Chapter 6

Implementation Strategies

Schedule of Implementation of the Mathematics Curriculum at the Primary and Secondary Levels

6.1 Both the primary and secondary mathematics syllabuses were under revision when the Ad hoc Committee was established in 1997. According to the original work plan, the two revised syllabuses would be finalized in mid-1999 and implemented in September 2001. Since we planned to submit our review report in late 1999, the schedule of implementation was re-adjusted to incorporate our recommendations.

The Revised Primary Mathematics Syllabus

6.2 Currently most primary schools are implementing the TOC PoS for Mathematics Key Stages 1 and 2 (1995) with reference to the Primary Mathematics Syllabus (1983). As the Syllabus (1983) was only slightly adjusted during the writing of PoS, some topics were considered out-dated (such as the technique on the computation of large numbers is phased out as calculators can be used instead). The need for revision to meet societal needs was obvious. Furthermore, as teachers have to refer to the PoS and the Syllabus (1983) simultaneously for details of learning targets, teaching content and strategies of individual topics, revising the primary mathematics syllabus to produce a unified syllabus document will certainly be welcomed by teachers.

6.3 In 1995, the Primary Mathematics Syllabus was reviewed and revised to incorporate the TOC elements contained in the PoS to form a revised syllabus. In mid-1997, a revised syllabus framework was developed and issued for public consultation. The proposal was well received by the teachers. It was originally planned to finalize the revised syllabus by mid-1999 and implement in P.1 in September 2001. The implementation date is chosen because by that time, most primary schools will have completed the TOC mathematics programme for a 6-year cycle.

6.4 To avoid the mismatch in work schedule with the holistic review, the finalization of the revised Primary Mathematics Syllabus is re-scheduled to August 2000. In this way, our recommendations could be properly considered and incorporated in the revised syllabus. The arrangement will also allow time for the CDC Committee on Mathematics Education to

evaluate the implementation of the PoS in a complete 6-year cycle in 2001. Experiences drawn from the implementation will be examined and made available for improving the revised syllabus.

6.5 In the meantime, teaching materials on the development of number, spatial sense and the use of IT in primary mathematics should be published to keep primary schools informed of the recent development of mathematics education.

The Revised Secondary Mathematics Syllabus

6.6 The former CDC Mathematics Subject Committee (Secondary) revised the Secondary Mathematics Syllabus with a view to updating the 1985 syllabus. Informal consultations with professional organizations and sponsoring bodies[9] were conducted in 1997. In mid-1998, a revised syllabus framework was developed and issued for public consultation. The design aims to fit in the curriculum needs of students who have undergone 6 years of TOC programme in their primary schools. Major concerns in mathematics education, such as design of learning dimensions, catering for learning differences, enhancing of HOTs and the use of IT in mathematics, have been incorporated in the revised syllabus.

6.7 The revised syllabus was finalized in July 1999 and will be implemented in September 2001 as planned. The implementation date is chosen because the first batch of students undergoing the TOC programme will move on to S.1 by that time.

Summary of the Programme of Work of Syllabus Revision

6.8 The following programme is made under the assumption that the present education system is unchanged. If there are changes in the education system, this schedule will be adjusted accordingly.

.	Preparation of teaching materials for primary mathematics	since 1999
	Finalization of revised Secondary Mathematics Syllabus	July 1999
	Ad hoc Committee's recommendations	Dec. 1999
	Finalization of new Primary Mathematics Syllabus*	Aug. 2000
	Implementation of revised Secondary Mathematics Syllabus in S.1	Sept. 2001
	Implementation of new Primary Mathematics Syllabus* in P.1	Sept. 2002

(* The new syllabus will be designed according to our recommendations, if necessary.)

[9] The organizations and sponsoring bodies consulted were the HK Association for Science and Mathematics Education Ltd., the HK Association for Mathematics Education, the HK Buddhist Association, Po Leung Kuk, Tung Wah Groups of Hospital, Sheng Kung Hui and Diocesan Schools Association.

Recommendation

6.9 We suggest the CDC Committee on Mathematics Education to consider our recommendations during the review of the Primary Mathematics Syllabus. At the same time, the content of the Secondary Mathematics Syllabus can be re-adjusted, if deemed necessary.

Assessment in the Mathematics Curriculum

6.10 Assessment can be used for a variety of purposes such as evaluating the teaching effectiveness, diagnosing the learning difficulties of students, etc. We have discussed the role of assessment in the mathematics curriculum and hold that assessment is a process of gathering information and interpreting result. It should be an integral part of the teaching-learning cycle. The evidence collected from the assessment activities is an important feedback from students and should be used for students to improve their learning and for teachers to adjust their teaching strategies and pace.

6.11 The complexity of learner performance cannot be described by a single set of scores or a single type of assessment activities. Both formative and summative assessments are necessary for providing a comprehensive profile of student performance. Evidence of learning should be collected through various modes of assessment activities to reflect the students' achievement in mathematics. However, it should be understood that not every learning outcome can be readily assessed and we should let different stakeholders understand it as well. The HOTs are difficult to be assessed by traditional written tests.

6.12 We agree that schools need to formulate their assessment policy according to their culture, teachers' experiences, learners' needs and interests. It is also agreed that the design of learning objectives, learning activities and assessment tasks should be aligned to ensure what is intended will be properly taught and successfully learned.

6.13 The assessment of students' performance should not only focus on paper-and-pencil tests. It may take many forms and should be integrated with other classroom activities. Examples include project work, class discussions, oral presentations and observations of students' performance during lessons. However, if this kind of school-based assessment is to be carried out in public examinations, piloting will deem to be most desirable and care must be taken to avoid the hindrance of students' performance by their available resources and backgrounds. The pros and cons should be considered carefully.

Pros	Cons
• More information is available to the end users. • The needs of different students may be catered for. • This would be of use to those students who might do the external examination uncharacteristically poor but perform well in other areas such as project work. • This would change the school examination culture whereby undue emphasis would not be given to the preparation of external examinations.	• Differences in assessment standards among schools exist which may lead to low reliability. • Authenticity of students' work may sometimes be doubtful. • Continual pressure on students and teachers would be created within the whole assessment period. • Extra workload would impose upon teachers who have already been overwhelming with teaching and administrative duties.

6.14 Minimal competence, which is the pre-requisite to the learning of mathematics at the next stage, is needed to help teachers report student performance in terms of the basic knowledge, concepts and skills acquired.

Recommendations

6.15 The possibilities of setting minimal competence for mathematics at various stages of schooling should be explored.

6.16 We consider that assessment for high-stake purposes (such as placement and selection) should be played down to reduce over-drilling to students and minimize interruption to normal teaching and learning in schools. Assessment should be used as a means to collect feedback from students to improve teaching and learning.

Catering for Learner Differences

6.17 With the introduction of the universal education in HK, the issue of learner differences at all levels is increasingly concerned. As a subject for all, the problem is especially marked in mathematics. Different students have different sets of developed intelligence, abilities, personality traits and educational experience. Hence, learner differences are inevitable as students learn with different learning styles in mixed ability

classes. Furthermore, research suggests that learner differences in mathematics begin to widen as students progress to higher levels. The mismatch between the curriculum and individual learning styles is considered as one of the causes for the drop of students' interest in learning mathematics. Therefore, the mathematics curriculum should be reviewed in order to cater for the diversified needs and different abilities of students since developing the potential of students, maximizing their learning and nurturing their uniqueness are considered important in school education.

6.18 The needs of students at both ends of the ability scale are equally important. Opportunities to learn should be maximized for all students. That is to say, attention should not be placed only on academically lower achievers. The needs of the more able students should also be catered for. More resources should be provided to strengthen the existing institution for the gifted and those related mathematics activities. However, every means should be taken to prevent labeling effect.

6.19 We understand the difficulties teachers face in organizing learning activities in crowded classrooms under packed curriculum while students with different abilities have to compete in the same assessment system. Although constraints exist in the current educational context, suitable measures could be taken in planning educational experiences to reduce the effect brought about by the learner differences of students.

6.20 Based on the educational beliefs and identified constraints, the following measures in catering for learner differences could be taken in different aspects.

Curriculum Aspect

6.21 A general mathematics curriculum should be developed to provide all students in the years of general education with all necessary knowledge, concepts, skills and attitudes essential for a knowledgeable citizen of the modern age and the mathematical power, such as reasoning, for life-long learning. As a subject for all, students can acquire adequate fundamental knowledge of mathematics to support their fields of study. They should be equipped with the core competence necessary for the daily life and workplace on one hand, and be able to enjoy and appreciate the excitement and the beauty of mathematics on the other.

6.22 It is important that the mathematics curriculum should be flexible enough to cater for a wide spectrum of abilities of students. By identifying the foundation and non-foundation parts of the mathematics curriculum, teachers can select and organize relevant learning experiences according to students' abilities. Enrichment content could be provided for more

able students while content could be trimmed down and adapted for lower academic achievers.

6.23 In line with the *Tailoring Guide for the Secondary Mathematics Curriculum (1996)*, the foundation part should

(a) be the minimum body of learning for every student,

(b) contain different components that constitute a coherent curriculum,

(c) emphasize on important knowledge, concepts and skills.

All teachers should try their best to help their students master this part.

6.24 As the content in primary mathematics curriculum is relatively fundamental, the foundation components in primary mathematics curriculum are relatively substantial. On the other hand, the non-foundation components should increase progressively in the years of basic education. Measures, such as identifying the foundation and non-foundation components, allocating spare time periods, facilitating curriculum adaptation, can also be considered.

6.25 As learning content and objectives in secondary mathematics curriculum are arranged in terms of key stages instead of levels, teachers can judge for themselves their own sequences of learning units by basing on the needs of their students.

6.26 Apart from incorporating the flexibility elements into the mathematics curriculum at the primary and secondary levels, curriculum differentiation at the upper end of the secondary schooling is adopted to cater for students' different needs. Students should be given opportunities for further studies as well as equal access to different combinations of modules according to their interests and needs. At the same time, students should be equipped with knowledge and skills necessary for further studies in tertiary education and application in the technological society. The current mathematics curriculum for the upper end of the secondary schooling should be re-organized, as stated in the subtitle "Mathematics Curriculum for Post-Basic Education" in Chapter 5, to achieve the purpose.

School Aspect

6.27 According to the needs, interests and abilities of students, schools can adopt organizational arrangements, such as ability grouping, as well as instructional and curricular arrangements (such as remedial teaching, integrated learning and enrichment activities), in catering for learner differences.

6.28 Mathematics-related activities like mathematics clubs, quizzes, competitions, games,

projects and workshops are good means both to cultivate the interest of students and to provide students with learning experiences through informal curriculum. Research suggests that students' participation of such activities is beneficial to students' learning. Through enhancement and consolidation activities, more able students can broaden their exposure in mathematics while lower academic achievers can consolidate their concepts.

Classroom Aspect

6.29 It is impractical for teachers to accommodate to the learning styles of all students in every lesson. However, active and purposeful learning activities, such as project work, worksheets, graded and optional class exercises, suggested leisure reading, that allows individualized ways in the construction of knowledge is definitely helpful. Appropriate use of IT also provides teachers with a way to cater for learner differences as it allows students with different abilities to learn at different paces.

6.30 School-based and class-based curriculum adaptations are possible ways in catering for the needs of low academic achievers as well as the more able students. Though the difficulties encountered by teachers and the workload of teachers are fully aware of, teachers are the most suitable persons to identify the needs and the progress of their students in school. Professionalism of teachers is crucial for the successful implementation of curriculum adaptation as learning experiences should be tailor-made for the individual students in order to maximize their potentials. However, merely trimming down the curriculum is not a desirable way to resolve the problem. Professional judgements have to be made on the selection of materials and the depth of treatment. Therefore, competent teachers are required to deal with the different mathematics abilities of students. Guidance, in-service courses and support for teaching students with learner differences offered by relevant bodies are invaluable.

6.31 Relevant and realistic contextual tasks should be carefully selected for students. Teaching strategies should be well-organized to provide a learner-centred situation to match the capabilities of students.

Assessment Aspect

6.32 In schools, more emphasis should be laid on the assessment of minimal competence as it is in line with the setting up of a minimal standard in the theory of individualized learning. Testing of unnecessarily complicated problems should be de-emphasized. So far as public examinations are concerned, we think that the existing practice laid down in the *Tailoring Guide for the Secondary Mathematics Curriculum (1996)* is feasible. Labeling effect is avoided in such a practice.

6.33 A wide range of assessment activities is recommended so that teachers can get adequate information to organize students' learning experiences. Further details are provided in the subtitle "Assessment in the Mathematics Curriculum" on page 39.

Quality of Mathematics Teachers

6.34 Mathematics education is a key learning area of the school curriculum. Implementation of the mathematics curriculum relies very much on the supply of competent and well-prepared teachers who are able to realize the ideals of the mathematics curriculum during implementation. We opine that a good mathematics teacher should be a committed teacher who has strong motivation in promoting mathematics education, a reflective teacher who can always adapt himself to a fast-changing working environment, and a scholarly teacher who possesses sound understanding in mathematics, pedagogy of teaching and the needs of students.

6.35 In HK, qualified mathematics teachers are mainly provided by teacher education providers through pre-service and in-service teacher education programmes. The HKIEd starts to offer BEd degree programmes in 1998. It has a range of full-time pre-service Certificate in Education programmes for preparing primary and secondary teachers. The Institute also offers a range of full-time and part-time in-service programmes for the professional development of teachers in the early childhood, primary, secondary, technical and special education sectors.

6.36 Both HKU and CUHK offer BEd degree programmes as well as full-time and part-time post-graduate teacher education courses. Master of Education courses with specialty in mathematics education are also offered regularly. Other local institutions like the HKBU, OUHK, etc., offer in-service BEd degree programmes to school teachers while some overseas institutes also organize taught courses and distance learning courses for their BEd programmes through local agencies.

6.37 Currently, all tertiary institutions in HK do not offer any full-time BEd courses majoring in Mathematics[10]. HKU is at present the only institute that has a part-time BEd course majoring in Mathematics for practising teachers.

6.38 A high proportion of primary mathematics teachers are non-degree holders and a large number of non-subject trained teachers are appointed to teach mathematics. On the contrary,

[10] CUHK will offer a full-time BEd course majoring in mathematics in September 2000.

a majority of secondary mathematics teachers hold a bachelor's degree in mathematics or related subjects (like science and engineering) and a significant number of secondary school teachers possess PGDE or PGCE qualifications.

Recommendations

6.39 A good mastery of teaching methods as well as a strong mathematical background are important traits for a mathematics teacher. Therefore, it is advisable to strengthen the subject specific component in BEd courses. On the other hand, training of teaching methods should be provided to practising teachers with BA/BSc degrees in mathematics.

6.40 It is desirable to have subject specialists to teach mathematics to students at the upper primary level or above. The primary mathematics teacher should preferably possess a BEd degree majoring in mathematics and the secondary mathematics teacher should be one with a strong mathematical background and suitable teacher training. We generally agree that an ideal qualification for a mathematics teacher, in the long-run, is a bachelor's degree in mathematics or related discipline together with PGDE or PGCE.

6.41 Mathematics teachers should see the importance of life-long education for teachers. Collegiate exchange among mathematics teachers both within schools and in the mathematics education circle should be encouraged. The Curriculum Resources Centre of CDI at Tin Kwong Road, Kowloon and the Education Resources Centre of AID at Pak Fuk Road, North Point, HK provide places for teachers to share their teaching ideas and experiences. The teaching and reference materials published by both CDI and AID also provide good resources to teachers.

Using Information Technology in Mathematics Education

6.42 IT has become a fact of life and we have enjoyed many benefits from the advent of information and communication technology. We hold that our teachers should make good use of the technology to enhance teaching and learning while our youngsters should master the technology to exchange and process information, to think and work logically and to become more adaptive to the dynamically changing environment.

6.43 We agree that using IT in teaching and learning mathematics may bring about the following benefits:

(a) IT can enhance and extend mathematics learning experience, and encourage active student participation in exploratory and investigative activities.

(b) IT, when used as a tool, can support, supplement and extend teaching and learning

activities, such as:

- exercises and tutorial,
- charting and graphical analysis,
- simulation and modeling,
- information retrieval and handling, and
- data processing.

(c) IT may lead to new teaching strategies and practices in classrooms such as providing students with an interactive learning environment for contextual and situation learning.

Recommendations

6.44 We propose the CDC Committee on Mathematics Education to further explore the uses of the following IT tools in teaching and learning mathematics at their particular level and subject(s):

- Calculators
- Multimedia educational software packages
- Graphing calculators
- Mathematics software tools
- Spreadsheets
- Internet

6.45 The future mathematics curriculum will focus on the effective use of information for problem solving - one of the principal reasons for studying mathematics. However, extensive use of the above IT tools may lead to de-emphasis of skills and trimming down of technicality. Therefore, we stress that mathematics should be taught in its own right and with its own educational objectives for the information age.

6.46 IT tools, in some cases, may provide shortcuts which are undesirable, especially in learning processes where mental development is needed for concept building. Therefore, we realize that IT should be cautiously used in classrooms and such messages and examples should be conveyed to mathematics teachers during teacher training sessions. Teachers should also act professionally towards choosing the most appropriate educational technology to benefit their students.

6.47 Effective use of IT in mathematics education depends on many factors. The IT education planners, curriculum developers and school administrators should be fully aware of the consequences of these factors and should address these issues tactfully in designing territory-wide implementation strategies and school-based plans:

- IT competency among mathematics teachers

- IT proficiency of students at various level of schooling
- Teachers' knowledge and skills on strategies of using IT in classrooms
- Need for quality educational software and mathematics software tools
- Equity of access to IT equipment
- Level of technical and curriculum support within schools