Paper".

Regarding assessment, the evaluation team would like to point out the way Sweden has arranged the handicraft subject slöjd in the Swedish schools. The subject is taught from Grade 3 to 9 and consists only of practical lessons with integrated theory. The assessment of the students is made through observations by the teachers. It is also worth mentioning another subject taught in the Swedish schools from Grades 4 - 6. The subject is called "Teknik" and should be understood as an integrated technical subject. Both these subjects are very much like Life Skills as defined in the UNDP/ UNESCO Project Quality Improvement of General Education.

Teacher training needs a lot of attention as it is there the attitudes to teaching methods are formed as well as the attitude towards order and maintenande. If low cost tools and equipment will be implemented and used in the schools, training must be carried out in the teacher training colleges using such equipment. Production of low cost tools and equipment could also form part of the training in woodwork and metalwork. Practical work must be strongly emphasized as a part of training and examinations should be based on practical work.

8.2. Findings from field study and related comments regarding Science

Introduction: included in this section are pertinent observations and comments from other observers, and comments and suggestions for improvement where it is felt the present system has deficiencies. Data was gathered by interviewing Science Education Officers, Principals, Science Teachers, Laboratory attendants and and senior students.

The team inspected laboratories, science class rooms, gas supplies, stockrooms, storage cupboards, apparatus, glassware and chemicals.

Parts of several lessons at both Junior Secondary and Senior Secondary levels were also observed. All of the lessons observed were in Sinhala and many of the interviews were conducted in that medium through the service of the Education Officer acting as interpreter. The team is aware of the possibility that impressions gained in this manner could be distorted. However, making use of local teachers as interpreters to encourage perhaps less guarded comments wherever possible, and cross checking major issues with different teachers in a number of schools, has resulted in a picture which the team feels is substantially true.

In case the above comments are misunderstood it must be emphasized that the team found all the Education Officers who assisted in the exercise to be extremely helpful and open in regard to deficiencies and weaknesses as they see them. A very broad range of schools from the good to the very bad were visited. The difficulty as the team saw it, was only the very natural and human hesitation on the part of teachers to perhaps criticize the system through their superiors!

8.2.1. Teaching Methods:

Lewin's statements that teachers -
"will have sufficient subject mastery and confidence to treat the content in an exploratory and open-ended manner and encourage student questions.
- will conscientiously and systematically plan and organize large amounts of experimental work," (Lewin pp 343) is sadly at variance with what was observed in the seventeen schools visited.

The integrated science lessons were mostly of the teacher dominated 'chalk and talk' variety. The team did not witness any student questions and only one lesson in which students actually handled apparatus. The teaching method most commonly adopted was the lecture assisted by blackboard diagrams followed by the dictation or copying from the blackboard of formal notes. One

teacher observed, dictated the results of an experiment which the class had not even seen demonstrated!

There is a very large gap between what is known in theoretical terms and what can be related to reality. In a grade 10 lesson, a student indicated correctly in a blackboard diagram how two resistances can be connected in parallel but could not describe in either Sinhala or English the actual appearance of a 'resistance'.

At the advanced level the picture is better. The lists of required experiments issued by the Curriculum Development Centre ensure that some practical experience is gained by students in all four subjects. However, as 'required experiments' the intrinsic reason for experimenting, the need to "put forward hypotheses and to design experiments to establish them" is entirely absent.

The team realises that genuine scientific enquiry is difficult at school level when the areas of knowledge to be explored have been mapped in their entirety, and 'maps' are available in the text book, but it is possible by careful planning of lesson sequences at both O and A Levels to raise questions on aspects of the subject under study which can be answered by subsequent experimentation.

In the opinion of the team there are several reasons why this methodology was not observed:

a) the teacher has not been trained in a methodology which recognizes that science has the two facets of knowledge and intellectual skills;

b) this in turn stems from a pre-occupation with examination oriented studies at both training college and school level.

   It is relevant here to point out the team noted exactly the same methodology of content oriented lecture demonstration at the training colleges.

   It would be unrealistic to expect a teacher to break out of the mould into which he or she has been cast by school and training college experience. Accordingly a revision of the teacher training curriculum as suggested in the White paper is strongly supported.

c) The lack of apparatus in sufficient quantity to allow the students to work in small groups is very demotivating particularly for the teacher working in grades 6 - 10.

Teaching methodology involves teachers and therefore it is appropriate to outline some impressions of science teaching staff and their work programmes here.

The majority of advanced level teachers interviewed were science graduates with a work load of approximately 35 periods per week out of a possible 40.

The grades 6 - 10 teachers have a slightly reduced work load of between 31 - 35 periods per week. The team was told that this was in recognition of the heavier marking load carried by these teachers.

A significant factor which emerged is the lack of liaison and common purpose which exists in most schools between the A-level and O-level science sections. In one instance this has reached the point where the O-level teachers are unable to make use of any equipment in the A-level section.

Many teachers in the larger schools run very profitable private coaching classes. One teacher the Eo Science informed us, was earning more than Rs 20 000/- a month in this work. Another took a regular day of leave each week in order to attend to these outside school activities.

It is obvious that teachers who, for economic reasons, seek and acquire outside remuneration greatly in excess of their official salaries, will not be dedicated to their class room role and will not put in the extra organisation work required to use a teaching methodology which includes significant practical work.

A more subtle effect of this outside work is to create in the teacher considerable resistance to liberalization of the syllabuses which if moved away from a content oriented examination approach, would seriously affect their income.

8.2.2. Content of Science taught

a) Integrated science the differences between the overall course objectives and the 'perceived' objectives in the course material have already been mentioned under 4.2.4. The latter objectives therefore predominate in the content of lessons observed during the field observation.

The team observed little attention being given to the processes of science or to the relationship between classroom science and the everyday world of the student.

While it is impossible in a study as brief as this to

explore all aspects, it is suspected that links with other subjects are also largely non-exisent.

b) Advanced Level

The chemistry syllabus appears to be a largely conventional treatment of physical and organic chemistry with the inclusion of specific chemistry of a few selected elements in the inorganic section.

The practical experiments listed concentrate on the verification of some of the laws of physical chemistry (eg. the Hess and Gay Lussac Laws, Reaction kinetics) organic preparations, and reactions of the main types of organic compounds (eg. hydrocarbons, acids, esters, alcohols, aldehydes and ketones). The practical study of inorganic chemistry appears confined to flame tests, some electro chemistry and acid/base volumetric work. In the syllabus there is an attempt to include appropriate aspects of local industries (eg. gem, graphite mining).

The team was surprised to hear, from one teacher that the 'Law of Multiple Proportions', 'equivalent the weights' and related aspects of Daltons atomic theory are still given significant emphasis. In most modern chemistry syllabuses these topics have been relegated to the history of the subject and receive only passing mention in the study of quantitative chemistry.

A topic which appeared lacking was the teaching of the Periodic Table as a pattern relating the elements and explaining the chemical reactions between them. The treatment of this topic would provide a rich field for meaningful theory-related inorganic practical work.

The other advanced level syllabuses are also conventionally constructed with additions which link some areas with aspects of Sri Lankan industries.
(eg. Zoology/inland fisheries; Botany/pests and pesticides; Physics/house wiring, lubricants, welding and radios).

8.2.3. Text Books

Integrated science: The majority of classes observed appeared to have access to the student textbooks and to use them regularly. Less evidence was forthcoming of teacher use of the guides. Most teachers seemed to prepare and conduct their lessons with primary reference to the student text book. This is in keeping with previously noted observations that the integrated science as taught has a strong leaning towards the basic factual content.
Lewin has shown that the student text material has

a large 'passive' ie. descriptive prose component while the teachers' guide is largely confined to advice on experiments and their class discussion.

Pupil Text Analysis (After Lewin pp 368)

	Year 1 %	Year 2 %	Year 3 %	Year 4 %
1. Treatment				
Active (experiments, exercise etc)	54	64	39	27
Passive description	46	36	61	73
	100	100	100	100
2. Content				
Descriptive factual	52	69	70	78
Activity related	37	23	25	17
Derivation of principles/concepts	6	6	2	2
Application of principles/concepts	5	2	3	3
	100	100	100	100

Teacher Guide Analysis (After Lewin pp 369)

1. Advice on Teaching				
Non experimental	14	13	23	30
Experimental	47	50	43	33
Discussion of results	11	18	18	24
2. Additional content	28	19	16	13
	100	100	100	100

The team suggests this difference explains in part the teacher preference for using the student text books for preparation and supports the impression of little practical work.

Advanced Level: the team were informed by teachers that "Nelkon and Parker Advanced Level Physics" (a standard text in British Schools) was available in

Sinhalese translation. However, a large number of mistakes have occurred in the translation process and the book is also very expensive (Rs. 425/-). A similar situation exists in Biology where "Grove and Newall" is available in an expensive translated edition.

In chemistry several locally written textbooks are available which are much cheaper (Rs. 50/- to 100/-) than the above books and appear to have been favourably received by teachers. However, in all schools visited very few textbooks are available at this level.

The majority have one copy of each which is ostensibly in the school library, but which in practice is in the teacher's possession and forms the basis of the teachers' notes which are issued to the students and which provide their main source of study materials.

The number of appropriate text books in Sinhala is a major limiting factor in providing additional study and reference materials for students. The team feels that at this level English may not be a major barrier for them and the inclusion in the library of a selection of standard English student texts would significantly improve the situation and bring students into contact with contemporary science.

8.2.4. Laboratory/Science Room teaching space and facilities

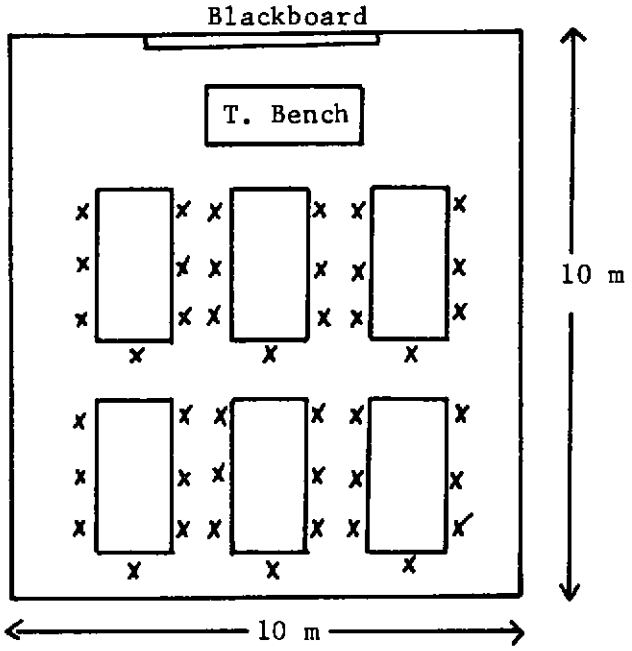
Reference has already been made to the provision of laboratory facilities under 5.2. The impression gained from inspecting facilities in the schools was that there was significant under-utilization of laboratory space. Most schools have at least two laboratories usually of a size which could accommodate a class of 30 with appropriate furniture, but which are reserved for the use of advanced level classes. Some laboratories of this type had been converted to 'lecture rooms' for advanced level work, a serious misuse of scarce facilities in the opinion of the team.

Careful timetabling could ensure that one laboratory could be reserved for advanced level work in all science subjects while the other could be refurnished to cater for the large classes common at grade 9 and 10 levels.

In the opinion of the team the use of one laboratory for advanced level would not seriously prejudice the teaching.
It is unnecessary to keep large quantities of apparatus and/or reagents related to any particular subject in the laboratory. Material required can be fetched from the storeroom immediately before the practical work and returned on its completion by the students concerned.

Such a system operates in other education systems facing similar constraints. While it may require a little advanced organization by the teachers and some supervision to avoid pilfering, it can be done.

The laboratory space released by adoption of this policy could be furnished with loose tables approximately 1.2m x 2.5m the arrangement of such tables as suggested in the diagram would enable large classes to be accommodated efficiently.



Seating for 42 around
tables 2.5 m x 1.2 m.

If the proposals outlined in the White Paper are implemented so that the 'middle school' is extended for an additional year (grades 6 - 11), the need to adopt a policy of reducing A-level laboratory accommodation and releasing it for O-level will become acute. Otherwise, the tendency towards purely theoretical teaching already prevalent in the middle school will be exacerbated.

Notwithstanding what has been said above, the team feels that the science room will be a feature of school science in Sri Lanka for many years.

Many of the science rooms inspected are quite adequate for the teaching of science in grades 6 - 8 provided they are seen as such and not as 'waiting' rooms pending the availability of a laboratory.

Recognition of this reality would suggest a permanent lockable cupboard or better an adjacent stockroom for the storage of appropriate equipment of materials. Flat top double desks or small tables would provide adequate bench space.

Some schools seen have already taken this step with a consequent improvement in the standard of science offered at this level.

Laboratory services - gas, water, electricity.
Aerogen gas generators have been fitted in many of the laboratories. However, with the exception of one, all were out of order because of maintenance problems (in most cases leaks in the system). Further, teachers complained that the purchase of petrol for the machines was an expensive demand against school funds thereby mitigating against too lavish a practical programme. When poorly maintained these machines constitute a considerable explosion/fire risk. The flame temperature produced is also relatively low.

Two schools observed have re-equipped themselves with bulk supplies of low-pressure petroleum gas which is now readily available at fairly low cost throughout the island.

Three major problems are associated with this improvement
(i) the existing gas plumbing often has leaks in it and requires overhaul;
(ii) the regulator purchased to reduce tank pressure to 'line' pressure is of the domestic variety designed to provide a gas flow for one or two stove burners.
(iii) the Aerogen burners cannot be used on the 'bottled' gas and while it is possible to convert them by fitting smaller jets it is generally unsatisfactory and new burners must be bought.

One solution which might be less expensive and more flexible would be to use small 2.5 kg cylinders mounted on trays and fitted with the domestic regulator and a multiple tap outlet. Such gas supplies could be placed on the bench where required, kept in stock rooms, and even used in science classrooms.

Spirit Burners: Most schools visited had several of the traditional glass spirit burners. Pressure burners or spirit and paraffin 'Primus' stoves were also seen in several schools.

The majority of the primus stoves were unserviceable and teachers indicated that generally the quality of locally purchased spirit was very low. Often it contains so much water added by shopkeepers, that it is impossible to light!

The solution might be to provide methylated spirits along with other reagents from central stores. It is understood that bulk purchase from the manufacturer has been tried but the re-bottling into smaller containers at central stores constituted such a fire and health hazard that the project was abandoned. Perhaps the solution might be to persuade the manufacturer to sell a bulk supply to stores but packed in 5 litre containers such as are used in the motor-oil industry.

The team feels that the spirit burner could be very useful in the science classroom particularly if it were rendered safe by making it from a small metal can instead of the traditional glass container.

Water Supply: The majority of laboratories have at least one sink but a supply of water to the sink is not available in the majority inspected. The reasons for this include poor plumbing, no connection to main supply, no watertank or water tank empty. There was no evidence that the lack of water was due to a shortage of water.

In one instance the water tank for the laboratory was situated under the eaves of the roof. All that is required to ensure a ready supply would be some lengths of bamboo guttering to direct rain from the adjacent roof into the tank.

Electricity: Mains electricity was available in all the advanced level schools visited and in most of the remainder. Only one school was observed to have a mains operated low voltage supply although most had battery chargers.
'NiCd' cells were generally in a very poor state of maintenance.

8.2.5. Organization: Laboratories and Equipment

a) Laboratory attendants: four of the schools visited had laboratory attendants. None of the laboratory attendants were qualified. One was unregistered and had been receiving a salary of only Rs. 100/- per month for the past seven years. While these attendants were unqualified, there was a perceptible difference in the standard and usage of apparatus and chemicals in schools where attendants were found.

None of the attendants interviewed had a specific written list of duties and all were vague as to their particular responsibilities and immediate superiors.

While one of the attendants showed the team a book in

which transactions for apparatus with the Integrated Science teachers were recorded, there appeared to be no systematic stock records of apparatus or reagents. The encouragement of low level laboratory attendants in all schools would greatly improve the utilization of equipment.

b) Organization: A common factor found in the organization of technical and science subjects was the non-existence of any clearly defined framework of responsibility or chain of command for individuals working within a subject area. The existence of such a system is of particular importance in practical subjects where material must be ordered, equipment maintained and upgraded and records kept of new equipment arriving, breakages, consumables, etc. One of the most frequent questions asked by the team when a particular shortage was being discussed was "who does the ordering?" The answer was invariably: "The Principal". While the Principal is ultimately responsible for sending orders through to the Ministry of Educational Services, he or she cannot be regarded as having the expertise required to decide on their content. This should be the responsibility of the teachers in charge of subjects and in the case of science, the overall responsibility should rest with a 'Head of Science Department'.

Such a system was not observed in the schools. While heads of subject existed they appeared to regard the positions as nominal and did not feel a significant responsibility for maintaining the "health" of the teaching resources used for that subject. None of the schools had a position corresponding to 'Head of Science'.

Only one school seems to have constructed an organizational system which has a clear command structure and instilled a sense of commitment in its various section heads.

In the opinion of the team the main reason for this situation is that little or no benefits accrue from being a section head. Some teachers are on higher grades but this is a function of their qualifications and experience and is not related to specific responsibilities. For acting as section head there are no additional emoluments, no discernible improved career prospects, and no reduction in teaching load.

While the financial implications would be significant, the team feels the establishment of a series of responsibility allowances related to clearly defined organizational duties, and the recognition that performance of such duties necessitates time being available which can only come from adjustments to the teaching load, would have a very great effect on the overall management efficiency for apparatus, chemicals, laboratory attendants, and the laboratories themselves. This would in turn lead to greater effectiveness in the science teaching.

8.2.6. Quantity of Equipment and Consumables: As has already been stated the team found that in general the quantity and range of equipment for A-level studies was adequate. This was particularly true of physics. In chemistry much of the required equipment is glassware and therefore subject to breakage. Few schools, for instance, had more than three or four burettes for volumetric work.

Microscopes are the most expensive items in the biological science apparatus, and present a significant problem.
While the number of microscopes often appears adequate, closer inspection reveals that the majority are unusable. Lenses and mirrors are missing, stolen the team was told, by the students. Fungal growth on the lenses also appears to be a major problem in the Sri Lankan climate. Since fungus grows most readily away from bright light and more particularly sunlight, it may be that the simplest solution would be to remove instruments from dark wooden boxes and cupboards and keep them in the open under transparent plastic bags to protect from dust.

A vigorously prosecuted maintenance and repair campaign would do much to improve the current situation, coupled with in-service training of teachers on aspects of security and simple day to day maintenance.

In the same category as the microscopes, the old-fashioned chemical beam balance is found in most schools in a non-functioning state. These instruments are very expensive and an inordinate amount of the practical period is taken up in accurately determining mass using them.

The team felt that it would make better teaching (and economic) sense to gradually phase in semi-automatic mono-pan balances or the newer electronic instrument.

For most student purposes the modest accuracy (of $\pm$ 100 mg) provided by the locally produced torsion balance is adequate.

Junior Secondary Equipment and Consumables: The quantity of equipment and consumables at Junior Secondary level is a problem which is clearly tied to the aim of achieving the original course objective and to the desired changes in teaching methodology. Without adequate numbers of each item of equipment it is a vain hope to expect small group work to be the norm in the science classroom, or to see students carrying out exploratory practical work which goes beyond the 'verification of what is known' stage.

If a policy of supplying conventional apparatus is adhered to, this problem is insurmountable, since the money required to adequately equip more than 5000 schools would exceed

the budgetary provisions for the entire Ministry.

The team suggests that the problem can only be solved by adopting an entirely new approach to the teaching of science in the Junior Secondary grades and in particular in grades 6 - 8.

If it is assumed that these classes are to be taught with small group practical work in the science class room, then what is required is ultra low cost equipment kits designed for the purpose and housed permanently in that room.

One member of the evaluation team offers assistance in the form of apparatus ideas and materials from experience with a low cost science programme in Zimbabwe.

An example of the approach the team has in mind is provided in Appendix 8.

The adoption of such a radically different solution to the problem of practical work could not be achieved on the strength of a low cost science kit alone. Implied in such a strategy are new student materials, teachers guides and teacher training programmes. In-service reorientation courses would be essential. Confidence in the standard of the examination and chances of success for students coming to it with the new learning experiences would need to be affirmed.

Supply and Distribution of Equipment: The machinery by which equipment is ordered and distributed has already been described under para. 7.2. However, the team noted from its interviews with teachers that frequently no equipment had been ordered for several years. Deliveries had been received from Educational Services of items still missing in terms of the "Standard Equipment List" but no initiative had come from the school for example to replace broken items or repair equipment such as microscopes.

A similar situation was encountered regarding chemicals where two of the Principals of schools designated as storage and distribution centres reported that schools did not come to collect the reagents to which they were entitled.

Part of the reason for this lack of school initiative undoubtedly lies in ignorance of the correct procedures, and part on the case of the chemicals, in the lack of suitable containers in which to collect the supply. But the team feels the main reason is once more the absence of an administration structure within the school which would have laid responsibility for these initiatives on particular individuals.

Several schools which had used the correct procedures reported long delays in receiving the items ordered. Up to two years from the time of ordering appears not to be unusual.

8.2.7. Storage of equipment and Chemical Reagents

All schools visited had at least one room in which equipment and chemicals are stored. Often more than one room is used for this purpose but in most cases each room contains both apparatus and chemicals.

In all schools at least one of the rooms designated for storage also doubles as a preparatory room and base for the laboratory attendant if one is attached to the school. In addition to these facilities all schools have at least one lock-up cupboard usually in or near the 'Science Room' where apparatus and chemicals for demonstration in grades 6 - 10 is stored.

In general the security of these storage facilities was found to be good. Keys were in charge of the teacher in charge of the section or in the case of Junior Secondary Science the teacher using the cupboard.

Storage rooms had iron bars or wire mesh on all windows. However, the rooms were not secure against entry through the ceiling. One school reported a burglary in which entry was gained via this route.

Where possible it would be advantageous to store chemical reagents away from apparatus particularly physics apparatus, balances and microscopes. Serious deterioration was observed in equipmnet stored in proximity to the general stock of fumes from bottles of acid etc. Where a laboratory attendant was employed evidence of systematic storage was found but in no cases were systematic records, stock cards or index files shown to the evaluation team.

One duty of the laboratory attendant or other teacher made responsible in the system of organisation outlined under para. 8.2.5. (b) would be the establishment and maintenance of the record system for apparatus and consumable materials. Records would enable shortages of chemicals to be anticipated and a regular annual equipment order to be submitted.

Storage of chemicals and equipment in the Junior Secondary cupboards was generally very poor. There was a great deal of evidence of spilled chemicals, open and poorly labelled bottles, broken apparatus and dirty glassware.

While not present to the same degree, many of the storage/ preparation rooms also had similar rows of open or spilled chemicals and a pile of dirty or broken glassware in the

corner.

The overall impression strongly supported the team's contention that practical work of any description at the Junior Secondary level is regarded as of little importance.

8.2.8. Safety in Storage Rooms, Laboratories and Science Rooms

Apart from the wastage implicit in the state of storage described above, there is inherent in such disorder serious dangers both to the fabric of the buildings and to the persons who work in it.

Spilled chemicals can create a fire hazard and may be injurious to health over a period of time. Some reagents are very poisonous and could unwittingly lead to serious contamination of the foodstuffs often found in preparation areas. Certain substances such as mercury and benzine have been shown to be extremely toxic in very small quantities.

The team strongly suggests that inservice courses be organised on laboratory safety and laboratory organisation and that similar courses be included in the curricula of the training courses.

There is a great deal of literature available (in English unfortunately). A start perhaps could be made by the C.D.C. carrying out such a literature search and preparing a suitable guide to safety for teachers.

The Association for Science Education (UK) is a useful starting point as is "A Safety Handbook for Science Teachers" Evrette and Jenkins published by John Murray.

There was little evidence of fire extinguishers in laboratories. While the provision of sophisticated extinguishers for chemical and electrical fires may be unrealistic it should be possible to provide each laboratory and science room with two buckets, one containing sand and the other water.

If the main thrust of this report, to improve and strengthen practical work in schools is successfully achieved, then attention to matters of safety will become of paramount importance since the health and safety of children will be involved.

8.2.9. Production of Equipment: Improvisation and SEPU

Mention has already been made under para. 7.1.1. (b) of the inservice courses which were run for the construction and assembly of low-cost electricity kits. While several of these kits were seen in schools

there was no evidence that there had been any attempt to construct additional kits making use of the school workshop facilities. Only one example of a home-made piece of apparatus (an electric motor) was seen.

This lack of evidence of improvisation and apparatus construction can be ascribed to the prevailing philosophy that group practical work is a waste of effort, but can also be viewed as stemming from a teacher and possibly student prejudice against 'home-made' equipment because it may not 'look like the real thing'.

The existence of such a prejudice was expressed by one teacher who claimed that students would not accept such apparatus as being part of "genuine science". The changing of such attitudes if they exist will be a necessary pre-requisite for the adoption of low-cost equipment for grade 6 - 8.

Mention has also been made of the team's visit to the Schools Equipment Production Unit (Para. 7.2.1.). It was depressing to observe the very low production rate of the Unit and the poor quality of items being produced. After completion of the team's visit, one of the team returned to take photographs of the workshop, only to find that even the modest degree of industry exhibited during the 'official visit' had disappeared in the intervening few minutes.

The Secretary for Education Services in an interview told the team that in his opinion the failure of SEPU could be ascribed to

i) The inability of the Unit to retain professional skills because of low public service salaries;

ii) the constraints imposed by the public service which make it difficult to dismiss personnel on the basis of incompetence or low output;

iii) the lack of incentives or promotion prospects for SEPU employees.

It is obvious that in its present form SEPU is totally uneconomic and a gross under-utilization of what are relatively sophisticated engineering and production resources was evident.

It is possible that the facilities could be used to upgrade the Ministry of Educational Services maintenance services, but the team feels that this would still be under-utilizing the resources. The approach most favoured by the team is to explore the possibility of leasing the facilities on perhaps a five year term to commercial enterprise with the functions of

a) centralised maintenance and repair of equipment on a cost effective basis

b) development of prototypes for apparatus to specification supplied by C.D.C.

c) the manufacture of science equipment

d) the manufacture of tools and equipment for technical subjects.

To these ends the successful leasee would be responsible for (a) the employment of appropriate staff and (b) the maintenance of all equipment in good order.

8.2.10. Conclusions from the Field Study regarding the Sciences

In the opinion of the evaluation team, improvement in the quality of science teaching and learning in Sri Lankan schools is dependent primarily upon changes in three areas:

(i) the organisational structure;

(ii) the quantity and functional quality of 'hand-on' science resources, particularly in the Junior Secondary grades 6 - 10;

(iii) the content of the examinations.

(i) Organisation: A teacher's role is superficially simple: to interpret a syllabus and communicate its contents, with understanding, to the students. In practice the science teacher is involved in the management of a multiplicity of resources which are essential aids to the full mastery of the role.

Without a clearly defined managerial framework within which responsibilities are specified and assigned, resources will not be maintained, renewed or enlarged.

(ii) Science Resources Much has been written in this report (and in stated course objectives) of the need to give students the experience of being scientists - of "sciencing".

Without sufficient equipment and consumable resources to enable students to experience the intellectual excitement of hands-on scientific investigations, this objective is beyond reach. The team feels very strongly that "sciencing" is not dependent upon the appearance or conventionality of the practical resources employed, only on their functional quality - a plastic cup will hold water for an experiment as efficiently as a glass beaker

and at a small fraction of the cost.

The development and introduction of ultra low cost science kits drawing upon local materials and mass produced everyday items presents a challenge to the ingenuity of teachers and curriculum developers which can breathe new life into the science teaching profession.

In the experience of one member of this team, meeting that challenge not only makes the attainment of widespread practical work feasible, but moves the science clear of the sometimes complicating clutter of elaborate apparatus, making the concepts taught more easily understood.

(iii) Examinations Another definition of a teacher's role might be: to teach the syllabus so that the students achieve a 'fit' between the syllabus and the examination.

If recognition of the active and participatory element of school science is to be won from teacher and student then the content and emphasis of the G.C.E. Integrated Science Examination must be modified. Changes in that examination will create the pressures required to induce reorientation and a new 'fit'.

Other supporting factors such as improvements in the quality of inservice and pre-service teacher training, and increased discretionary funding to schools are important but will have little long term effect without the changes which will:

- create a professional framework for school science management,
- provide the resources for closing the gap between declared course objectives and classroom realities
- cause a shift in emphasis towards the testing of scientific aptitudes as well as knowledge.

9. THE LIFE SKILLS SUBJECT

In the "White Paper" it is proposed that a new subject "Life Skill" will be introduced on the Junior Secondary level. The main objectives are stated in part 4 of this report.
In regard to Junior Secondary level the "White Paper" gives clear indications that the concept of Life Skill will continue:

"The emphasis on life skills will continue at this stage as well, with some degree of specialisation provided for through a suitable array of optional technical subjects such as Wood work, Metalwork, Agriculture, Home Science etc. In view of the availability of a G.C.E. Technical stream under the Technical Education Authoroties (TEA) for those seeking early vocational training, orientation in life skills will receive emphasis in schools. Technical subjects will be considered as part of general education, the principle being that general education properly administed can provide the background training for vocations with the added advantage of facilitating adaptation to changing circumstances. However, it is considered necessary to focus the pupil's interest on the 'world of work' while developing the general skills, interests, competencies and personal qualities that are most in demand in the job market".

With the purpose of assisting the Government in the introduction of "Life Skill" UNDP/UNESCO started a project 'Quality Improvement of General Education'.

9.1. UNDP/UNESCO Project for Quality Improvement of General Education

The project started in May 1982 and is focussed on the following areas:

i) introducing a new subject entitled Life Skills in the Junior Secondary School.

ii) preparing guidelines for the teaching of technical subjects in the Senior Secondary School.

iii) revising curricular material in science and mathematics.

The project will also set up a central workshop for the production of teaching aids.

To date the project is monitoring a Pilot scheme where the new curriculum concerning Life Skills is introduced

into 300 schools.

The project has prepared a list of "Learning Events". The production of teaching aids in the form of teacher's guides in Sinhala is going on.

The project has its own training centre provided by the government, where inservice training of teachers for the pilot scheme is near completion. Then 1130 teachers will have been trained for 4 days in Life Skills.

The project has provided equipment for the 300 pilot schools where necessary.

A tripartite review with participation from UNDP, UNESCO and the government is scheduled for August, 1984.

Appendix 1

17 February 1984

TERMS OF REFERENCE FOR A REVIEW OF THE SWEDISH SUPPORT TO SCIENCE AND PRACTICAL SUBJECTS, MINISTRY OF EDUCATION PROGRAMME, SRI LANKA.

1. Background

SIDA has since 1977 provided funds for procurement of equipment for practical subjects at secondary level - home economics, handicraft, wood work, agriculture etc. - and science subjects. The purpose of the support is to strengthen the non-academic subjects and to develop pre-vocational skills.

Most of the equipment is purchased locally by the Ministry of Educational Services which also distributes it. Funds are also allocated to the Regional Education Offices for purchase and distribution.

At the annual consultations between SIDA and the Ministry of Education in March 1983, it was agreed to make a review of the support.

2. Purpose of the Mission

The mission shall make an evaluation of the ongoing programmes. There is a double purpose of the study. Firstly, issues and problems related to pedagogical aspects, and the linkage between the existing curriculum and the usage of the equipment should be examined.

Secondly the mission shall look into the purchase, distribution and maintenance of the equipment.

3. Duties

The main duties for the consultants are:

- to describe and review the administrative set-up at the central level - the Ministry of Education (Including the Curriculum Development Centre) and the Ministry of Educational Services, - the regional level - the Regional Education Offices - and the local level - the school in regard to practical and science subjects.

- to give a description of the curricula and syllabus for the two subject areas including linkages to the equipment.

- to describe and review the training given in the teacher training colleges and in in-service training courses to teachers of the relevant subjects.

- to collect data and describe to what extent the practical subjects and science have been introduced - number of schools, students.

- to describe and review how the equipment is used in regard to frequency, the various levels, etc.

- to describe and analyse the administrative routines for purchase distribution and maintenance of the equipment.

- to give recommendations in regard to the utilization of the Swedish support based on the findings.

4. Members of the Mission

The mission will comprise Mr Alan Dock, B.Sc., Graduate Certificate in Education, Diploma in Education, Lecturer in Science Education, Project Leader Zimbabwe Integrated Science. Low Cost Project, and Mr Soren Salomonson, B.A. (Educational Planning), Teacher Certificate in Vocational Training, ILO expert in Skill Development Project.

5. Implementation

The work will be carried out during 19 March - 6 April, 1984. The missions shall work in close contact with the Ministry of Education and shall, for studying of the actual school situation, concentrate the work in two different districts (Kandy and Matara) and a minimum of eight secondary schools. The mission shall also have discussions with the UNDP supported Life-Skills project and should visit the pilot projects.

A draft summary report in English, presenting findings and recommendations shall be presented to the Ministry of Education at the end of the mission.

The final report to SIDA should be ready not later than 30 April 1984, in such a format that it can be used directly for printing.

6. Costs

The costs for the mission will be met with funds under the Specific Agreement on Development of Education.

Appendix 2

Institutions Visited

Ministry of Education
Ministry of Educational Services
Curriculum Development Centre

Schools in Kandy Region

Ambatenna M.V.
Dharmarajah M.V.
Kingswood College
Keppetipola Vidyalaya
Mahanama
Paranagama
Pushpadana
Walala Central College
Wattegama

Schools in Matara Region

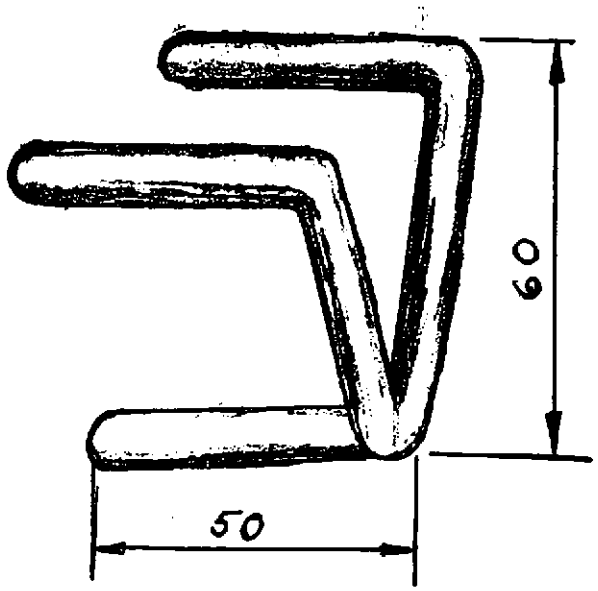
Dickwella M.M.V.
Galpamuna K.V.
Morawaka M.V.
Rahula M.V.
Siddhartha M.M.V.
Sri Sumangala Balika M.M.V.
Sujatha Balika M.V.
Telijjawila M.M.V.

Teacher Training Colleges visited

Maharagama T.T.C.
Naiwela T.C.
Pattalagedera T.T.C.
Unawatuna T.T.C.

SEPU, Pattalagedera

Vidya Silpa, Manufacturers and suppliers of Laboratory Science Equipment.



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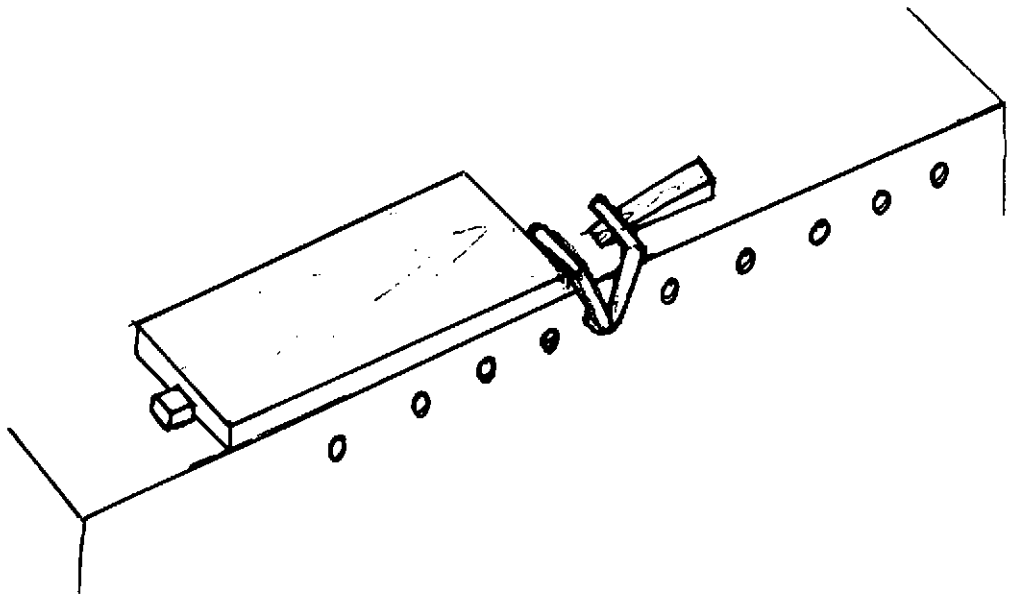


Appendix 4

PURCHASE OF EQUIPMENT UTILIZING SIDA AID - 1983.

Handicraft Equipment

Kit B	32	14 813.90	474 044.80
Standard version planing machine	32	43 225.76	1 383 224.30
4 Drawer Cabinet	32	1 548.00	49 536.00
Steel Cupboard	32	1 472.00	47 104.00
			1 953 909.10

Home Science

Kit A	210 x 6025/=	1 265 250/=
Kit B	210 x 870/=	182 700/=
Kit C	210 x 520/=	109 200/=
Kit D	210 x 480/=	100 800/=
Iron Beds	210 x 1510/=	317 100/=
Mattresses	210 x 295/=	61 950/=
Electric Plugs	22 x 5/=	110/=
Lamp with Chimney	22 x 60/=	1 320/=
		2 038 430/=

Agriculture

Kit A	210 x 4550/=	910 000/=
Kit B	75 x 11223/=	841 725/=
		1 751 725/=

Schedule "A"

Handicraft Equipment

	Kit B Containing the Following items	Quantity
1.	10 mm single speed drill type 101F	01
2.	10 mm single speed drill type D 52	01
3.	10 mm Hammer drill type H 501/H40	01
4.	Drill Stand type GD 80	01
5.	Angle Grinder 4½" type SAG/550	01
6.	Bench Grinder 5" type 7909	01
7.	Finishing Sander light duty type 5550	01
8.	Planner 75 mm type D750	01
9.	Single speed Jig Saw type DN 751	01
10.	5 AMP Plug Base and Top	09
11.	15 AMP Plug Base and Top	02
12.	30 AMP Trip Switch	01

Schedule "B"

Home Science Equipment

Serial No.	Description	Quantity
	Kit (A) containing the following items	
1	Kerosene cooker 2 burner table model side bottle	01
2	Oven for single burner cooker 14" x 14" with heat indicator	01
3	Set of aluminium saucepans with lids and handles local sizes 6", 7", 8", set of 3	01
4.	Steamer with fitting saucepan alum. 7" diam.	01
5	Saucepan with lid and handle stainless steel 7" diameter	01
6	Household scale table model 10 lbs or 5 kg.	01
7	Deep frying pan local 8" diam.	01
8	Shallow frying pan alum. with a single handle 20 cm diam.	01
9	Kitchen tools set 5 pieces stainless steel 20 cm.	05
10	Kitchen knives stainless steel blade 16 cm. 18 cm. 20 cm. set of 3	03
11	Enamel bowl 10" diam.	01
12	Enamel bowl 6" diam.	01
13	Enamel plate 10" diam.	01
14	Coconut scraper with ball bearings table model	01
15	String hopper mould wooden	01
16	String hopper mats cane, small size 06 nos.	06
17	Serving spoons, stainless steel 6 pieces	06
18	Table spoons 6 pieces	06
19	Table forks 6 pieces	06
20	Table knives 6 pieces	06
21	Tea spoons	01
22	Metal tray 44 cm x 32 cm	01
23	Food cover bylon rectangular 24" x 18"	01
24	Coconut strainer plastic 7½" diam.	01
25	Wooden spoons length 10"	01
26	Wooden spoons length 12"	01
27	Kettle alum. 2 pints	01
28	Grater 8" x 4" stainless steel	01
29	Mixer, electrically operated	01
30	Drinking glasses ½pint set of 6	06

Serial No.	Description	Quantity
	Kit (B) containing the following items	
1	Electric iron heat control	01
2	Ironing board stell	01
3	Basins 14" diam. alum.	03
4	Buckets plastic or galvanised medium size	02
	Kit (C) containing the following items	
1	Baby doll plastic 20"	01
2	Baby bath plastic 30" diam.	01
3	Plastic pail (medium size)	02
4	Feeding bottle glass with valve	01
	Kit (D) containing the following items	
1	Ice bag - rubber	01
2	Hot water bottle (small size rubber)	01
3	Enamel jug 5 pints	01
4	Clinical thermometer	01

Schedule "C"

Agriculture Equipment

Serial No.	Description	Quantity
	Kit (A) containing the following items	
1	Mammoties 7" x 10" or 8" x 10"	10
2	Garden rakes 12 teeth or 14 teeth	02
3	Digging forks 4 prong	02
4	Hand forks 4 prong	03
5	Hand showels	03
6	Watering cans 2 gals. galvanized/plastic	03
7	GI II" galvanised buckets 2½ gals	02
8	Budding knives (local)	01
9	Pruning knife No. 8	01
10	Wheel barrow 2 x 5 x 2 rubber wheels	01
11	Secateur	01
12	Alvango (flat nose)3 3/4", 7/8"	01
13	Axe with handle 1 3/4 lbs	01
14	Hammer 1½ kilos	01
15	Hand saw 12"	01
16	Spring balance 100 kg.	01
17	Garden shear	01
18	Knapsack sprayer hand model automatic	01
	Kit (B) containing the following items	
1	Soil testing kit	01
2	Ph. meter	01
3	Specimen Jars 10"	20
4	Petri dishes 4"	01
5	Conical flasks - medium size	10
6	Hand lense - 8"	01

Summary: Integrated Science Syllabus

Grade 6

6-1	Examining the environment
6-2	Living organisms
6-3	Examining the soil
6-4	Changes in substances
6-5	Changes in nature
6-6	Building blocks in nature I
6-7	Plant propagation and food supply
6-8	Effects of heat on substances
6-9	Effect of solar radiation
6-10	Movement and force
6-11	Useful substances from the soil

Grade 7

7-1	Interaction
7-2	Digestion absorption of food
7-3	Simplifying work
7-4	Building blocks in nature II
7-5	Electricity
7-6	Transmission of light (Further study)

Grade 8

8-1	Liquid and gas pressure
8-2	Solubility and transport in Animals
8-3	Formation of new substances
8-4	Building blocks in nature III
8-5	Work and Energy
8-6	Excretion of Water Balance in Animals
8-7	Instruments that use light
8-8	Patterns and generalisation

Grade 9

9-1	Force and Movement
9-2	Food manufacture in plants
9-3	Building blocks in nature 1V
9-4	Electricity
9-5	Changes and factors affecting them
9-6	Co-ordination and movement in animals
9-7	Continuation of Life
9-8	Interdependence of organisms
9-9	Cycles in nature

SUMMARY OF PROPOSED GRADE 6 - 11 SYLLABUS FOR INTEGRATED SCIENCE

Appendix 6

Year 6

6-1	Exploring the kitchen
6-2	Dissolving substances
6-3	Heating things collected from the neighbourhoo
6-4	Measuring things
6-5	Exploring the living world
6-6	Exploring the non-living world
6-7	The air around us
6-8	Some useful forms of energy
6-9	Science through toys
6-10	Observing the sky

Year 7

7-1	Food and living things
7-2	Preservation of food
7-3	Cleaning clothes and utensils
7-4	The air around us
7-5	Use of electricity
7-6	Water we need
7-7	Making work easy
7-8	Diversity of living things
7-9	Soil
7-10	Light
7-11	The sky we see

Year 8

8-1	Inter-relationships between man and his environment
8-2	Heat
8-3	Matter
8-4	Air
8-5	Force and its application
8-6	Density
8-7	Weather
8-8	Our food
8-9	Water
8-10	The sky
8-11	Light
8-12	Electricity and magnetism

Year 9

9-1	Diversity of living things
9-2	Air
9-3	Heat
9-4	Electricity
9-5	Soil
9-6	Water
9-7	Force, work and energy
9-8	Light

Year 9 (cont)

9-9	Synthesis and transport of food in plants
9-10	Digestion and absorption of food in animals
9-11	Transport in animals
9-12	Atoms and molecules
9-13	Simple machines

Year 10

10-1	The atom
10-2	Energy for life processes
10-3	Sound
10-4	Periodic table
10-5	Chemical bonding
10-6	Floatation
10-7	Patterns in the periodic table
10-8	Elimination of wastes
10-9	Heat
10-10	Acids, bases and salts
10-11	Balance in nature
10-12	Motion

Year 11

11-1	Balance in nature
11-2	Combustion
11-3	Co-ordination in living organisms
11-4	Air travel and space travel
11-5	Effects of electricity
11-6	Simple electronics
11-7	Activity series
11-8	Continuity of life
11-9	Work and energy
11-10	Generation of electricity

Appendix 7

STANDARD LIST OF SCIENCE EQUIPMENT

REVISED - 1982

PERMANENT

Grade 6 - 10

Ammeter 0-5A	3
Amplifier	1
Air Pump - bicycle	1
Atomic Model - set	1
Balance - Chemical	2
Balance Spring 100 gm.	3
Balance Spring 500 gm.	3
Balance Spring 1 kg.	3
Battery Charger	1
Battery - Solar 6V	2
Barometer - fortins	1
Bell Electric	1
Blow Lamp	1
Boat Model (Air chamber)	1
Box of Weights (without small weights)	2
Calorimeter Copper with jacket	2
Circuit board	6
Compass pocket	5
Cork borer - set	1
Cork borer - sharpner	1
Cells Daniel	1
Cells Nife	4
Clock stop	5

PERMANENT

	6 - 10
Dissecting set - small scissors, large scissors, scalpels, fine forceps.	1
Dynamo - model	1
Earphones - magnetic - high impedence	2
Galvonometer moving coil central zero	2
Holder - Lens	10
Holder Test Tube	12
Hygrometer wet and dry, bulb	1
Loud speaker	2
Magnet - Bar	6
Magnet - Horse Shoe	2
Micrometer screw gauge	1
Microscope - 2 eye piece 3 objective x 600	2
Motor - electric - model	1
Pendulum bob	2
Pulleys - single	4
Pulleys system of 3	1
Pulleys system of 4	1
Rules ½ meter	5
Rules 1 meter	5
Rheostat	5
Resistance coils - set of 13	2
Rods ebonite	2
Spherometer	1
Stroboscope - hand	1

PERMANENT

	6 - 10
Stand - Test Tube	10
Stand Iron, with clamp and bosshead	10
Stand wood - burette and funnel	5
Stoves pressure - kerosene - 1 pt	3
Spoons Deflagrating	5
Tapes measuring	1
Trays - dissecting	2
Tuning forks, known frequency set of 8	1
Trolleys	4
Telescope	1
Tool Kit - Screw drivers, hammer, hand saw, snipper shears, triangular file, chisel, plier, soldering iron 30W	1
Voltmeter - centre zero 0-5V	5
Vernier calliper	1
Vibrator	2
Watch - stop	2
Weights slotted - set of	1

PERISHABLES

	6 - 10
Barometer tubes	2
Brushes - 10-32 mm	8
Carborundum oil stone	1
Charcoal blocks	6
Cork Bark assorted	8 doz
Cork rubber assorted	4 doz
Cover clips pkts.	1
Clips - crocodile	15
Clips mohr	5
Clips screw	5
Clay triangles	10
Diodes (OA 70 or 71)	5
Electrolyte - Nife cell in tins	5
Filter paper pkts.	10
Glass rods	2 kg.
Litmus paper - Red books	5
Litmus paper - blue books	5
Pins - drawing	2 gr.
Paraffin wax	1 kg.
PH indicator - books	6
Slides - glass	2 doz.
Tubes - Glass assorted	3 kg.
Tubes - Rubber	5 m.
Tubes - Boiling	½ gm.
Tubes - Ignition soda glass	1 gr.
Test Tubes	1 gr.

PERISHABLES

	6 - 10
Wire - copper 32 SWG	300 g
Wire - copper 18 SWG	300 g
Wire - Platinum	6 "
Wire - Nichrome 26 SWG	200 g
Wire - Manganin 26 SWG	100 g

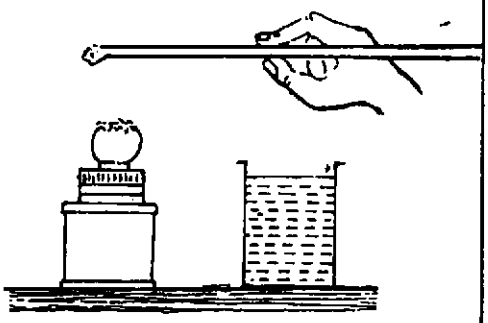
GLASSWARE

	6 - 10
Beaker - 50 ml	5
Beaker - 100 ml	10
Beaker - 250 ml	10
Beaker - 500 ml	10
Beaker - 1000 ml	5
Beehive shelves	2
Bottles Reagent 250 ml	12
Bottles weighing	3
Bottles specific gravity 25 ml	5
Bottles dropping 30 cc	8
Burettes 50 ml	5
Blocks glass rectangular	5
Bell Jar	1
Cylinders - measuring 100 ml	5
Cylinders - measuring 500 ml	5
Cobalt glass	6
Condenser - Liebig	1
Crucible with lid	6
Clock-glass	8
Desiccator 8"	1
Dishes - Evaporating	10
Electroscope - Gold Leaf	1
Jars - gas 8" x 2"	5
Flask - conical 250 ml	6
Flasks - round bottom 250 ml	4
Flasks - round bottom 500 ml	4

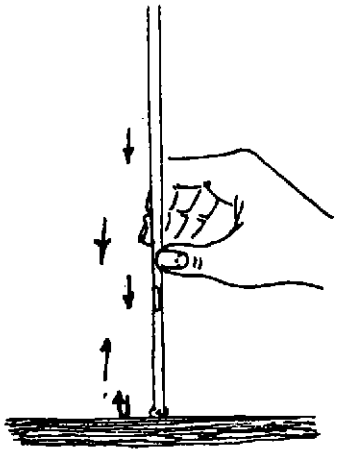
GLASSWARE

	6 - 10
Flasks - flat bottom 250 ml	6
Flasks - flat bottom 1000 ml	2
Funnels - 3"	3
Funnels - thistle	2
Lens - Concave - different focal lengths	10
Lens - convex - different long focal lengths	10
Lens - Hand x 10	5
Mirror - plane strips	8
Mirror - concave diff. focal	5
Mirror - convex - diff . focal	5
Mortar & Pestle small	6
Petri dishes	20
Pipette 25 ml	5
Prisms - 60 x 60 x 60	5
Spirit Lamp	6
Thermometer 0 - 110 C	8
Thermometer Clinical	4
Trough - glass	1
Trough - plastic	1
Tubes - T	4
Tubes - U	4
Tubes - Y	4
Tubes - Combustion	1
Tubes - J	4

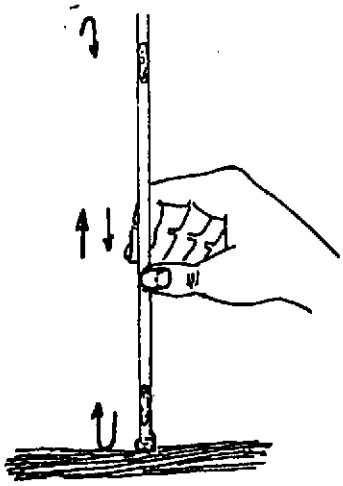
1. First you must close one end of each straw. Light your burner. Hold a straw in one hand. Wet the thumb and first finger of the other hand with water. Now hold the straw with the end about 5 cm above burner flame, turn it round while you count to three and quickly take it out and pinch the end closed with your wet finger and thumb.
   Check that it is closed properly by trying to blow through it with the closed end in your cup of water.
   Repeat with the second straw.



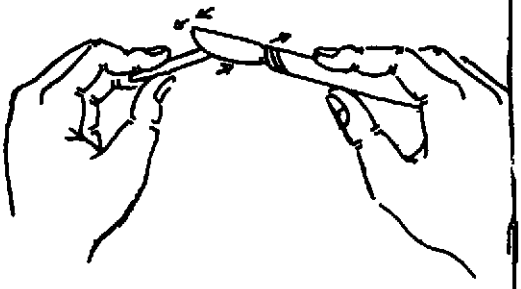
2. Roll up a piece of filter paper into a tube small enough to slide down the straw. Tap the straw to get the filter paper to the closed end or push it down with a piece of grass.
   Repeat for the second straw.



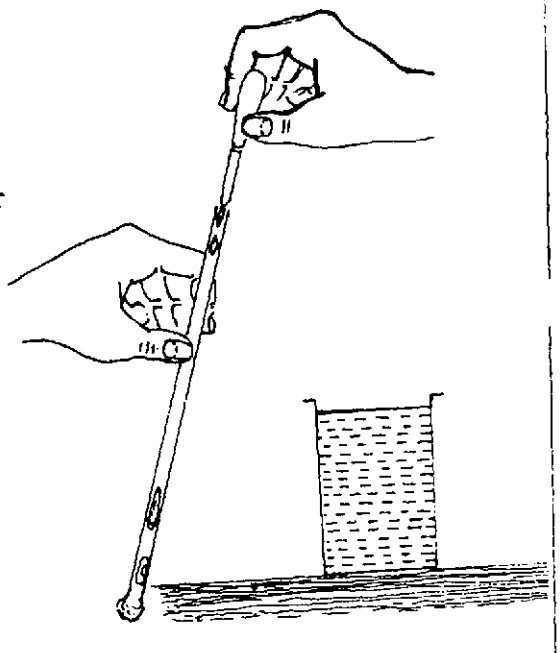
3. Twist and roll the steel wool and put it into the first straw. Tap it to get it to the closed end or use the piece of grass again.



4. Clean the magnesium by scraping it with a scalpel or razor blade until the surface is shiny.
   Put it into the second straw.

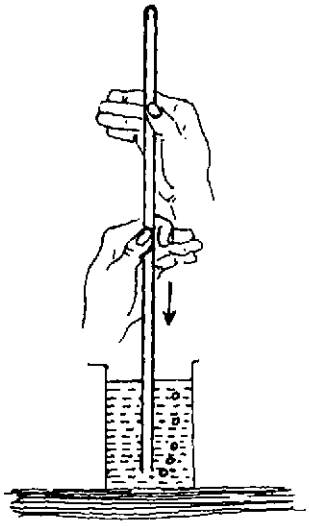


5. Drop 5 drops methylene blue indicator into each straw so that the filter paper is all wet. The blue colour should show clearly.

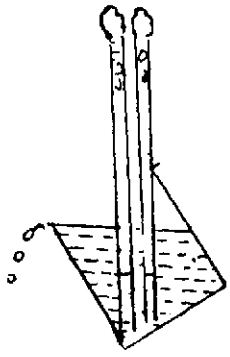


6. Put the straws into the plastic cup with the open end down.

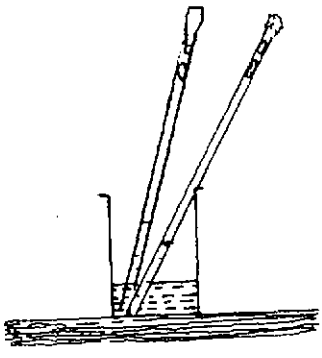
7. Squeeze some of the air out of each straw, by pinching the straw and moving your fingers down it while keeping the open end under water. The water will come in to take the place of the air you have squeezed out.



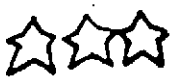
8. <u>Carefully</u> pour out <u>most</u> of the water from the cup so that the level of water in the straws is above the level of water in the cup.



9. Measure the length of the air space in each straw. Leave undisturbed for several days. Then answer Exercise 2.



When the steel wool was left in contact with the damp air, you observed rust on the surface of the steel. You also observed that about one fifth of the air was used up in the rusting. The filter paper changed from blue to white, which was the change of colour expected when the oxygen was taken away.
Therefore you can deduce that:



1. Rusting used up oxygen
2. The oxygen filled up one fifth of the air space.

The magnesium was not so easy to see. However, after several days you observed a black colour on the surface of the magnesium. It lost its shine. This is called TARNISHING. The process was very slow, so you could not observe all the oxygen being used up. You might have noticed a change in filter paper colour from blue to white. Therefore you could deduce that

3. Tarnishing used up oxygen.

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