

付属资料 4

Investment Master Plan Framework on Science and Mathematics Education
May 1996 MoEYS

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Royal Government
of Cambodia

Preliminary Discussion Document

Ministry of Education,
Youth and Sport

Investment Master Plan
Framework on
Science and Mathematics Education

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Foreword

Generating a regular flow well-qualified scientists and technologists is vital for Cambodia's sustained economic development and its competitiveness in regional and international markets. The Ministry of Education, Youth and Sport recognises that urgent improvement in all aspects of science and mathematics teaching in schools is therefore vital.

As a first step, MoEYS, through the PMMU and provincial education offices undertook a detailed needs assessment and survey in late 1995. The result was the publication of the *Science and Mathematics Education, Secondary Schools Survey*, which was circulated to MoEYS departments and the international community in April 1996.

This survey should be read as a companion volume to this Science and Mathematics Education Master Plan. The survey report provides detailed information on the qualifications and experience of the teaching force and the availability of teaching resources for these subjects.

The purpose of this preliminary discussion document, consisting of an indicative Master Plan is to stimulate further discussions about the way forward in investing in the upgrading of teaching in these subjects. The objective is to provide an initial framework for coordinating future investments. In particular, the Master Plan outlines areas of future work and research needed to refine and finalise the details.

This Master Plan should be also read in conjunction other Plans, such as the Textbook Master Plan, draft School Construction Master Plan and the upcoming Teacher Training Master Plan scheduled for late 1996.

In particular, I would like to take this opportunity to acknowledge the support of the Government of Japan in providing technical assistance to the PMMU to undertake this work. In addition, a word of thanks to Mr. Norio Kato, PMMU Adviser who design and coordinated both the survey and Master Plan development. A word of gratitude to MoEYS technical departments and provincial directors of education who assisted with data collection.

We look forward to receiving your comments on both the Survey and the discussion Master Plan document. The upcoming Science and Mathematics Education Conference, May 1996, hosted by MoEYS with Government of Japan's assistance, will provide an early opportunity to move developments forward.

Seng Kan
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I. Policy and Planning Framework

I-A. Situation Analysis

I-A1. An Overview

The Secondary Science and Mathematics Survey: Companion Volume In late 1995, the MoEYS carried out a comprehensive survey of the status of secondary Science and Mathematics teaching in Cambodia. This survey included an analysis of the qualifications and experience of teachers, instructional hours for these subjects, the availability of teaching materials, recurrent cost allocations for the teaching of these subjects and various aspects of program management and monitoring. *This Master Plan is underpinned by the Survey's qualitative and quantitative analysis which should be read as a companion volume.*

Variable Teachers' Qualification Systems: The qualification system for technical subjects (including Science and Mathematics) in lower secondary level is complicated and it seems non-standard as technical subject teacher, because the person who has taken a technical subject course is considered as a qualified teachers in the subject. As a result, many teachers have a several kind of qualifications. In the upper secondary level, much more specialty is required as a technical teachers. Therefore each teachers are basically handling one professional subject. *A key issue is to standardize the qualification required for deployment as a science /Mathematics teacher at various levels of the system in order to inform intake levels into different training institutions.*

Uncertain Teacher Training Quality: According to the new teacher training system, six RTTCs have a role to both pre-service and in-service training for lower secondary level and FOP has began to open a teacher training course for UPP graduates to be upper secondary teachers. However teaching forces in these training institutes especially science subjects are quite insufficient in quantity and quality. Some of institutes do not have their own staffs and many experienced staffs prefer to teach in other secondary schools because of poor teaching environments and incentives. *The key issues are to rationalise the roles of different teacher training institutions in Science/Mathematics teacher development and improve the quality of programs through various initiatives.*

Variable Education Background of Teachers: Many teachers are only lower secondary graduate holders (around 40%). Teachers those who had trained in the teacher training colleges are the second (30% in Biology, 26% in Chemistry, 31% in Mathematics, 28% in Physics). Only a low percentage of teachers are the graduates from University of Phnom Penh or the Faculty of Pedagogy. Particularly in secondary schools, the percentage of women science and Mathematics teachers is very low, which based on international experience, contributes to low enrolment of girls in these subjects. ***An urgent objective is to upgrade the quality and effectiveness of the current science and Mathematics teaching force, particularly at the upper secondary levels.***

Teaching & Learning Environment and Budgetary Support: Almost all schools do not have science rooms and equipment as well as poor general school infrastructure. The source of school budget depends on donations from PTAs, communities or school income generation program. However, allocations of budget to science/Mathematics subjects are quite limited (around 3%). Therefore a recurrent budgetary support system for maintaining science equipment and consumables provisions must be strengthened.

Improving the textbooks availability situation is critical; about 40% of schools do not have science and Mathematics textbooks in secondary schools. Where textbooks exist, only a small percentage of students are entitled to use them on a one book per student ratio. Availability of teacher manuals is much better than textbooks, nevertheless non-existence of manuals is reported in 36 schools. ***Taking account of projected primary and lower secondary textbook provision under the Textbook Master Plan, an immediate priority is provision of effective upper secondary textbooks. Assuring sustainability of textbooks and equipments supply is vital.***

Provincial Disparity: Provincial disparities are observed in all aspects of provision. Qualified teachers are concentrated on populated areas, while low qualified and inexperienced teachers are in the remote areas. Non-existence of textbooks are also reported in these remote areas (Kep, Koh Kong, Mondulhiri, Preah Vihear, Ratanakiri and Stung Treng). ***Equitable access and provision is an over-arching concern of this Master Plan.***

1-A2. Summary of Recommendations

This comprehensive situation analysis and quantitative survey conducted by MoEYS for science and mathematics education in secondary level (from November 1995 to January 1996) indicates that key thrusts of improving science and math teaching in primary and secondary schools include:

- The necessity of establishing teacher's qualification standards, long term teacher training programs and effective measures for science and Mathematics teaching force utilisation.
- Reduction of provincial disparities by the deployment of qualified teachers and increase incentives especially to remote areas, including affirmative action for recruitment of female teachers in these subjects.
- Appropriate design and implementation of programs using low cost science/math kits based on local materials
- Strengthening the overall learning and teaching environment for these subjects including adequate capital and recurrent financial provision.
- Reviewing and updating existing lower & upper secondary science/Mathematics curricula and textbooks to match to promote modern teaching methodologies

An over-arching concern is to ensure that Science and Mathematics education, as well as technology education, plays an important role for the promotion of national development. The knowledge, way of thinking and practical skills to be applied in real life through learning these subjects will be critical for national scientific human resource development. In addition, these skills will be useful to help individuals to lead a more productive life. The need to improve science and mathematics education is therefore central to long term national development.

1-A3. Need for Master Plan

Lack of Strategic Approach in the Sector: Since 1990, the Ministry of Education, Youth and Sports has designed and implemented many projects based in part on 'Investment Framework Education Sector 1995-2000' which mainly focused on basic education for reconstruction phase. However those programs are designed for various schools, without clear delineation of science and Mathematics requirement. The absence of a subject-specific comprehensive development plan for this subsector makes it difficult to strengthen the overall capacity of science and mathematics teaching.

To strengthen this subject-specific subsector, the Ministry recognises that some kind of strategic approach and plan over all school levels is required. This approach is consistent with MoEYS efforts to develop other investment master plans: 'Strategy Plan for Technical and Vocational Education and Training', 'Textbook Development Master Plan', have been completed for the implementation of projects in the sub-sector. A 'Teacher Training Master Plan' is now under discussion. A 'School Construction Master Plan' is at draft stage.

It should be noted that there will be some overlaps and duplications with proposed investments in other Master Plans. Nevertheless, this Master Plan is designed to provide a coherent, strategic and plan investment for particular donors within interests in supporting science and mathematics HRD and teaching.

Lack of Aid Coordinates: Individual small scale assistance in this sector are provided mainly by NGOs and some donors. Limited information and non-existence of an overall plan in this subsector causes difficulties in tackling needs by a strategic approach.

The Plan will also allows the Ministry to monitor and coordinate effective and efficient implementation of the Plan, including strengthening some management and monitoring structures as well as evaluation of each component.

I-B. Policy, Strategies and Objectives

I-B1. Policy Issues

Ministry recognizes that in order to improve the quality of education in science and mathematics, teacher training system development as well as curriculum reform, material provision and staff development are necessary. The Ministry recognizes that further detailed policy and strategies development to inform this overall plan will be necessary. Key issues and program components for policy and strategy framework development are outlined are described Program 1A.

Much more survey works (eg, resource studies, procurement system for science materials) will be required for the effective refinement and development of this Master Plan. It will also be necessary to discuss and review the Plan other MoEYS departments with the Teacher Training Master Plan. The Science and Mathematics Education Conference, hosted by MoEYS, is designed to provide a first opportunity to plan the ways forward on refining and finalising the Plan.

I-B2. Strategy

In order to implement the Plan and the various projects, the Ministry recognises the need to initiate a fundamental short to medium term priority project as a nucleus at both central and provincial levels. This project will act as the seed for both promoting and acting as the centre of development in this subsector. The Ministry recognises the value of using a *model school approach* so that initial improvements of science and mathematics and many other technical programs and training can be disseminated outwards.

The Ministry also recognises to strengthen this model school approach effectively, a National Centre for Science and Mathematics Education (NCSME) is essential. This Centre will function not only as the leading institute to upgrade quality of teachers but as a development centre for new science and mathematic pedagogical skills and resource development. The Ministry seeks assistance to develop this centre see Program 6.

The Ministry has already begun to work existing teacher training system reform both in-service and pre-service as a teacher training master plan, Faculty of Pedagogy and some selective RTTCs or PTTCs will be expected to play an important role as national level or provincial level. The new centre will be integral part of this network (see Programs 2 and 3).

In the medium and long term, curriculum and textbooks revisions appropriate for the science/mathematics education system will be required. The Ministry is already committed to carry out these reforms in the Textbook Master Plan for Basic Education. However, much more technical discussion at the upper secondary level is necessary (see Program 4).

The Ministry recognises the critical infrastructure situation in science, including non-existence of science equipment as well as laboratory rooms, which must be improved. As a first step, Ministry proposes to implement selective refurbishment and construction of multi-purpose laboratory rooms to the model schools. For that purpose, Ministry will formulate standard design of laboratory rooms and necessity equipment list suitable for Cambodian setting.

The Ministry survey noted that strengthening of financial resources for operations to introduce effective laboratory teaching. Various financing measures at both central and local levels will be examined for the sustaining of the program.

I-B3. Target by Year 2002

Over the Plan period, the Ministry's targets are as follows:

- a) Resource persons in each cluster school in primary level will be trained in PTTCs (around 400 teachers in Mathematics, 400 teachers in Science).
- b) Around 240 graduate mathematics teachers and 120 to 140 science teachers will be generated from per-service institutions to cope with increasing number of students at secondary level.
- c) All teachers in model lower(around 400) secondary schools will be trained in RTTCs and upper secondary teachers(around 400) in model schools will be also trained in National Centre at Faculty of Pedagogy.
- d) Science and Mathematics Inspectors (92 persons, 23 persons for each four subjects) will be trained in National Centre and they will play an important role to conduct mobile training to other schools in cooperation with model schools.
- e) All lecturers and trainers in teacher training institutes will be trained through the technical assistance either locally or overseas study.
- f) New curriculum and textbook development suitable for practical teaching
- g) Multi-purpose laboratory rooms and science equipment & mathematics kits will be provided to all lower, upper model secondary schools and PTTCs.
- h) Science laboratory rooms and equipment will be provided to all RTTCs.
- i) National Centre for Science and Mathematics Education (**NCSME**) will be established. NCSME will play an important role not only for teacher training but for strengthen other functions such as pedagogical research, science & mathematics teaching material development.

I-C. Summary of Programme

List of Components

Program 1. Strengthen Planning Strategies

- 1-A. Capacity building for Science & Mathematics Planning & Financing

Program 2. Upgrading Pre-service Teacher Training Institutions

- 2-A. Primary School Teacher Development
- 2-B. Lower Secondary School Teacher Development
- 2-C. Upper Secondary School Teacher Development

Program 3. Strengthen In-service Training Provision

- 3-A. Primary School
- 3-B. Lower Secondary School
- 3-C. Upper Secondary School

Program 4. Curriculum & Textbook Development

- 4-A. Supplementary Science and Mathematics Provision at Primary School
- 4-B. Supplementary Science/Maths Provision at Lower Secondary School
- 4-C. Core Science and Mathematics Provision at the Upper Secondary School

Program 5. School Facility Upgrading

- 5-A. Resource Center in Primary Cluster School
- 5-B. Model Science/Maths School at Lower Secondary School
- 5-C. Model Science/Maths School at Upper Secondary School
- 5-D. Development of Science & Mathematics Kit for Other Schools

Program 6. Establishment & Upgrading Teacher Training Institutes for Science and Mathematics

- 6-A. Establishing a National Center for Science and Mathematics Education
- 6-B. Upgrading RTTCs for Lower Secondary Teacher Training
- 6-C. Upgrading PTTCs for Primary teacher Training

Program 7. Strengthening Management & Monitoring

- 7-A. Strengthen PMMU Capacity
- 7-B. Strengthening Procurement Systems

I-D. Financing Plan

(US\$'1000's)

List of Components	Project Cost	1997	1998	1999	2000	2001
<i>Program 1. Strengthen Planning Strategies</i>						
1-A. Capacity building for S&M Planning & Financing	240	120	120	0	0	0
<i>Program 2. Upgrading Pre-service Teacher Training Institutions</i>						
2-A. Primary School Teacher Development	250	50	50	50	50	50
2-B. Lower Sec. School Teacher Develop.	100	20	20	20	20	20
2-C. Upper Sec. School Teacher Develop.	50	10	10	10	10	10
<i>Program 3. Strengthen In-service Training Provision</i>						
3-A. Primary School	2250	450	450	450	450	450
3-B. Lower Secondary School	300	60	60	60	60	60
3-C. Upper Secondary School	150	30	30	30	30	30
<i>Program 4. Curriculum & Textbook Development</i>						
4-A. Supple. S&M Provision at Pri. School	4800	960	960	960	960	960
4-B. Supple. S&M Provision at LSS	960	0	0	320	320	320
4-C. Core S&M Provision at USS	2600	0	0	800	800	1000
<i>Program 5. School Facility Upgrading</i>						
5-A. Resource Center in Primary Cluster School	3000	600	600	600	600	600
5-B. Model S&M School at LS Level	550	0	0	183.33	183	184
5-C. Model S&M School at USS Level	690	0	0	230	230	230
5-D. Development of Science & Math. Kit for other schools	820	0	0	273.33	273	274
<i>Program 6. Establishment & upgrading Teacher Training Institutes for Science and Mathematics</i>						
6-A. Establishing a National Center for Science and Mathematics	5000	120	4000	640	120	120
6-B. Upgrading RTTCs for Lower Sec. Teacher Training	120	0	30	30	30	30
6-C. Upgrading PTTCs for Primary Teacher Training	440	0	110	110	110	110
<i>Program 7. Strengthening Management & Monitoring</i>						
7-A. Strengthening PMMU Capacity	600	120	120	120	120	120
7-B. Strengthening Procurement System	400	200	100	50	50	0
TOTAL	23,320					

I-E. Management , Monitoring and Evaluation

I-E1. Establishment of Effective Plan Management System

Components of the program in science and mathematics spread over many tasks of departments. For the effective implementation of projects, each department and institute should have tight cooperation for every components.

Establishment of a National Centre for Science and Mathematics Education (NCSME) board is one of the options. The discussions in this board will be both technical and policy & implementation matters. PMMU will play a lead role in supporting this board in plan management.

The discussions at the board will be wide-ranging, such as accreditation system of teacher training institutes, national standards for science rooms and equipment, in-service training systems and procurement systems for chemicals and equipment, etc.

I-E2. Monitoring and Evaluation Function

In order to make every project successful, the Ministry recognises effective monitoring and evaluation at each project stage will be necessary. By the nature of this program, monitoring will be carried out following three level: central level, provincial level and inter-institutional level.

At both central and provincial levels, PMMU and PAMO will take overall responsibility for Plan monitoring and evaluation in consultation with technical departments. The NCSME Board will take in charge of day-to-day progress monitoring, especially at the school/inter-institutional level.

II. The Investment Program

Program 1: Strengthen Planning Strategies (US\$ 0.24 mil.)

1-A. Capacity building for Science & Mathematics Planning and Financing (US\$ 0.24 mil.)

In order to make an effective and efficient plan, involvement of science and mathematics personnel is necessary. However, external assistance is required in the short term to establish appropriate strategy and promote capacity building and resource personnel development. At the same time, strengthen financial resource and management capacity for the subjects will be required for the sustainable management in school level.

This Program will include staff development needs assessments and plans, including requirements for procurement system development and production of low cost science/ maths kits. These planning studies are scheduled late 1996 until late 1997.

Program 2: Upgrading Pre-Service Teacher Training Institutions (US\$ 0.40 mil.)

2-A. Primary School Teacher Development (US\$ 0.25 mil.)

Through increases of student pupil's population, more teachers will be required. Assignment of qualified teacher trainers to PTTCs that should have responsibility for pre-/ in-service science and maths teacher training for primary school will be necessary. Selective deployment of UPP graduates may be considered to upgrade teacher educators capacity at primary level in these subjects.

2-B. Lower Secondary School Teacher Development (US\$ 0.10 mil.)

Student teachers ratio at this level is quite low (around 18 students per teacher). Therefore much more rationalization is anticipated for effective use of Cambodian resources for science and maths teaching. To cope with increase number of students, minimum number of new teachers will be recruited through RTTCs. It is necessary to recruit qualified teacher trainers in science/maths subject in RTTCs which have many vacant posts.

2-C. Upper Secondary School Teacher Development (US\$ 0.05 mil.)

Faculty of Pedagogy has started to train UPP graduates as upper secondary teachers. However too many trainees could cause supply and demand problem in the near future. Institutional based training based on students/teachers forward projections as well as quality improvement for FOP staff will be necessary.

Program 3: Strengthening In-Service Training Provision (US\$ 2.65 mil.)

In the field of science and mathematics, further knowledge and capability for creativity are required, especially at the secondary level. In order to acquire these capabilities, continuous in-service training for existing teachers during summer vacation will be necessary. Some alternative courses such as Long term training for technical inspectors, medium or short term courses will be offered in accordance with qualification of teachers.

3-A. Primary School (US\$ 2.25 mil.)

All teachers will be retrained through cluster school systems. Some of teachers who should be a key resource person will be trained in PTTCs.

3-B. Lower Secondary School (US\$ 0.30 mil.)

As a short and medium term objective, in-service training for model school teachers will be emphasized. Mobile training in other secondary schools will be conducted by model school teachers and technical inspectors.

3-C. Upper Secondary School (US\$ 0.15 mil.)

As a short and medium term objective, in-service training for model school teachers will be emphasized. Long term training will be offered some resource teachers who can be a supervisor in provincial level. Mobile training to other schools will be conducted by model school teachers and technical inspectors.

Program 4: Curriculum and Textbook Development (US\$ 8.36 mil.)

The Textbook Development Master Plan indicated that the necessity of distribution of textbook to each pupil/student by year 2000. However as development of programs in science and mathematics, further revision of both curriculum and textbooks will be required, especially at the secondary level. In addition, an evaluation system of the impact of textbook on pupils/students achievement must be upgraded.

**4-A. Supplementary Science/Maths Provision at Primary Schools
(US\$ 4.80 mil.)**

Expansion of an integrated approach will be emphasized in lower grade. Further curriculum reform will be necessary based on daily life focus. Curriculum analysis both in rural and urban level is recommended. Numeracy and analytic attitude to improve daily life focus are important to further curriculum/textbook reform. The Program includes technical assistance and selective supplementary materials to schools.

**4-B. Supplementary Science/Maths Provision at Lower Secondary School
(US\$ 0.96 mil.)**

In order to improve analytic ability, sectoral approach will be gradually emphasized in this level. It is also important to deal with daily phenomenon so that students could have an attitude to find out better ways to improve daily life through scientific methodology. The Program includes technical assistance and selective supplementary materials to schools.

**4-C. Core Science/Maths Provision at the Upper Secondary School
(US\$ 2.60 mil.)**

This is a first step to improve their ability from concrete thinking way to abstraction thinking way. And more analytic process will be emphasized. The Program will include a curriculum textbook development TA for grades 10-12, alongside support for the production and distribution of books to schools.

Program 5: School Facility Upgrading (US\$ 5.10 mil.)

For the effective use of limited resource, resource centre approach or model school approach are recommended. Each resource centre or model school will be equipped with enough resources to provide science/maths teaching resources on a rental basis to neighbouring schools. NCSME or teacher training colleges will support both supply system development through technical assistance.

5-A. Resource Centre in Primary Cluster School (US\$ 3.0 mil.)

Each clusters have their own resource centre. Each school can borrow science and mathematics materials from resource centres. The Program includes provision of low cost science/maths kits for rental, and technical assistance for rental system development and training of resource centre managers.

5-B. Model Science/Maths School at Lower Secondary Level (US\$ 0.55 mil.)

Multi-purpose laboratory and science equipment will be provided to the model schools after in-service teacher training is carried out. Qualified teachers will distribute science/maths kits to other schools in the course of conducting seminar through mobile training system. The Program includes kits provision and training workshop costs.

5-C. Model Science/Maths Schools at Upper Secondary Level (US\$ 0.69 mil.)

Multi-purpose laboratory and science equipment will be provided to the model schools after in-service teacher training is carried out. The model school will also play a role as a resource centre in the provinces. Qualified teachers will distribute science kits to other schools in conducting seminar through mobile training.

**5-D. Development of Science & Mathematics Kits for Other Schools
(US\$ 0.82 mil.)**

Appropriate kits will be developed in NCSME, teacher training colleges and resource centres. All of information will be based in the National Centre. The Program includes TA for kit development and distribution of trial kits to Teacher Training Institutions.

**Program 6: Establishment and Upgrading Teacher Training
Institute for Science and Mathematics (US\$ 5.56 mil.)**

Reconstruction of science/maths teacher training facility will be one of the key factors in upgrading teachers to greater professional level. NCSME as a centre of excellence, will play a central role in promoting nationwide quality improvement in the subsector.

**6-A. Establishing a National Centre for Science and Mathematic Education
(US\$ 5.00 mil.)**

A National Centre for Science and Mathematics Education will be established in the annex of Faculty of Pedagogy. Technical assistance will be necessary to promote capability of this Faculty so that training functions and research capabilities can be enhanced. The Program includes selective rehabilitation of plant, equipment for model laboratories, and technical assistance for staff and teaching resource development.

**6-B. Upgrading RTTCs for Lower Secondary Teacher Training
(US\$ 0.12 mil.)**

Science laboratory and equipment as well as technical support by national centre will be arranged. All trainers will have a chance to receive a in-service training at the National Centre. The Program will include equipment provision and technical assistance for RTTC tutor development.

6-C. Upgrading PTTCs for Primary Teacher Training (US\$ 0.44 mil.)

Multipurpose laboratory rooms and science equipments will be provided through RTTCs. Technical training will be conducted at the National Centre. The Program will include selective plant rehabilitation, provision of teaching materials and staff development.

Program 7: Strengthening Management and Monitoring
(US\$ 1.00 mil.)

7-A. Strengthening PMMU Capacity (US\$ 0.60 mil.)

In order to ensure optimum Plan aid management and monitoring, PMMU capacity to undertake this task will be strengthened. The Program consists of short term TA to help develop Plan performance monitoring indicators (eg. output of trained teachers, etc.) and training of PMMU and MoEYS technical staff in BME techniques. Training beneficiaries will include NCSME staff responsible for field data collection and progress monitoring.

7-B Strengthening Procurement Systems (US\$ 0.40 mil.)

A key objective is to establish cost effective science/maths equipment procurement and contract management system within MoEYS. The capacity will be located in either a central MoEYS department or at NCSME. Technical assistance will be provided for system development and training.

