

Quality mathematics education – The case of Singapore

Berinderjeet Kaur, National Institute of Education, Singapore

Introduction

This paper presents three significant aspects of Quality Mathematics Education (QME) in Singapore. Students from Singapore have consistently been ranked amongst the top performers in international benchmark studies such as TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment). Amongst the factors that may have contributed to this stellar achievement is QME for all students in the nation. Three significant aspects of QME, namely “the school mathematics curriculum - mathematics for all but more mathematics for some”, “access to quality mathematics instruction” and “unconditional support for all to improve their achievement” are notable.

The School Mathematics Curriculum

Mathematics for all but more mathematics for some

It may be said that the curriculum is tailored to meet the needs of the students and matched to their abilities. Primary school comprises six years of schooling. The first four years constitute the foundation stage and the next two years the orientation stage. During the foundation stage emphasis is on building a strong foundation in the English Language, Mathematics and Mother Tongue language. All pupils take the same course for mathematics. In the orientation stage pupils are streamed according to ability. Subject-based banding is adopted. Pupils either take the Foundation Mathematics or Mathematics course of study. The Foundation Mathematics syllabus is a sub-set of the Mathematics course of study. The recommended curriculum time per week for mathematics in the primary school is shown in Table 1.

Table 1. Curriculum time per week for mathematics in primary school

Primary 1 - 2	4 hours
Primary 3 - 4	5.5 hours
Primary 5 – 6 (Mathematics)	5 hours
Primary 5 – 6 (Foundation Mathematics)	6.5 hours

Pupils sit a national examination called the Primary School Leaving Examination (PSLE) at the end of Primary six. The examination assesses pupils’ suitability for secondary education and places them in an appropriate secondary school course that matches their learning ability. Three Courses are available at the secondary school level. Pupils undergo four or five years of secondary education with different emphases.

- i) Special Course – a four-year course leading to the Singapore-Cambridge General Certificate of Education (GCE) ‘O’ level examination. In this course, pupils study their mother tongue at an advanced level, in addition to the usual humanities, mathematics and science subjects.
- ii) Express Course – also a four-year course leading to the GCE ‘O’ level examination. In this course pupils study their mother tongue at an ordinary level and offer a curriculum similar to that in the Special course.
- iii) Normal Course – a four-year course leading to the GCE ‘N’ level examination. A

fifth year is available to pupils who do well in this examination to prepare for and take the GCE 'O' level examination. Pupils in this course follow either the Normal (Academic) or Normal (Technical) curriculum. In the N(A) curriculum, they will learn English, mother tongue, mathematics and a range of subjects similar to those in the Special and Express courses. In the N(T) course, pupils will learn English, mother tongue at a basic level emphasizing oral/aural competence and reading comprehension, mathematics, computer applications and subjects with a technical and practical bias such as technical studies.

As mathematics is a compulsory subject for pupils in school, the mathematics curriculum at the secondary school level is differentiated to cater to the needs and abilities of pupils in the different courses. Core mathematical concepts are common to all courses and the content for the Special Course is identical to the Express Course. The content for the Normal (Academic) Course is a subset of the content for Special/Express Course while that of the Normal (Technical) Course is a subset of the Normal (Academic) Course. For all the three courses most of the topics taught at the various year levels for mathematics are similar. However the depth at which they are taught at a particular year level differs. Table 2 shows extracts from the syllabuses (Ministry of Education, 2012a; 2012b; 2012c) that highlight the varying depth.

Table 2. Extracts from MOE syllabuses

Secondary One - Algebra
<u>Special / Express Course</u>
<ul style="list-style-type: none">○ Algebraic expressions and formulae○ Use letters to represent numbers○ Express basic arithmetic processes algebraically○ Substitute numbers for words and letters in formulae and expressions○ Simple algebraic manipulation○ Manipulate simple algebraic expressions – include collecting like terms and removing brackets○ Simple linear equations○ Solve simple linear equations○ Solve problems involving linear equations – emphasize understanding of the problem leading to formulation of mathematical expressions/equations
<u>Normal (Academic) Course</u>
<ul style="list-style-type: none">○ Algebraic expressions and formulae○ Use letters to represent numbers○ Express basic arithmetic processes algebraically○ Substitute numbers for letters in formulae and expressions○ Simple algebraic manipulation○ Manipulate simple algebraic expressions – include collecting like terms and removing brackets
<u>Normal (Technical) Course</u>
<ul style="list-style-type: none">○ Algebraic expressions and formulae○ Concept and notation○ Use letters to represent numbers○ Express basic arithmetic processes algebraically○ Substitution

-
- Substitute numbers for letters in expressions and formulae (exclude expressions with brackets & expressions involving squares and high powers)
 - Simplification
 - Simplify simple algebraic expressions (include collecting like terms but exclude removing of brackets at this level & expressions involving squares and higher powers)
-

Table 3 shows the recommended curriculum time per week for mathematics in the secondary school.

Table 3. Curriculum time per week in the secondary school

Special / Express Course	2.5 - 3 hours
Normal (Academic) Course	2.5 - 3 hours
Normal (Technical) Course	4 - 5 hours

The intended curriculum is provided by the Ministry of Education to all schools and adopts a spiral approach. The syllabuses are a guide for teachers to plan their mathematics instructional programmes. Teachers are not bound by the sequence of topics but ensure that the hierarchy and linkage are maintained. Teachers are free to exercise flexibility and creativity when drawing up plans of work, which serve as a blueprint for them to implement the instructional programme. Textbooks are an essential part of the intended curriculum. They are produced by publishers with close guidance from Curriculum specialists of the Curriculum Planning and Development Division (CPDD) at the Ministry of Education. All textbooks used in schools must have the approval of the Ministry of Education.

Quality Mathematics Instruction

Every child in school has access to quality mathematics instruction.

Mathematics teachers like all other teachers in Singapore schools are life-long learners. They are entitled to 100 hours of funded training and core-upgrading courses each year to keep abreast with the current knowledge and skills. Schools have People Developers who take charge of the Professional Development needs of their teachers. The Enhanced Performance Management System (EPMS) (Ministry of Education, undated) put in place by the Ministry of Education (MOE) in 2005 has empowered teachers to take charge of their development. The EPMS is an appraisal system that contains rubrics pertaining to fields of excellence in the education system be it teaching, leadership or senior specialist. The EPMS clearly articulates the expectations of teachers in their chosen fields of excellence. For the field, excellence in teaching teachers must slowly but surely develop themselves in the core competency (nurturing the whole child) which comprises of 4 main areas: cultivating knowledge (subject mastery, analytical thinking, initiative and teaching creatively), winning hearts and minds (understanding the environment, developing others), working with others (partnering parents, working in teams) and knowing self and others (turning into self, personal integrity, understanding others and respecting others). The levels in the teaching field are characterized as follows:

- Beginning Teacher
- General Education Officer (GEO) 1 / 2
- General Education Officer (GEO) 1A1 / 2A1
- General Education Officer (GEO) 1A2 / 2A2
- Senior Teacher
- Master Teacher

Table 4 shows expectations of a mathematics teacher related to the domains of Knowledge and Skills for three levels of the teaching field. It is apparent from the table that a teacher desirous of advancement in his/her career must engage in lifelong learning so as to gain deeper insights into both the content and pedagogical areas that are specific to his/her teaching needs. There is extrinsic motivation for teachers to advance from one level to another in their field, as their salaries and other performance perks are pitched to their levels in their field of excellence, in this case teaching.

Table 4. Expectations in the domains of Knowledge and Skills

Level	Knowledge (Mathematics)	Skills (Teaching of Mathematics)
Beginning Teacher	Comprehend framework and core concepts of relevant school mathematics curriculum.	Understand pupil management skills. Competent in the delivery of mathematics lessons.
GEO 1A1/2A1	Demonstrate knowledge of: - relevant core concepts and broad coverage of mathematics curriculum; - teaching resources and enrichment/remedial programmes associated with level of mathematics being taught.	Demonstrate pupil management skills and appropriate application of a variety of pedagogic techniques in teaching mathematics. Deliver interesting lessons to students of varied abilities and profiles and instill learning in mathematics through interactive activities.
Master Teacher	Demonstrate - knowledge of significant relationships, history, structure with Mathematics and the application of this knowledge to inspire interest in Mathematics; - strong awareness of trends and issues surrounding mathematics beyond the school setting and in industry/field. - knowledge core concepts of other related subjects which integrates the learning of mathematics to the world outside of school.	Demonstrate specialized techniques and strategies in the teaching of mathematics and curriculum integration to ensure achievement of learning objectives and inspire learning across schools in the cluster including customized approaches for niche groups of students.

Support for Every Child to Maximize Potential

Unconditional support for all to improve their achievement

Since 1981 when the New Education System (Ministry of Education, 1979) was implemented every effort has been made to cater to the diverse learning needs of students in the education system. Also, flexibility in the system caters for late bloomers and different aptitudes of individuals. The only natural resource that Singapore has is its people for economic survival and therefore the nation invests heavily in developing its natural resource. No child is deprived of educational opportunities. Adequate funding is available for all to school comfortably. Both the rich and poor are equal in the system as rewards are based on merits. In addition, the lower socio economic status students are assisted in multiple ways to bridge their needs in terms of support for school meals, textbooks, uniforms, subsidies for educational trips, etc. There is also support from national self-help groups such as MENDAKI, SINDA, and CDAC in terms of out-of-school support for students to improve their achievement in mathematics. Parents of students are key stakeholders of the school and they are engaged through multiple avenues, for example Parent Support Groups, Parent-Teacher meetings, etc.

Teachers have high expectations of their students and make special effort to track the progress of their charges through the academic year. Failing students are helped and excelling students are challenged. Parents too, generally, have high expectations of the children and are often in communication with teachers about the development of their child in school. Success in school is viewed by society as an avenue for social mobility and therefore society as a whole values education. Generally issues related to education are always close to the hearts of many in Singapore.

Conclusion

This presentation has shared with fellow conference participants at EARCOME 7 an insider's perspective of QME in Singapore. This perspective has been shaped by the presenter's 26 years of work in mathematics education in Singapore.

References

- Ministry of Education. (1979). *Report on the Ministry of Education by Dr Goh and his team*. Singapore: Ministry of Education.
- Ministry of Education (2012a). *O-level mathematics teaching and learning syllabus*. Singapore: Curriculum Planning & Development Division, Ministry of Education.
- Ministry of Education (2012b). *N(A)-level mathematics teaching and learning syllabus*. Singapore: Curriculum Planning & Development Division, Ministry of Education.
- Ministry of Education (2012c). *N(T)-level mathematics teaching and learning syllabus*. Singapore: Curriculum Planning & Development Division, Ministry of Education.
- Ministry of Education. (undated). *Enhanced Performance Management System*. Singapore: Ministry of Education.

Berinderjeet Kaur

National Institute of Education, Nanyang Technological University, Singapore
berinderjeet.kaur@nie.edu.sg