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Students' Views of Mathematics Learning: A Cross-sectional Survey in Hong Kong *

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As a part of a commissioned research to investigate views of various stakeholders on the existing mathematics curriculum in Hong Kong, a questionnaire survey was administered to a random sample of 9,696 primary and secondary students to study their conceptions of mathematics, their attitude toward and habits of learning mathematics, and the perceived difficulty level of various mathematics topics. The data collected showed a clear picture of students' perception of mathematics learning with regard to categories of interest, preference for understanding, confidence and competence, textbooks, classroom learning and outside-class learning, and learning habits. It also depicted substantial trends of changing views and attitudes toward mathematics learning across grade levels. Students' responses to the Conception of Mathematics Scale were consistent with previous studies of a much smaller scale, and demonstrated some specific characteristics of their views of mathematics. This survey has provided useful background information regarding students' needs and aspirations in mathematics learning for curriculum planners and frontline teachers in future curriculum reform and implementation.

* The research was commissioned by the Education Department, Hong Kong.

Introduction

The policy of nine-year compulsory education has been fully implemented for nearly twenty years in Hong Kong. Despite the optimistic expectations of the community in the early years, the quality of education in the second decade of its implementation has aroused the concern of the public in general and educators in particular. A comprehensive review of compulsory education has revealed that mathematics, just next to English, is the subject which children find most difficult (Wong, 1996). Moreover, the proportion of students who encounter difficulties in learning mathematics increases from Primary 3 onward. These findings indicate an urgent need to improve curriculum and instruction in this subject.

The school curriculum is a major factor shaping the quality of education (Education Commission, 1999). It has been recognized that the quality of mathematics education directly affects learning in other scientific disciplines, hence influencing the development of human resources in the field (see for example, Education and Manpower Bureau, 1993; Education Commission, 1999). This is seen most clearly in a highly technological society such as Hong Kong, where every citizen needs to become mathematically literate (Mathematical Sciences Education Board, 1989).

Research and experience in different parts of the world suggest that comprehensive appraisals should be carried out before the commencement of curriculum reform (Lawton, 1989; Skilbeck, 1984). Certainly, comprehensive appraisals of curriculum reform before its commencement were performed in countries other than Hong Kong. *Mathematics Counts* ("Cockcroft's report" of the Committee of Inquiry into the Teaching of Mathematics in Schools: Cockcroft, 1982) of the U.K. and *Everybody Counts* (Report to the Nation on the future of mathematics education: Mathematical Sciences Education Board, 1989) of the U.S. are two well-known examples of research into mathematics education.

In 1997, in response to the needs for a comprehensive curriculum review in Hong Kong, an ad hoc committee was set up by the Curriculum Development Council to conduct a holistic review of the mathematics curriculum from primary school right up to the sixth form level. The authors were commissioned to investigate the views of various stakeholders, including students, teachers, parents, university professor, employers and curriculum planners, on the existing mathematics curriculum. While the entire report could be found in Wong et al. (1999), we would focus, in this article, on our findings on students' views of mathematics.

The close relationship between students' view on mathematics and their learning of mathematics has been widely recognized (e.g., Pehkonen & Törner, 1998; Schoenfeld, 1989, 1992; Silver, 1985; Underhill, 1988; Wittrock, 1986). On the one hand, students' experiences in learning mathematics influence the formation of their views (Wong, 2000, 2001). On the other hand, their views or beliefs affect how they behave in learning situations, which in turn affect the way they learn mathematics (Frank, 1988; Spangler, 1992). Pehkonen and Törner (1998) see mathematical beliefs as a regulating system which has a prognostic character. In their words, mathematical beliefs form a frame for an individual's knowledge structure which broadly influences the mathematics performance of the individual. For example, when a student sees mathematics merely as calculations, this understanding of the student is often a result of a teacher-dominated learning situation with special emphasis on calculations. In that case, tasks which require a deep level of thinking might be difficult and even impossible for the student (Wong, 2000, 2001). In the present article, we study students' views of mathematics and mathematics learning, including their conception of mathematics, their attitude toward mathematics, their learning habit in mathematics, and their perceived difficulty in learning mathematics. The findings, we believe, will present an important reflection of the realistic learning situation of mathematics classroom in Hong Kong from the learners' perspective.

To elaborate, we aim at investigating the following in our study:

1. students' conception of mathematics (e.g., "Is mathematics seen as being calculable and useful, and involving thinking?");
2. students' attitudes toward mathematics learning such as interest, preference for understanding, and confidence;
3. their perception of classroom learning and the habit of learning mathematics; and
4. the levels of difficulty of various topics as perceived by the students.

Methodology

Sampling and Administration

The study was carried out in May 1998. The survey went through a two-step random sampling procedure. First, a random sample of 90 primary schools and 50 secondary schools out of all local government and

subsidized schools was selected. Then, in each chosen primary school, one Primary 3 and one Primary 6 classes were selected at random, and in each chosen secondary school, one Secondary 3, one Secondary 4 and two Secondary 6 [1] classes were selected at random. The students in these classes were requested to respond to a questionnaire. The overall return rate was 95%. The characteristics of the respondents are listed in Table 1 and the numbers of respondents in different streams (Science, Arts, Commerce) in senior forms are listed in Table 2. We understand that some of the respondents did not take any mathematics course in the current year, yet as they are still the end-users of the mathematics curriculum, how they perceive mathematics and mathematics learning was also included in the present study.

Table 1 Characteristics of Respondents

	Primary 3	Primary 6	Secondary 3	Secondary 4	Secondary 6	Total
Male	1,192	1,401	852	711	1,046	5,202
Female	1,037	1,229	505	642	373	3,786
Unidentifiable	118	16	127	3	444	708
Total	2,347	2,646	1,484	1,356	1,863	9,696

Table 2 Streams of the Participants in Senior Secondary Grades

	Arts	Science	Commerce	Others
Secondary 4	340	648 *	207	161
Secondary 6	373	1,046	434	10

* Of the 648 Secondary 4 students in the Science stream, 220 students study general mathematics and 428 students study Additional Mathematics in addition.

Instruments

In the student questionnaire for Primary 3, Primary 6, Secondary 3, Secondary 4 and Secondary 6, students were requested to:

1. rate the level of perceived difficulties of the topics they learned in the current academic year, and how difficult they find the learning of specific topics within the curriculum;
2. respond to 30 questions of questions [2] about their attitude toward and habits of learning mathematics, such as their confidence in doing mathematics and their dependence on teachers and textbooks;
3. respond to 27 items of questions about their conception of

mathematics (the item about "what they think mathematics is" was excluded from the Primary 3 questionnaire to make it shorter for these young students);

4. indicate the time they spent in the previous week on homework in general and mathematics homework in particular; and
5. indicate whether they had private tutors (or attended tutorial classes) outside their schools.

The questionnaire items for all grade levels were set in Chinese, the mother tongue of the respondents. Pilot tests of the student questionnaire were performed with 540 students (62, 69, 208, 156 and 45 from Primary 3, Primary 6, Secondary 3, Secondary 4 and Secondary 6 respectively). Based on the feedback about the pilot tests, a number of minor amendments and standardization in procedures were made. Details of the instruments used are listed as follows.

Perceived Level of Difficulty

The topic names used in the questionnaire for secondary classes were taken from the mathematics syllabuses issued by the government (Curriculum Development Committee, 1985; Curriculum Development Council, 1991a, 1991b, 1992a, 1992b, 1992c); those for primary classes were taken from popular textbooks as it was believed that the topic names listed in the syllabuses would be too technical for primary school students. Students were requested to rate the level of perceived difficulty of each of these topics on a 5-point Likert scale (1 = very difficult, 2 = difficult, 3 = fairly easy, 4 = easy, and 5 = very easy). Since the questionnaire was administered in May (i.e., near the end of the academic year), most of the topics listed should have been taught. However, if the topic had not yet been taught, students were requested to check across the column "not yet taught" instead of rating the level of difficulty. For each individual topic, those respondents who reflected that the topic had not yet been taught did not go into the analyses. Those sixth formers who did not take mathematics in the current year will check across the column "not yet taught" for all the topics.

Attitude Toward Mathematics and Habits of Learning

The subscale comprised 4 items on interest, 6 items on preference for understanding, 3 items on confidence, 4 items on competence, 5 items on

textbooks and classroom learning, and 3 items on outside-class learning. They were set in a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = fairly agree, 4 = agree, 5 = strongly agree). It was supplemented by 2 items on habits of learning, with four options each.[3] These options can be found in Table 6. These questionnaire items had been used before in the local context with satisfactory results (Cheng & Wong, 1991; Wong & Cheng, 1991a, 1991b).

Conception of Mathematics

The Conception of Mathematics Scale was developed through a local, grounded research conducted by Wong, Lam, and Wong (1998). It consisted of 14 items on the notion that "mathematics is a subject of 'calculables'" (sample item: "Mathematics is a subject that involves addition, subtraction, multiplication and division"), 6 items on "mathematics involves thinking" (sample item: "Learning mathematics cannot be relied on rote memorization"), and 6 items on "mathematics is useful" (sample item: "Mathematics is widely applicable in daily life"). They were set in a 5-point Likert scale. The questionnaire was administered to Primary 6 to Secondary 6 students only.

Results

Perceived Difficulty of Topics

At present there is only one general mathematics syllabus for Primary 1 to Secondary 3. At the level of Secondary 4 and 5, there are two mathematics syllabuses: one is also a general mathematics syllabus for all students, and the other is an Additional Mathematics syllabus for the more mathematically oriented students. In Secondary 6 and 7, four mathematics syllabuses are offered, namely Advanced Supplementary Level (AS) Mathematics and Statistics, AS Applied Mathematics, Advanced Level (AL) Pure Mathematics, and AL Applied Mathematics. Except the AS Mathematics and Statistics, these syllabuses require a strong mathematics background. One AS subject equals approximately half an AL subject in content.

A list of topics was given to the students for rating. The topics for the secondary classes were taken from the mathematics syllabuses issued by the government (Curriculum Development Committee, 1985; Curriculum Development Council, 1991a, 1991b, 1992a, 1992b, 1992c). Those for

primary classes were taken from popular textbooks. Students were requested to rate the level of perceived difficulty of each topic on a 5-point Likert scale (1 = very difficult, 2 = difficult, 3 = fairly easy, 4 = easy, and 5 = very easy). The result is summarized in Table 3.

Table 3 shows that as students moved up the grade levels. they found mathematics more and more difficult. The mean score of Primary 3 students' rating was 4.24, with a downward trend to about 2.6 in Secondary 6. A more refined picture emerges as we take into account the topics which they rated the easiest or the most difficult.

Primary 3 students did not perceive any difficulty with any of the topics. The rating had a high mean score of 4.24 and a relative small range from 3.81 to 4.68. For Primary 6, the range widened, and the mean dropped sizably to 3.80. Topics with the greatest perceived difficulty were "application of algebraic equations to solve algebraic problems," "percentage and its application," and "speed." The easiest topics were "symmetry," "curve stitching," and "positive and negative numbers." Comparing the two sets of topics, it is observed that the easy topics for Primary 6 students are those which do not involve calculations.

In Secondary 3, the range narrowed but the mean continued to drop noticeably. In fact, none of the topics had a mean score higher than 4. The most difficult topics were "coordinate geometry of straight line" and "common logarithm." For Secondary 4 mathematics, the pattern of change — the narrowing of the range and the drop in the mean — continued and the most difficult topics were "applications of trigonometry" and "probability and statistics." Even the easy topics ("quadratic equation in one unknown, surds" and "proportion and variation") had a low mean score.

Let us turn to the situation after streaming in Secondary 4.

In Secondary 4, those students who showed greater aptitude in mathematics took Additional Mathematics. Despite the streaming, the mean score for these students dropped further. In other words, most of the topics were perceived by the students to be difficult. The most difficult topics were "integration" and "trigonometry," both of which involve tedious computations. This may be a reason for the low rating. Even the easiest topic "mathematical induction" had a low mean score of 3.08.

Further streaming took place at Secondary 6, which offers AL Pure Mathematics, AL Applied Mathematics, AS Mathematics & Statistics, and AS Applied Mathematics. The mean scores in Table 3 show that, in general, Secondary 6 students had difficulty in the subject. The means varied between 2.62 and 2.74.

Table 3 The Two Easiest and the Two Most Difficult Topics as Perceived by Students

	Range and mean*	The two easiest topics and their mean scores (in parenthesis)	The two most difficult topics and their mean scores (in parenthesis)
Primary 3	3.81–4.68 mean = 4.24	• Bar charts (4.68) • Addition and subtraction of fractions with the same denominator (4.56)	• Mixed manipulation with multiplication and division (3.81) # • Factors and multiples (3.82) #
Primary 6	2.99–4.62 mean = 3.80	• Symmetry (4.62) • Curve stitching (4.62)	• Application of algebraic equations to solve algebraic problems (2.99) • Percentage and its applications (3.17) #
Secondary 3	2.71–3.47 mean = 3.15	• Percentages (3.47) • Uses and abuses of statistics (3.47)	• Coordinate geometry of straight line (2.71) • Common logarithm (2.94)
Secondary 4 Mathematics	2.73–3.31 mean = 3.08	• Quadratic equation in one unknown, surds (3.31) • Proportion and variation (3.23)	• Applications of trigonometry (2.73) • Probability and statistics (2.89)
Secondary 4 Additional Mathematics	2.41–3.08 mean = 2.95	• Mathematical induction (3.08) • Quadratic equation and quadratic function (2.79)	• Integration (2.41) • Trigonometry (2.45)
Secondary 6 Advanced Supplementary Level Mathematics and Statistics	2.00–3.00 mean = 2.66	• Normal distribution and its applications (3.00) • Population and sample statistics (3.00) • Frequency distribution and fitted probability distribution (3.00)	• Bernoulli, binomial, geometric and Poisson distributions (2.00) • Permutation and combination (2.26)
Secondary 6 Advanced Supplementary Level Applied Mathematics	2.38–2.95 mean = 2.74	• Fixed point iteration, Newton's law and secant method (2.57) • Lines of best fit (2.95)	• Probability (2.38) • Vectors (2.57)
Secondary 6 Advanced Level Applied Mathematics	2.33–3.80 mean = 2.66	• Interpolation (3.80) • Basic statistical measure (3.31)	• Simple harmonic motion (2.33) • Motion of rigid body (2.36)

Table 3 (Cont'd)

	Range and mean*	The two easiest topics and their mean scores (in parenthesis)	The two most difficult topics and their mean scores (in parenthesis)
Secondary 6 Advanced Level Pure Mathematics	2.15–3.07 mean = 2.62	• Mathematical induction (3.07) • System of linear equation (3.00)	• Complex numbers (2.15) • Sequences, series and their limits (2.24)

* 1 = very difficult, 2 = difficult, 3 = fairly easy, 4 = easy, and 5 = very easy

\# Though it is one of the two most difficult topics, it is still perceived as easy as reflected by the Likert scale.

For the AL Pure Mathematics group, "complex numbers" and "sequence, series and their limits" were found to be the most difficult topics. Students' prior acquaintance with these topics in Secondary 4 Additional Mathematics did not make their sixth form work any easier. The easiest topic they perceived was "mathematical induction." This was consistent with the situation in Secondary 4.

As for Applied Mathematics, the slightly higher level of difficulty in the AL than the AS level was not unexpected as the students who took the AL syllabus generally achieved higher entrance qualifications.

Although the two AS level subjects were designed for students with lower mathematical ability, they did not appear to be easy for the students. The ratings for all the topics were found in a narrow range.

Students' Attitudes Toward Mathematics

As shown in Table 4, the three statements that Primary 3 students most agreed to were "I wish there could be more pictures in the textbook so that I can understand the content better" (mean = 4.16: those who agreed outnumbered those who did not by 65%), "I have confidence in doing numerical computations" (mean = 4.02, difference = 64%), and "I am interested in mathematical calculations" (mean = 3, difference = 57%). On the other hand, the three statements that these students most disagreed to were "Understanding the content is unimportant; but it is important to know how to do the calculations in examinations" (mean = 2.00, difference = 59%), "It is not necessary to read the textbook; the teacher will explain everything" (mean = 2.27, difference = 42%), and "I seldom try those problems not required by the teacher" (mean = 2.61, difference = 25%). It is obvious, therefore, that

Table 4 The Three Statements Students Most Agreed to and the Three Statements Students Most Disagreed to

	Statements that most agreed to	Statements that most disagreed to
Primary 3	• "I wish there could be more pictures in the textbook so that I can understand the content better." • "I have confidence in doing numerical computations." • "I am interested in mathematical calculations."	• "Understanding the content is unimportant; but it is important to know how to do the calculations in examinations." • "It is not necessary to read the textbook; the teacher will explain everything." • "I seldom try those problems not required by the teacher."
Primary 6	• "I have confidence in doing pure numerical computations." • "I wish there could be more pictures in the textbook so that I can understand the content better." • "If I understand the concept concerned, I can always find a way to calculate the problems."	• "I often take part in mathematics extracurricular activities." • "Understanding the content is unimportant; but it is important to know how to do the calculations in examinations." • "It is not necessary to read the textbook; the teacher will explain everything."
Secondary 3	• "I would use calculators for numerical calculations." • "If I understand the concept concerned, I can always find a way to calculate the problems." • "Though I know how to calculate, sometimes I don't know the reasons for the calculation."	• "I often take part in mathematics extracurricular activities." • "I often read mathematics 'supplementary readers'." • "It is not necessary to read the textbook; the teacher will explain everything."
Secondary 4	• "I would use calculators for numerical calculations." • "Though I know how to calculate, sometimes I don't know the reasons for the calculation." • "If I understand the concept concerned, I can always find a way to calculate the problems."	• "I often take part in mathematics extracurricular activities." • "I often read mathematics 'supplementary readers'." • "I have confidence in doing word problems."

Table 4 (Cont'd)

	Statements that most agreed to	Statements that most disagreed to
Secondary 6	• "I would use calculators for numerical calculations." • "Though I know how to calculate, sometimes I don't know the reasons for the calculation." • "When learning a new topic, I wish that I could think it through by myself first and not having the teacher telling me everything."	• "I often read mathematics 'supplementary readers'." • "I often take part in mathematics extracurricular activities." • "It is not necessary to read the textbook; the teacher will explain everything."

their responses were unanimously positive with regard to their attitude toward the subject.

For Primary 6 students, the three statements that they most agreed to were "I have confidence in doing pure numerical computations" (mean = 3.73, difference = 46%), "I wish there could be more pictures in the textbook so that I can understand the content better" (mean = 3.64, difference = 39%), and "If I understand the concept concerned, I can always find a way to calculate the problems" (mean = 3.58, difference = 38%). Though the responses were still relatively positive, they began to diversify slightly. The three statements students most disagreed to were "I often take part in mathematics extracurricular activities" (mean = 2.14, difference = 60%), "Understanding the content is unimportant; but it is important to know how to do the calculations in examinations" (mean = 2.16, difference = 58%), and "It is not necessary to read the textbook; the teacher will explain everything" (mean = 2.20, difference = 57%).

For Secondary 3, the three statements students most agreed to were "I would use calculators for numerical calculations" (mean = 3.77, difference = 51%), "If I understand the concept concerned, I can always find a way to calculate the problems" (mean = 3.47, difference = 32%), and "Though I know how to calculate, sometimes I don't know the reasons for the calculation" (mean = 3.38, difference = 26%). While the second statement depicted a positive attitude toward mathematics, it was superceded by another statement which concerned mere technicalities of mathematics. Moreover, the mean score of the second statement dropped a little bit from 3.58 (the mean score of the same statement for

Primary 6) to 3.47. On the other hand, the apparent contradiction between the second and the third statements indicated the discrepancy between "preference" and "reality." Students realized the importance of understanding, but it was not often that they did understand. The three statements students most disagreed to were "I often take part in mathematics extracurricular activities" (mean = 1.72, difference = 87%; an almost unanimous response), "I often read mathematics 'supplementary readers'" (mean = 1.84, difference = 79%; again quite unanimously), and "It is not necessary to read the textbook; the teacher will explain everything" (mean = 2.25, difference = 59%). This might indicate a strong textbook-dependence in mathematics learning.

As for Secondary 4, "I would use calculators for numerical calculations" (mean = 3.80, difference = 56%), "Though I know how to calculate, sometimes I don't know the reasons for the calculation" (mean = 3.42, difference = 38%), and "If I understand the concept concerned, I can always find a way to calculate the problems" (mean = 3.38, difference = 26%) remained to be the statements students most agreed to, though their order changed a bit. At the other extreme, "I often take part in mathematics extracurricular activities" (mean = 1.74, difference = 83%) and "I often read mathematics 'supplementary readers'" (mean = 1.79, difference = 81%) remained the two statements students most disagreed to. The third was replaced by "I have confidence in doing word problems" (mean = 2.26, difference 58%). In fact, this statement was the fourth statement that Secondary 3 students most disagreed to (and only the eighth statement for Primary 6 students). It showed that more negative attitude toward learning mathematics had begun to set in from Primary 6.

In Secondary 6, the statements students most agreed to were "I would use calculators for numerical calculations" (mean = 3.93, = difference 61%) and "Though I know how to calculate, sometimes I don't know the reasons for the calculation" (mean = 3.49, difference = 34%). The third was replaced by a very positive statement: "When learning a new topic, I wish that I could think it through by myself first and not having the teacher telling me everything" (mean = 3.33, difference = 21%). Although those who agreed with this statement outnumbered those who did not by only 21%, this presumably indicates that these students wished to opt for deeper understanding. It is another question whether students were really competent enough to do so. In general, compared with their junior counterparts, sixth-formers were more mature in learning mathematics. As to the most-disagreed-to statements, "I often read mathematics 'supplementary readers'" (mean =

1.67, difference = 87%) and "I often take part in mathematics extracurricular activities" (mean = 1.69, difference = 86%) remained the top two in the list. The third was substituted by "It is not necessary to read the textbook; the teacher will explain everything" (mean = 2.04, difference = 74%). "I have confidence in doing word problems" became the fourth.

Trends of Students' Attitudes

In order to have a clearer picture of the trends of students' attitude toward mathematics, observations were made according to these categories: interest; preference for understanding; confidence and competence; textbooks, classroom learning and outside-class learning; learning habits; and conceptions of mathematics.

Interest

Table 5 reveals that students' interest in solving mathematical problems, attending mathematics classes, and mathematical calculations all dropped substantially from Primary 3 to Primary 6 although their interest in learning mathematics maintained a score close to 3 throughout the grade levels.

Preference for Understanding

Table 5 shows that, in general, students at all levels realized that understanding was important. This is reflected in the low score (2.00 to 2.49) for "Understanding the content is unimportant …" and the high score (3.86 to 3.26) for "If I understand the concept concerned, I can always find a way to calculate the problems." Although there was a concern for understanding the reasons behind a formula, there was a slightly decreasing trend in this concern from Primary 3 to Secondary 6. Students tended to be more receptive to formulas in the higher grade levels.

Confidence and Competence

As far as confidence is concerned, the students' confidence in numerical computations and solving word problems dropped continuously. A similar pattern was found in how they perceived their competence in understanding the content in the mathematics class. A slight increase was also found in the

Table 5 Trends of Students' Attitudes Toward Mathematics

Item	Mean (on a 5-point scale)				
	P3	P6	S3	S4	S6
Interest					
I love solving mathematical problems.	3.82	3.19	3.13	3.10	3.12
I am very interested in attending mathematics classes.	3.86	2.99	2.79	2.89	3.00
I am interested in mathematical calculations.	3.91	3.03	2.90	3.03	3.07
I seldom try those problems not required by the teacher.	2.61	3.02	3.11	3.06	3.02
Preference for understanding					
Reading the explanations in the textbook is not necessary, we can learn just by reading the formulas.	2.27	2.20	2.25	2.28	2.11
When learning a new topic, I wish that the teacher could tell us the formula right away and not ask us to look for it out for ourselves.	2.48	2.73	2.73	2.71	2.71
When learning a new topic, I wish that I could think it through by myself first and not having the teacher telling me everything.	3.57	3.30	3.25	3.37	3.82
Understanding the content is unimportant; but it is important to know how to calculate in examinations.	2.00	2.16	2.27	2.49	2.44
If I understand the concept concerned, I can always find a way to calculate the problems.	3.86	3.58	3.47	3.38	3.26
In learning a new topic, I am not concerned with how the formulas come about, I only care about how the formula are applied in solving problems.	2.64	2.80	2.92	2.93	2.98
Confidence					
I have confidence in problems that involve substituting numbers into formulas.	3.30	3.08	3.24	3.33	3.39
I have confidence in doing pure numerical computations.	4.02	3.73	3.32	3.19	2.94
I have confidence in doing word problems.	3.73	2.95	2.36	2.26	2.32
Competence					
I fully understand the content in the mathematics class.	3.61	2.97	2.61	2.57	2.38
Usually I fully understand word problems.	3.53	2.93	2.48	2.42	2.63
I have difficulty in solving word problems.	3.06	3.05	2.73	2.72	3.17
Though I know how to calculate, sometimes I don't know the reasons for the calculation.	3.14	3.36	3.38	3.42	3.49

Table 5 (Cont'd)

Item	Mean (on a 5-point scale)				
	P3	P6	S3	S4	S6
Textbook, classroom learning and outside-class learning					
Usually I won't confine myself to reading the formulas of the textbook but I read the explanations too.	3.17	2.89	2.81	2.78	2.86
Teachers often ask us to read the explanation in the textbooks.	3.49	3.25	2.80	2.69	2.61
It is not necessary to read the textbook; the teacher will explain everything.	2.51	2.59	2.67	2.64	2.59
I wish there could be more pictures in the textbook so that I can understand the content better.	4.16	3.64	3.32	3.3	3.08
I hope that I could have less homework.	.95	3.40	2.92	2.68	2.48
I would use calculators for numerical calculations.	—	—	3.77	3.80	3.93
I often read mathematics "supplementary readers."	3.11	2.30	1.79	1.77	1.67
I often take part in mathematics extracurricular activities.	2.96	2.14	1.72	1.69	1.55

Notes: 1. P3 = Primary 3; P6 = Primary 6; S3 = Secondary 3; S4 = Secondary 4; S6 = Secondary 6.
2. The use of calculator was absent in the primary mathematics curriculum.

mean score of the statement "Though I know how to calculate, sometimes I don't know the reasons for the calculation."

To recapitulate, the trends in the above domains were consistent. Students did realize that just knowing how to calculate was not enough and understanding the concepts behind the calculation steps enabled one to be more effective in finding ways to solve problems. It is clear that students' interest and confidence dropped continuously as they moved up the grade levels. The drop was especially significant from Primary 3 to Primary 6. The same is true for their perceived competence in doing mathematics, especially in solving word problems.

Textbooks, Classroom Learning and Outside-class Learning

As the students moved up the grade levels, they relied more and more on textbooks. Younger students hoped for a more lively approach in their

textbooks, such as the inclusion of more pictures. It is worthwhile to note that Primary 6 is the only grade level that feels a pressure induced by homework. This is probably due to the need to prepare for the secondary school place allocation examination that takes place at that grade level. A low level of participation in mathematics-related extracurricular activities was also found.

Learning Habits

Table 6 reveals the part on students' learning habits in the questionnaire. The results indicated that most Primary 3 students took positive steps (e.g., consulting the teacher) to solve their problems and were reluctant to give up when they encountered learning difficulties. This habit shifted at Primary 6. Their intention to consult the teacher dropped noticeably. They preferred to seek help from their classmates. It is also at this grade level that most

Table 6 Learning Habits of Students

Item	Percentage (unless otherwise stated)				
	P3	P6	S3	S4	S6
When I meet difficulties in learning mathematics, I will					
(a) consult the teacher	41.2	18.8	15.7	16.7	13.6
(b) discuss with classmates	41.4	53.3	53.0	49.8	56.1
(c) search for references	15.9	23.8	23.1	23.0	25.1
(d) give up	1.4	4.0	8.1	10.3	4.9
When I meet difficulties in solving mathematics problems, I will *					
(a) insist on working them out by myself	25.2	9.0	8.5	7.6	9.5
(b) accept others' advice	61.7	31.9	60.9	61.2	62.4
(c) accept others' assistance	10.9	43.2	17.7	17.6	18.9
(d) don't mind copying others' work	2.2	15.8	12.6	12.9	9.0
The extent of topics that students did not know their applications (on a 5-point scale)	2.74	2.81	2.33	2.21	2.04
Number of hours spent weekly on homework	8.61	8.78	4.78	7.85	9.63
Number of hours spent weekly on mathematics homework	2.31	2.61	1.65	2.88	2.74
Percentage of time spent on mathematics homework	26.8	29.7	34.5	36.7	28.5
Students having tutors or tutorial class (%)	30.8	33.6	29.2	26.1	31.1

* The sum for Secondary 4 does not come up to 100% because of "missing values."

Note: P3 = Primary 3; P6 = Primary 6; S3 = Secondary 3; S4 = Secondary 4; S6 = Secondary 6.

students did not mind copying the work of others and over 40% of them relied on other people to find the solution. This is alarming. Fortunately, the rate of choosing to give up at this grade level was still low. This may be because peer influence is not quite strong until the stage of adolescence. The most worrying attitude toward learning difficulties was found among Secondary 4 students, who had the highest rate of opting for giving up.

Most of the students did not know how the mathematics they learned could be applied, and the extent of difficulty they encountered in learning mathematics increased with the grade levels. The same was also true for the extent of mathematics topics they did not understand.

As reported by the students, they used, on average, 8.13 hours per week on homework, and 2.45 out of the 8.13 hours per week on mathematics homework. The proportion of time spent on mathematics homework was around 30%, which was consistent with the figures obtained in earlier studies (Wong, 1992; Wong & Cheng, 1991a, 1991b). The highest percentages occurred at grade levels of Secondary 3 and Secondary 4. Furthermore, over 30% of the students either had private tutors or joined tutorial classes. The percentage reached its peak at Primary 6 and rose appreciably again at Secondary 6.

Conceptions of mathematics

Previous studies (Lam, Wong, & Wong, 1999; Wong, Lam, & Wong, 1998) reveal that students often perceive mathematics as a subject of "calculables," which could be the most tangible part of mathematics. Students in the early grades felt quite confident when tackling something that they can manipulate step by step. However, if this view is reinforced and the student sees this as the only aspect of mathematics, it could be an obstacle to deeper understanding of the discipline. Another facet of students' conception of mathematics is that mathematics involves thinking: mathematics is a "thinking exercise"; just as "physical exercises" strengthens the body, so doing mathematics strengthens the mind. Such a conception is common among the teachers, too (Wong, 2001). Another dimension of students' conception of mathematics found in earlier research studies is that mathematics is useful, particularly when applied to daily life.

Using the Conception of Mathematics Scale which was developed according to these three dimensions and the findings of earlier empirical research, it is found in the present study that the subjects strongly agreed with the statements in the subscale "mathematics is a subject of

Table 7 Students' Conception of Mathematics

Sub-scale	Mean (on a 5-point scale)			
	P6	S3	S4	S6
Mathematics is a subject of "calculables."	3.38	3.27	3.32	3.21
Mathematics involves thinking.	3.90	3.92	3.94	4.04
Mathematics is useful.	3.72	3.24	2.99	3.22

Note: P6 = Primary 6; S3 = Secondary 3; S4 = Secondary 4; S6 = Secondary 6.

'calculables'." The mean score ranged from 3.21 to 3.38. The perception that "mathematics involves thinking" was even stronger; the mean score for Primary 6 was 3.90 and it continued to increase to 4.04 at Secondary 6. As for the usefulness of mathematics, in general, students perceived mathematics as a useful subject. The only exception was found in Secondary 4, which showed a relatively low mean score of 2.99 (see Table 7).

Discussions

Research findings revealed that Primary 3 students were generally interested in mathematics but then the interest dropped substantially, especially at Primary 6. Among all students, the interest in attending mathematics lessons was not as high as the interest in mathematics itself. They also possessed a very positive attitude toward mathematics, opting for deep understanding rather than rote learning. Items in this aspect were mostly rated as "strongly agreed". Students unanimously agreed to the statement "When learning a new topic, I wish that I could think it through by myself first and not having the teacher telling me everything," and strongly disagreed with the opposite statement "When learning a new topic, I wish that the teacher could tell us the formula right away and not ask us to look for it for ourselves." This may surprise many of our mathematics teachers. This preference for a deep level of learning is in line with the oft-quoted findings that Asian learners have a strong preference for deep learning (Watkins & Biggs, 1996). Marton (1997) points out that Asian students realize that understanding is a better way than (and can replace) rote memorization (Marton, 1997). The students' responses in the present study reflected that they were not only concerned about how the formulas are applied to solving problems, but also how the formulas come about. They tended to believe that if one understands the concept concerned, one can always find a way to solve problems.

In addition, students showed confidence in solving problems, especially numerical and routine problems. However, they had trouble with word problems. Their confidence with word problems dropped as they moved up the grade levels, except for Secondary 6. It is possible that competence in language (English, in most cases) might have adversely affected performance in solving mathematical word problems.

However, this does not mean that students did not encounter problems in learning mathematics. They faced real (actual) learning problems — the discrepancy between what one hopes for and what one can really do. This could be the source of frustration and helplessness. This is evident from the fact that they strongly agreed with the statement "Though I know how to calculate, sometimes I don't know the reasons for the calculation."

When we look at the perceived difficulty of topics, we get a pessimistic picture. On moving up the grade levels, students' attitude toward mathematics learning became more and more negative and they perceived greater difficulty in the topics learned. There are a number of speculations of the reasons behind, but certainly we have to take into consideration that younger students may underestimate the learning difficulty they are facing. However, since mathematics is an "accumulative" subject, decreasing interest and accumulating learning problems at junior levels may turn out to be major learning difficulties at senior levels, especially when the content of learning becomes more abstract and requires more conceptual understanding.

If our students have interest and a high regard for mathematics, their declining performance could be attributed not only to their competence, but also to the mismatch of the curriculum in a broader sense. Curriculum developers and teachers should reflect upon whether our intended curriculum (curriculum documents, textbooks) and our implemented curriculum (including classroom teaching and teaching style) suit the needs of our students and help them to sustain their interest in the subject throughout their schooling. The desire for more pictures in the textbooks may be taken as an indicator of the urge for liveliness in teaching and teaching materials. The lack of interest in participating in mathematics extracurricular activities (including "supplementary readers") as indicated by the students' responses lends support to this speculation. Whether the problem lies in the lack of provision (of extracurricular activities), lack of enthusiasm in participation, or lack of time due to heavy homework needs further investigation and is beyond the scope of this research.

Our research suggests that more attention should be paid to two grade levels, namely Primary 6 and Secondary 4. The interest in mathematics

dropped noticeably at Primary 6, which was the only grade level that students hoped for less homework. We are not sure whether this is resulted from the pressure of the school place allocation examination on Primary 6 students. But definitely, over-drilling can hamper understanding, which needs both time and space to promote. Similarly, the problem became more noticeable at Secondary 4. Students showed no interest in mathematics textbooks, and they were also reluctance to pay effort to understand the subject. Also, Secondary 4 was the only grade level at which students did not perceive mathematics as a useful subject, though the respondents included both Arts and Science students and also students taking Additional Mathematics. In other words, even those mathematically oriented students who took Additional Mathematics did not consider mathematics as useful.[4] Besides, the rate of opting for giving up (when facing learning difficulties) was highest at this grade level. One of the reasons might be the inadequate provision of help to those who lag behind. Why was the problem so serious at Secondary 4? Basically, as students moved up the grade levels from Primary 6 to Secondary 5, they became more and more negative toward mathematics. Since we did not have the data about Secondary 5 students, it was natural that Secondary 4 was seen as having the most serious problem. The apparent turn-back at Secondary 6 might be due to a screening of Secondary 5 students based on academic achievement to select around 30% of them into Secondary 6. Those who were able enough to remain in the school system were, therefore, more academically motivated. Moreover, students may choose not to study mathematics at this level.

It is not easy (and may not even be desirable) to summarize a list of topics that students found the most difficult (or the easiest). But it seems that those topics involving technical (if not tedious) manipulations were least welcome by the students, whereas those requiring visual and hands-on experiences were students' favorites. Apparent difficulty and impracticality were also some of their concerns.

The new primary and secondary mathematics curricula for the new millennium have recently been published (Curriculum Development Council, 1999, 2000). Nevertheless, this is just the beginning of curriculum reform. A great deal of effort is needed to ensure that the spirit of the curricula is understood and practiced by all concerned. In this light, the present research offers timely information on the learning style of students and the difficulties they face. The rich data collected in this research offer curriculum planners and frontline teachers a full picture of mathematics education in Hong Kong, in which the study was conducted. Though a few years have elapsed

since the survey was carried out, we believe that some basic information is still valid. With this information in hand, curriculum planners and teachers should be able to have a better curriculum implementation. On the other hand, there is a pressing need to cater for learner differences and to devise means to help students with learning difficulties. Curriculum tailoring and differentiation should be considered. In such an examination-oriented culture, every care should be taken to safeguard students from ever-increasing examination pressure and its backwash These research findings could help not only educators in Hong Kong, but also those in regions with similar socio-cultural settings, to understand how students perceive mathematics learning.

Notes

1. Secondary 6 classes usually have a smaller size.
2. Seven items and one item were omitted in the Primary 3 and Primary 6 questionnaires respectively due to the irrelevance of these items (e.g., the items about formulae were deleted from the Primary 3 questionnaire as Primary 3 syllabus does not cover formulae). So the numbers of items in the Primary 3 and Primary 6 questionnaires in this part were 23 and 29 respectively.
3. The numbers of items for Primary 3 and Primary 6 were reduced for the same reason as stated in note 2.
4. In the questionnaire, students were asked how useful mathematics was perceived in real life rather than in one's personal career.

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