How do Hong Kong Students think about the mathematics curriculum and teaching

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Introduction

In Hong Kong, the policy of nine years compulsory education has been fully implemented for nearly twenty years. In this time, the quality of education seems to have declined arousing the concern of the public in general and educators in particular. A research commissioned by The Chinese University of Hong Kong has revealed that children's proficiency in mathematics deteriorates as they move up the grade levels, and mathematics, just next to English, is the subject which children find most difficult (Wong, H.W., 1996). In 1997, in response to the need for a reform in the mathematics curriculum in Hong Kong, a high level ad-hoc committee was set up in the Curriculum Development Council to conduct a holistic review of the mathematics curriculum from primary school right up to the sixth form level. The committee aimed, among other endeavours, to conduct an appraisal of the current state of the mathematics curriculum.

A situational analysis is the first step in curriculum development (Lawton, 1989; Skilbeck, 1984). Popham, (1993) points out that a review should cover the following tasks:

(a) assess the weaknesses and strengths of the present curriculum and identify

areas which need to be improved;

(b) understand the social and political developments in the society;

(c) depict a clear picture of how teachers teach and how students learn;

(d) detail recent development in the subject discipline; and

(e) find out the expectations of students, schools, teachers and employers towards school education.

In the holistic review of the Hong Kong mathematics curriculum, a research was commissioned to the authors to investigate different stakeholders' view on the mathematics curriculum(*). These stake holders include students, teachers, parents, university professors, employers and curriculum planners (see Wong et al, 1999, for details).

As for the students' part, a questionnaire was administered to nearly 9000 students in a random sampling of 90 primary and 50 secondary schools. It was aimed at investigating (a) the levels of difficulty of various topics as perceived by the students, (b) their attitudes towards mathematics, (c) their habits in learning mathematics, and (d) their conception of mathematics. Results revealed that students possessed a high regard for mathematics and preferred a deep level of understanding to simple rote memorisation. They wished to know how formulas come about and are applied. They found interest in learning mathematics at a young age though this interest declined and they found mathematics learning more and more difficult at higher grade levels. They experienced the greatest pressure from homework at Primary 6. Topics that involved tedious calculations were least welcome and word problems were thought to be difficult. Students hoped for liveliness and real life applications both in teaching and in textbooks. Secondary school students felt that the syllabus at the junior secondary level was too fragmented and there was much overlapping of topics at Secondary 1 with those at primary levels. Senior secondary school students showed dissatisfaction with the whole senior secondary and sixth-form mathematics curriculum structure. They reflected that the syllabuses could not cater for their needs.

(*) Authors' Note: The research was commissioned by the Education Department, Hong Kong.

Qualitative research by interviews can reveal more on students' attitude towards mathematics and their view on the current curriculum and the aim of the present paper is to report on a semi-structured interview that was conducted among 60 students, which is part of the research leading to a holistic review of the mathematics curriculum.

Sampling and procedure

Fifteen groups of students, in groups of four, from twelve schools were invited to attend a semi-structured interview. Both boys and girls were included except for students from single-sexed schools. Details of their characteristics are given below.

	Number of students				
Academic ability	Primary 3	Primary 6	Secondary 3	Secondary 4	Secondary 6
High	4	4	4	4	4
Average	4	4	4	4	4
Low	4	4	4	4	4

The interview questions focused on the following aspects:

(a) Classroom teaching: The elements, features and characteristics in mathematics teaching that may foster or hinder mathematics learning as perceived by the students.
(b) The curriculum: Students' perception of the relationships between the usefulness and the difficulties in learning specific mathematics contents of the curriculum.

Each interview lasted for about 45 minutes. All interviews were audio-taped, transcribed and content-analysed.

Students' views on classroom teaching

Students' definition of good classroom teaching was consistent among the schools and among the different levels in general. The teacher was the key person in classroom teaching. The students perceived that teachers had the responsibility of delivering good explanations, designing and conducting

activities in lessons, creating a good environment and showing concern for students' progress. In general, students at a higher level were able to mention more features in their descriptions of good classroom teaching than the lower levels.

(a) Personality: Friendliness, patience and showing concern for students were the most important attributes of a good teacher. It was mentioned by all students from all levels in all schools.

(b) Lively classroom atmosphere: Students from all levels preferred a lively classroom atmosphere. This appeared to be the most important factor for the younger students. Students in Primary 3 showed interest in a range of activities. They mentioned many examples of hands-on activities such as pinboards, doing measurement around the school and working with models and patterns. They also enjoyed competitions and working on the blackboard in front of the class. In addition to a lively atmosphere, students from two schools mentioned that they also wanted a well-disciplined classroom so that they could concentrate on learning.

(c) Good teaching practice: The students in the higher levels were more aware of the characteristics of good teaching practice and teaching pace. In addition to the these features, students in Primary 6 and above mentioned the following characteristics of good teaching: (i) clear and lively presentation; the teacher being responsive to students' questions and allows time for peer discussion; (ii) sufficient practice, challenging tasks and exercises that provoke thinking (iii) the pace of teaching being geared to students' progress, understanding and feedback.

Secondary 3 students became more specific in their descriptions of good teaching practices. In addition to the above, they expressed great concern for their teachers' ability to facilitate their understanding and they, more than the primary students, were more sensitive to being labeled "weak in mathematics". In sum, teachers should treat students with respect and fairness, should not label weak classes and should show genuine concern for students' understanding. They should allow time for students to assimilate new contents, give feedback, conduct regular quizzes, listen and be responsive to students' questions, and

clarify common mistakes. Teachers should also provoke students' thinking with challenging problems. However, these problems should be appropriated to students' abilities. Teachers should give clear, concise explanations which contribute to the students' conceptual understanding. The students perceived a good lesson as one that was systematic and well organised, consisting of activities with clear procedures such as teacher's talk, students' seatwork, and checking of answers. Examples and problems should be taken from textbooks as well as other sources, and they should help students link the usage of mathematics with the real world.

It is worth noting that the Secondary 3 students also mentioned the characteristics of an undesirable teacher as being opposite to their ideal model. They described undesirable teachers as those who lacked liveliness in their teaching, were unenthusiastic about their subject, showed indifference to weak students, applied a lot of pressure on the students, were not prepared for their lesson and made lots of mistakes, scolded students, and set very difficult questions in examinations.

Secondary 4 students expressed additional concern that teachers should foster thinking in their students and help them to enjoy the subject. In particular they thought teachers should put emphasis on training students in analytical and logical thinking, help them analyse problems, give alternative answers and guide them to develop thinking skills. As for undesirable features, they mentioned rote-learning, pressure, being embarrassed in front of their classmates during lessons, teacher-talk only (i.e., an equivalent of 'boring'), and lack of classwork time. Although they were fully aware of the time constraint, they still believed that student-talk was important during lessons. They believed that skilful questioning would test students' understanding and exercising students' thinking. They liked to be able to organise their materials before answering questions. Classwork was seen as important because it provided opportunities for them to think and understand, and ask questions according to individual needs. They wanted to learn self-study habits such as reading and working through textbooks by themselves. They believed that a good textbook was one in which the problems were arranged in increasing order of difficulty

and they also liked full solutions given which would help their self-study.

As for Secondary 6 students, their perception of good teaching was very similar to that mentioned by Secondary 3 and Secondary 4 students. In addition to the characteristics mentioned earlier, there were other suggestions such as using more Chinese in instruction, giving immediate feedback on classwork, allowing time for questioning, using interesting but meaningful approaches, being sensitive to students' needs and problems, and helping students use their past experience. The undesirable features included: reading from the book, strictly following the book and giving too fragmented information.

Students' views on understanding

A teacher's ability to help students understand the content was very important. This was mentioned in two schools at Primary 3 level and in all schools at other levels. Understanding was directly associated with high scores and being able to do (difficult) problems independently. Primary 3 students from one school mentioned good mental computations. Primary 6 students were more explicit in describing what they perceived to be understanding which included knowing how to approach a problem, understanding and applying formula, and being able to apply theory to new problems. Secondary 3 students saw understanding as being important as it would enable them to do difficult problems and problems outside the curriculum.

As for Secondary 6 students, in addition to competence in solving problems, they associated understanding with awareness of one's own knowledge and being able to apply it, identifying one's mistakes, seeing patterns, and knowing the variations of a particular type of problems.

Students' attitude towards mathematics

Students generally held a positive attitude towards mathematics. Some were neutral but most of the interviewees liked the subject. Different students might have started liking the subject at different levels; generally this occurred

whenever they mastered and understood the subject. Learning difficulties occurred when they could not solve problems, and could not understand the subject matter.

Primary 3 students liked the subject because they enjoyed the mathematics lessons and the computation, and because it gave them a sense of achievement. The students' fondness for the subject was always associated with how well they coped with it. Understandably, none of the students liked tedious computations and difficult problems in which they could easily make mistakes. Some mentioned Primary 3 as being the level at which they first learned to like the topics and could cope with the subject. Another common reason for liking the subject was that mathematics was concerned with computation, and interesting games, and did not require rote learning. Students from two schools said they liked the subject because they like the teacher.

Reasons given by Primary 6 students were similar. Some added problem solving, training of the mind, lively classroom atmosphere and interesting club activities as their reasons. In addition, they did not like long and difficult tests/examinations and contents which had little practical value.

The reasons for liking mathematics were similar for all the students from the Secondary 3, Secondary 4 and Secondary 6 students for all schools. They saw the subjects as being lively, a training of the mind, not requiring a lot of memorisation, practical, providing a sense of achievement and being useful for their future career. Besides, several Secondary 4 students liked mathematics because the subject helped them in other disciplines such as Geography and Economics. Students who enjoyed thinking highlighted the requirement of thinking and logic in the subject. This was very obvious in Secondary 6.

Another very important reason for liking mathematics was confidence in coping with the subject. It was mentioned at all levels in all schools. This was mentioned in many examples of individual experience. For example, one Secondary 3 student started to like the subject in secondary school because he learned to understand and cope with the subject. A Secondary 4 student said

that he used to be scared of the subject when studying in Mainland China but changed his attitude when he began to handle the subject confidently in Hong Kong. One Secondary 4 student said that he was not interested in the subject because he was not good at the thinking process that was required in mathematics. Secondary 6 students described as instances of failure when they could not find a solution or make use of what was learnt after a lot of thinking and trials.

Students' views on the curriculum

Primary levels

Primary 3 students generally liked topics that they found easy and manageable. Their favorite topics included: fractions, addition, subtraction and multiplication. Students from one school liked symmetry and working with patterns because the activities were interesting. Students from another school liked bar charts because it did not involve computation.

Students did not like topics which involved tedious calculations or those in which they made mistakes easily. Some had difficulty with money units which involved division, addition and subtraction, and topics dealing with circumference. Some found factorisation and algebra difficult.

Views of Primary 6 students were more divergent than those of Primary 3. The favorite and non-favorite topics varied according to individuals. For example, the Chinese abacus and magic squares were liked by some students but not welcomed by others. Students from one school did not like fractions, multiplication, and formulae that they learned in Primary 5. They also disliked series and sequence because they either found them tedious or were required to memorise formulae. Students from another school did not like two-dimensional figures, scale, areas of circles, positive/negative integers and rates because they were complicated, tedious and difficult.

As far as the curriculum in general was concerned, some students found that there were repetitions in Primary 3, e.g., bar charts. Some found that there was a sudden increase in the difficulty level in Primary 5, e.g. greatest common

divisor and least common multiple which they had not learned before. Some pointed out that the time allowed for teaching in Primary 5 was limited because of the preparation for the Academic Aptitude Test and they believed that some topics could be taught earlier, i.e., at Primary 1–4.

They saw primary mathematics as foundational and found it useful in daily life, for example, activities such as calculating prices in shopping and time in traveling. They, in general, believed that there would be more to learn in secondary school.

Secondary Three

The students liked topics which were related to real life, interesting, consisting of variations, appeared to be new and different from what they had learned in the past. Favorite topics and non-favorites varied between schools. Probability, equations, quadratic equations, inequalities, trigonometry, and mensuration were mentioned as favorites by one or two schools.

Many students found logarithm difficult and thought it was not useful. One school had a longer list of non-favorites than the other two. This list included: trigonometry (impractical, complicated, difficult), geometry (difficult), quadratic equations (complicated), graphical method of solving quadratic equations (difficult), percentages (difficult), and factorisation (involving a lot of numbers).

For the general aspects, students thought that mathematical skills were acquired through practice. They thought that breadth was more important than depth and criticised the current curriculum as being insufficient in depth. They also saw the need for coordination between different subjects, e.g., bearings was taught in geography and thus unnecessary, and trigonometry should focus on its uses in physics. They felt that there were too many topics which were taught far too quickly. More than one student found repetition boring and said that it should be avoided. For example, trigonometry could start in Secondary 4.

Secondary Four

In general, students found the mathematics syllabus for Secondary 4–5 far

too long for the time allocated to the subject.

The factors affecting students' liking of a topic varied. The most important reason was that they found the topic easy and manageable. That is, their feeling towards a specific topic depended on the strength of their confidence in the topic. For this reason, some students would like geometry, volume, circle, factorisation, quadratic equations, remainder theorem, linear programming, probability and statistics. Another reason was associated with students' exposure to the topics. Some students who had studied Additional Mathematics found the topics repeated in general mathematics easier. A student from Mainland China found that certain topics taught in Hong Kong were easier than those taught in China, e.g., trigonometry.

Another criterion for choosing their favorite topics was the relevance to real life. The favorite topics were statistics and percentages. Some students liked a topic because of its intrinsic mathematical nature. For example, some liked problems in statistics because they knew how to obtain a definite answer. Some liked problems in trigonometry because they appreciated that the links between diagrams and formulae gave a predictive power and they had fun solving the problems.

Findings show that different students found difficulty in mathematics at different school years. Some students found the difficulty level of Secondary 3–5 mathematics to be similar. Some found the Secondary 5 mathematics most difficult. On the other hand, some began to like the subject in Secondary 3 because the problems were more interesting. One student found that the mathematics taught in Secondary 1 was mostly a repetition of that taught in Primary 5–6 and he had difficulty adjusting to the more difficult level in Secondary 2 level.

Students generally did not like topics that they found difficult and in which they easily made mistakes. This criterion was similar to that in primary and secondary 3. For example, students found word problems difficult because they could easily misinterpret the meaning of the questions; similarly they

found 3-dimensional problems difficult because mistakes could be made by mis-reading diagrams. Other topics were the bisection method, and arithmetic and geometric sequences. They also queried the value of coordinate treatment of straight lines and circles. Probability was difficult because it needed a very good understanding of the concepts. Some did not like topics that required a lot of memorising, e.g., indices, and approximation solution of simple equations.

When asked for suggestions for changes, they mentioned some general principles and some specific rearrangement between different levels. First of all, there should be more real life examples given for each topic to enable students to see its applications. The unimportant topics should be removed. They also believed that Secondary 1–3 were the foundation years when they could learn the basics in mathematics but some students found that a number of topics were repeated throughout the secondary level, e.g. the topic of indices was covered in Secondary 3 and therefore should not be repeated in Secondary 4–5. Some would like to move some Secondary 4 topics such as functions, proportions and quadratic equations to Secondary 3 to allow more time for other topics. Similarly, some Secondary 4 topics could be taught in Secondary 5. One suggested putting arithmetic and geometric sequences to lower grade levels, but was concerned about the linkage problems created (i.e., how these topics fit in with others in the lower grade level syllabuses).

Some of their comments referred to the streaming issue. Some felt that one mathematics syllabus for all students was unfair for the students studying arts subjects because they needed more time than Science students to learn mathematics and that Arts and Science students might not perceive the usefulness of mathematics in the same way. One student suggested designing two different mathematics syllabuses, one for students of Arts and the Social Sciences and the other for Science students. Some thought that Additional Mathematics was more fun and had more variations. Some believed that taking Additional Mathematics required a higher level of ability in mathematics. One student suggested that Arts and Science students could study the same mathematics syllabus, but special arrangements should be made in examinations.

The student suggested having different papers with questions of different difficulty levels for Arts and Science students.

Secondary Six

In general, they felt that there was insufficient time to cover the curriculum. Sometimes, teachers did not spend enough time on certain topics. They found that the textbooks did not contain enough examples and the examples lacked variety. When compared with mathematics at lower grade levels, the Secondary 6 mathematics syllabus was more abstract and complicated.

They did not have any specific favorite topics. They generally did not like memorising formulae and topics which they found difficult. Examples of topics they disliked were: calculation of the mode and median in histogram (very complicated), trigonometry in Additional mathematics (difficult to remember the rules), percentages (dealing with a lot of English and going through tedious procedures), probability (demanding precision in the thinking process), permutations and combinations (easily confused), standard deviation, set, complex numbers (not practical, meaningless), and application of differentiation and limit (difficult).

As for the AS level, there were the following comments: some found AS Applied Mathematics much more difficult than that of Secondary 5 in that it required a great deal of thinking. However, given sufficient time and making good effort, they could manage. Some thought there was little difference in using English or Chinese in Mathematics and Statistics. One student commented that students with background in Secondary 4 – Secondary 5 Additional Mathematics would find integration and differentiation in Mathematics and Statistics easier to manage. Another student shared the same view, saying that background in Applied Mathematics would help the learning of integration and differentiation.

They were not very excited by the use of computer in learning mathematics. There were several reasons for their reservation. First, a computer could not answer all their queries. Second, they might waste time if

they were not familiar with the operations. Third, they preferred the close relationship with their teachers if they were able to talk to them. However, they found the computer efficient in drawing graphs. Some believed that 20–30% of lesson time spent with a computer was quite acceptable.

Conclusion

The above results gave a clear picture of what the students considered to be an ideal learning environment. In sum, the students showed high regard for mathematics. Students found mathematics interesting especially at lower grade levels, though negative feelings on the subject began to emerge as they moved up the grade levels. That is related to the interest in the curriculum and the quality of teaching. Many students described the mathematics class as boring. Students repeatedly asked for the introduction of more lively teaching methods and quality textbooks. They suggested that more pictures in textbooks, teaching aids, real life applications, and mathematics-related extra-curricular activities such as games, would be helpful.

As previous studies have found (Wong, Lam, & Wong, 1998), students perceived mathematics as a subject which was practical, calculable and involved thinking. In fact, students repeatedly opted for a deep level of understanding as against rote-memorisation throughout their responses. They wished that teachers could immediately show them the correct way of tackling mathematical problems.

Students began to face learning difficulties at Primary 6 and at this stage the question of the practicability of the learning content emerged. It was at this level that they felt the pressure of homework. Students were also concerned about the disruption resulting from preparations for the Academic Aptitude Test. Secondary 3 students found the junior secondary mathematics syllabus fragmented. The repetition of Secondary 1 topics that had already appeared at primary levels and recurring topics at junior secondary levels distracted the students from seeing the mainline progression. We discovered that the greatest percentage of drop-outs occurred at the Secondary 4 level. Senior secondary students in general felt that the current Mathematics/Additional Mathematics

curriculum structure could not cater for their individual needs, in particular, those studying in the Arts stream. Secondary 6 students had similar problems, saying that Pure Mathematics was too abstract and the other two subjects (Mathematics & Statistics and Applied Mathematics) too impractical. The linkage of subject matter between sixth-form mathematics and senior secondary mathematics was not clear.

There were a number of topics the student wanted to remove from the curriculum, because they perceived them as being either difficult or impractical (irrelevant). Some of them are paper-folding (Primary 3), equations at Primary 6 (too difficult), figurate numbers (Primary 6: impractical). While Secondary 3 felt coordinated geometry of straight lines, common logarithm, probability & statistics, and inequalities to be difficult, Secondary 4 students mentioned trigonometry, circles, polynomials, proportion and variation, inequalities, and 3-dimensional problems.

A significant theme emerged throughout the study: the teacher was of the utmost importance to learning. A good teacher, according to their description, is one who is conscientious, prepares his/her lessons well, is skilful in creating a relaxed atmosphere yet keeping good order in the classroom. They expressed the view that students should be actively involved in the lessons but at the same time they should be quiet and attentive. They also wished to have more collaborative activities among classmates. The teachers' personal interest in the students and his/her ability to give clear explanations were also seen as important. The students expected the teacher to be able to provide clear, step-by-step explanations to help students solve problems. The teachers should also check from time to time if the students understood the lesson and give exercises that are appropriate to their ability (not too difficult nor too routine) and are thought-provoking. To this end, a tight curriculum resulting in a hasty attempt to complete it in a given time would surely have detrimental effects on student's learning. All these findings are consistent with those of other research studies conducted locally and abroad (Anderson, Ryan, & Shaprio, 1989, p. 292; Wong, N.Y., 1993, 1996).

Finally, we conclude with a summary of the characteristics which, in the students' minds, constitute the ideal mathematics lesson.

An ideal mathematics lesson is one in which:

(a) The lesson is thoroughly prepared with the objective of cultivating students to think and to understand the subject matter. The teacher shows concern for each student and encourages each one to work to the best of his/her ability.
(b) The classroom atmosphere is relaxed but focused to enable students to maintain a high level of interest and involvement.
(c) Classmates can collaborate and assist each other in learning.
(d) Discipline is maintained so that students can focus on the lesson.
(e) There are opportunities for students to achieve good results. Thus, students can develop a sense of achievement and maintain their motivation for learning.

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