MATHEMATICAL EDUCATION IN SINGAPORE

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Mr. Chairman, Ladies and Gentlemen, it is a rare pleasure and a very real one that I have this morning - that of presenting a paper on mathematical education in Singapore at this Symposium.

At a first glance, mathematics might appear to some to be a universal language, cutting across all barriers of language and nationality and independent of the stage of development of any particular country. But, if we go a little beneath the surface, it becomes obvious that the type of mathematics taught in a country at any particular time is greatly influenced by the social and political climate of that country at that particular period of time. And Singapore is no exception.

Background and Development

Prior to 1953, there appears to have been no teaching syllabus for mathematics in Singapore. Most English Secondary Schools were simply following the Cambridge Examination syllabus for mathematics and the Chinese Middle Schools were following their own individual syllabuses, usually determined by the type of textbooks used by the individual schools and local examination syllabuses. At the primary level, instruction in mathematics was confined to teaching the four basic operations and weights and measures. At the secondary level, teaching of mathematics was compartmentalised. The English Schools taught arithmetic, algebra and geometry as three separate branches of mathematics, but they were taught side by side in the same academic year. As for the Chinese Schools, the teaching of mathematics was even more compartmentalised. The whole of the first year in the Junior Middle School was spent on learning arithmetic. The whole of the second year in the Junior Middle School was devoted to algebra and the third year of the Junior

Middle School was spent on learning Euclidean geometry. A similar division of topics also existed at the Senior Middle School level. The pattern followed in most Chinese Middle Schools was as follows:-

Junior Middle School :	I	Arithmetic
	II	Algebra
	III	Euclid's Geometry
Senior Middle School :	I	Trigonometry
	II	Higher Algebra
	III	Analytical Geometry

There were no proper teaching syllabuses and students, both arts and science, went through the same content.

In 1953, a teaching syllabus for the English Schools was drawn up by the Department of Education in the Federation of Malaya and in Singapore, in collaboration with the then Malayan Mathematical Society. The main innovation compared with the earlier syllabuses was that an attempt was made to unify mathematics into a single subject as opposed to the practice of sub-dividing mathematics into separate branches called arithmetic, algebra, geometry, etc. However, the Chinese Schools still continued to teach mathematics in a rather compartmentalised way, that is, the various branches were taught in isolation in different years as mentioned above. The weakness of the system is quite obvious. This usually gave rise to great difficulties in the later stages when new branches were introduced or when pupils had to sit for external examinations. For example, a pupil who had learnt algebra in his Junior Middle II might have forgotten all about it by the time he was in Senior Middle II, preparing to study higher algebra. He would also be handicapped by similar lapses in memory when he has to sit for an external examination covering all the branches of mathematics, some of which he might have studied four or five years earlier. The other drawback of the system is the artificial separation of mathematics into fixed

subjects which does not allow the pupils to see the unifying threads which run through all mathematics, and which prevents pupils from using the most convenient method of solving a problem, irrespective of the branch of mathematics they are dealing with.

An attempt was made in 1959 to produce a new unified syllabus for all the streams by the then Ministry of Education in collaboration again with the Malayan Mathematical Society. According to the foreword written by the then Director of Education "the new syllabus made no distinction between English Mathematics, Chinese Mathematics and Malay Mathematics". The new syllabus emphasised the point that mathematics should be taught as a unified subject in all the schools irrespective of the language stream.

However, the tradition of teaching mathematics in compartments was so strongly established in the Chinese Schools that few of them cared to follow the new syllabus. When the present Government first came into power in 1959, it was anxious to evolve a truly unified national curriculum for all the schools and set up new syllabus committee to draw up new unified syllabuses in all the subjects applicable to all the language streams. The newly set up syllabus committee for mathematics brought out its new syllabus in mathematics in 1960.

While the new syllabus committee was fully aware of the advantages of teaching mathematics as a unified subject, it had to be realistic in recognising the different traditions of teaching mathematics in the English and Chinese streams. Therefore, the syllabus issued in 1960 catered for this difference by having two alternative syllabuses for the secondary schools.

Alternative I treated mathematics as a unified subject and in Alternative II the subject was sub-divided into arithmetic, geometry and trigonometry. All the English Schools followed Alternative I. The Chinese Schools were free to choose either Alternative I or II. Fortunately, more and more Chinese

Schools realised the advantages of teaching mathematics as a unified subject and switched over to Alternative I, and Alternative II gradually disappeared.

The adoption of Alternative I by most Chinese Schools paved the way for further improvements in the mathematics syllabus. By then, the time was also ripe for introducing a new syllabus. In many parts of the world, especially in the advanced countries of the West, the mathematical curriculum was in a state of flux in the years following 1960. Programmes, courses and methods of instruction and exposition were being modified, restructured or reorganised. Topics usually taught in higher grades were being pushed down into lower ones and new topics formerly dealt with only at the College level were being introduced into the school curriculum. What was the rationale behind all these innovations?

Present Trend

The growing need in all societies for technicians, engineers, economists, statisticians and experts in numerous other fields with training in mathematical thinking and quantitative analysis was of course one of the main reasons which influenced the restructuring of mathematical syllabuses all over the world. The urge to get rid of material which has little use in our modern context and to substitute it with more relevant modern material was another factor in the move to modernise the syllabuses. The rapid expansion of mathematical knowledge also exerted a pressure to transfer some of the topics normally dealt with at the university level to be taught at the secondary school level, using a simplified approach.

This world-wide movement to modernise the mathematical syllabuses had a profound influence on the syllabus planners in Singapore. Singapore was rapidly industralising and could not afford to lag behind. Therefore, in 1965, the new revised mathematics syllabus for secondary schools was introduced. The main feature of the syllabus as you all know is the common

Secondary I and II syllabus with a sizeable amount of modern content. You also know that for Secondary III and IV level, there are two alternative syllabuses, namely B and C, and schools are free to choose any one of the two syllabuses.

Adaptation to the Change

The key factor in introducing any new syllabus is the teachers. No syllabus can be successfully implemented if teachers are not prepared for it. In fact, in many advanced countries the move to modernise the mathematics syllabuses was initiated by the practising teachers themselves. However, in Singapore, the initiative for change in syllabuses has usually come from the Ministry of Education.

Before introducing the new syllabus, the Ministry wanted to ensure that the teachers had a good understanding of the contents of the new syllabus. That is why the Ministry of Education, in conjunction with the Institute of Education, conducted a good number of In-Service courses in teaching modern mathematics so that the common Secondary I and II syllabus could be introduced to all the schools smoothly by 1974. It is heartening to note here that the Singapore Mathematical Society also played its part in this respect, by organising some courses to help the teachers.

As for Secondary III and IV, the schools still have the option to stick to the more traditional B syllabus or the more modern C syllaus. It is interesting to note here that in 1976 nearly 50% of the pupils sat for the C syllabus at the GCE 'O' level and 55.7% of them scored grades between 1 and 6. In the same year, of the remaining 50% of the pupils who opted for the B syllabus at the GCE 'O' level, only 39.9% scored grades 1 to 6. If these statistics are of any significance at all, then we can expect more and more schools to switch over to the C syllabus in the coming years.

Traditional or Modern Mathematics?

At this point, it may be worthwhile to consider the

question of whether it is better to teach traditional mathematics or modern mathematics. I must hasten to add here that the term 'modern' is used here only in a relative sense. Modern mathematics, in the context of our schools, does not mean mathematics from the latest research papers. It is only modern relative to what has been taught in our schools until recently. In fact none of the topics that we teach under the high-sounding title of "modern mathematics" is really that modern; most of these topics date back to the 18th & 19th centuries.

We must also bear in mind that even the most ultra modern syllabus cannot afford to discard some of the traditional topics, such as solving quadratic equations, which are still useful. Therefore, the important criterion for including a topic in the syllabus or excluding a topic from the syllabus is not whether it is traditional or modern, but whether it is useful for the further development of mathematical knowledge in the pupils or not.

A study of the contents of Syllabuses B and C shows that more than 70% of the topics are common to both syllabuses. The topics that are found in B Syllabus, but left out in the C Syllabus are mainly concerned with formal geometry. On the other hand, most of the new topics that have been introduced into Syllabus C have great relevance to higher mathematics and a basic foundation at 'O' level in these new topics will be an advantage for the further study of mathematics at the higher level. Even for those who are not likely to continue with their mathematics beyond 'O' level, the new topics will be far more appealing and useful then formal geometry.

Some parents object to modern topics, because they do not understand them and therefore could not help their children when they have difficulties with their homework. This is a short-sighted attitude. If we want our children to learn only what we ourselves have learnt, and want our grand children to learn only what our children have learnt, and so on, then our

learning in turn will be limited to only what our ancestors learnt and we will end up as a stagnant society.

Growth and progress involve change. While there could be change without progress, there cannot be growth and progress without change. Therefore, if we want to develop and progress, we have to accept changes and learn to cope with changes. Like any other vital subject, mathematical knowledge is expanding at a very rapid rate and our syllabuses have to be periodically reviewed to see which of the new discoveries in mathematics can be profitably included in the syllabus and which of the old ones can be omitted without any adverse effects.

Another common observation made is that students who follow a modern syllabus are poor in computation. As pointed out earlier, more than 70% of the topics covered in the B and C syllabuses overlap and these topics include topics which involve a lot of computation. Therefore, the introduction of a few modern topics cannot be a reason for the poor computational abilities of some students. Some of the students are naturally weak in computation and this has very little to do with whether a modern or traditional syllabus is being followed.

Even though the C syllabus is more in keeping with modern trends than the B syllabus, the Ministry of Education has not made its adoption compulsory. It has been left to the schools to make the switch as and when they feel competent to do so. However, the common syllabus for Secondary I and II with some modern content gives the schools no option. Some teachers seem to think that this common Secondary I and II syllabus is more suitable to students who will eventually be following the C syllabus than to students who will be opting for the B syllabus. In terms of mathematical education, both categories of students will benefit equally by an exposure to some of the modern ideas included in the common syllabus.

Another common complaint made by many teachers is that the syllabus is too wide and that thay are not able to cover it. Any worthwhile syllabus must obviously contain sufficient

material to cater for the needs of the able pupils, therefore most syllabus designers pack their syllabuses with an overdose of topics. However, the notion which many teachers have, that every pupil, however weak he is, must also complete the whole syllabus, is wrong. This is like forcing a not too healthy person to enjoy a ten-course dinner meant for a person in robust health. The natural thing for a person in poor health is to eat just what he can digest and no more. By doing this, he may eventually regain his health and be in a position to enjoy his meals like his healthy friend.

In the same way, it is not necessary for every pupil to cover 100% of the syllabus. The amount of syllabus to be covered will vary from pupil to pupil, depending on his ability and background knowledge. From the view point of mathematical education, it is better to cover 60 or 70% of the syllabus well than to cover the whole syllabus in a haphazard manner. Even from an examination point of view, it is better for weaker pupils to cover 60 or 70% of the syllabus thoroughly than for them to rush through the whole syllabus.

The important thing to remember is that whatever the pupils learn, it must be learnt well and with proper understanding. Mathematics as you know is a progressive subject. A pupil who has not learnt how to find the area of a rectangle will be at a loss when you try to teach him how to find the area of a triangle.

Teaching Method

In no other subject is the maxim "proceed from the known to the unknown" more applicable than in mathematics. And yet, how often we easily forget this! A teacher of mathematics at Secondary III level assumes that all his pupils have a thorough grasp of all the topics taught at Secondary II level, or he thinks it is not his business to concern himself about his pupils' background knowledge. His job, he tells himself, is to teach only the Secondary III syllabus. I think this is taking a very narrow view of one's responsi-

bility as a mathematics teacher. It should be the duty of every teacher of mathematics at every level to ensure that his pupils have the requisite foundation before he starts to build up further mathematical knowledge in his pupils. Otherwise, his efforts and the efforts of his pupils may not be very productive.

I have talked at some length about syllabuses, but what is more important than the content of any syllabus in any subject is the method of approach to the subject and the interest stimulated in the students and the attitudes developed in them, which will have a life-long influence on their thinking and behaviour. We may have the most up-to-date syllabuses and the best textbooks and teaching aids, but if the teaching is lacking in imagination and inspiration, if the teachers do not have a thorough understanding of the topics they are teaching, the end results will be confused and disinterested students who claim they have learnt nothing from mathematics.

Teachers of mathematics in Singapore schools, irrespective of whether they are teachers of modern or traditional mathematics, may find the following points useful when teaching mathematics:-

1. A thorough understanding of the content you wish to teach and a wide background knowledge are very essential. This can only be achieved by broad reading on the subject and doing some mathematics yourselves.

2. Solving problems is the most cardinal mathematical activity. Even if you do not succeed in solving the problem, the very attempt to solve the problem provides valuable training. Therefore, problem-solving by the students is the most essential part of the mathematical education. Problem-solving naturally develops certain attitudes and patterns of thought, the usefulness of which is not restricted only to mathematical problems.

Therefore, in addition to training students to do routine problems, it is your duty as a teacher of mathematics to train your pupils to solve problems of a non-routine nature with confidence.

3. Teachers must be able to arouse an enthusiasm for mathematics among their pupils. The best way to do this is for the teachers themselves to be enthusiastic about mathematics. Enthusiasm is infectious.

4. Teachers must ensure that whatever students learn, they learn it with understanding and insight. Learning without understanding is labour lost. It is not learning at all.

5. Pupils must be guided with the right-type of activities to discover for themselves important mathematical relationships. Teachers must resist the temptation to turn their pupils into sheer recipients of formulae and rules. Instead, pupils must find out or be guided to find out for themselves important mathematical concepts for themselves. As Piaget said, "the goal of education is not to increase the amount of knowledge but to create opportunities for a child to invent and discover."