5. INTERVIEWS WITH STUDENTS

5.1. Sampling

Sixty students from twelve schools were invited to attend a semi-structured interview, in groups of four. Among these 15 groups, from grade levels of P.3, P.6, S.3, S.4 and S.6, we chose one from a school of high academic standard, one from an average school and one from a school of relatively low academic standard. Among these schools, three schools provided two grade levels to be interviewed. Each group consisted of four students (there were boys and girls, except for those from single-sexed schools) who came from at least two different classes taught by different mathematics teachers.

5.2. Interview questions and procedures

The interview questions focused on the following aspects:

(a) Classroom teaching: The elements, features and characteristics in mathematics teaching as perceived by students that may foster or hinder mathematics learning.

(b) The curriculum: Students' perception of the relationships between the usefulness and the difficulties in learning specific mathematics contents of the curriculum.

As a warm-up exercise before the interview, the students had to respond to three written open-ended questions. These questions had been used in a local research and yielded fruitful results (Wong, 1993a, 1993b, 1996). They are:

(a) Mathematics is …
(b) Mathematics learning is …
(c) The mathematics class is …

The interview which immediately followed the completion of these questions lasted for about 45 minutes. All interviews were audio-taped, transcribed and content-analysed.

5.3. Results: open-ended questions

The three open-ended questions probed into the students' perception of mathematics, mathematics learning and mathematics classroom respectively. The students' written responses were analysed and the results are given below.

5.3.1. Perception of mathematics

5.3.1.1. Primary Three

Most P.3 students said that mathematics was something interesting, but they were not specific about what they found interesting. Some students focused on learning in general:

> Mathematics is about acquiring learning a lot of knowledge. (Sz-P3-1-L)[(5)]
> Mathematics is a subject. (Sz-P3-4-L)

One P.3 student focused on subject specific learning. This response also concerned the intrinsic nature of mathematics:

> Mathematics is +, −, ×, ÷. (Sze-P3-3-L)

5.3.1.2. Primary Six

New categories emerged in P.6 students' responses. An outstanding one was the appreciation of the functional aspect of mathematics. We got responses like,

> Mathematics helps people think. (Md-P6-3-H)
> If we do not learn mathematics, we will not know how to do computation. (Tg-P6-1-M)
> Mathematics trains our mind to be more active. (Tg-P6-2-M)
> Mathematics trains our mind. (Tg-P6-3-M)
> Mathematics exercises our brain. (Tg-P6-4-M)
> Mathematics helps us record or calculate quantity. (Sz-P6-2-L)

It could be seen that many students saw doing mathematics as a training of the mind.

Primary 6 students used "interesting", "difficult" and "challenging" to describe their perception of mathematics. When compared with P.3 student responses, there were fewer responses that described mathematics as "interesting". On the

[(5)] Sch-G-n-S refers to quotation n in the interview with a student at grade level G in school Sch with academic standard S (L for low, M for medium, H for high).

other hand, these results showed that students of P.6 had already found mathematics to be a difficult and challenging subject. Here are some of their responses:

> Mathematics is interesting, but it is a relatively difficult subject. (Md-P6-1-H)
> Mathematics is interesting, but some topics are relatively difficult. (Md-P6-2-H)
> Mathematics is a challenge; there is a sense of achievement from being able to solve a problem quickly and accurately. (Sz-P6-1-L)
> Mathematics is a challenging and difficult subject. (Sz-P6-4-L)

Compared with P.3 student responses, there was more focus on learning in general:

> Mathematics is knowledge that has a lot of variations. (Md-P6-4-H)
> Mathematics is something we must learn. (Tg-P6-1-M)
> Mathematics is a subject. (Tg-P6-3,4-L)

Although not a strong theme, it is clear that some students were looking at the intrinsic nature of mathematics but most of the responses reflected that mathematics was perceived as something "calculable", such as,

> Mathematics is made up of numbers. (Sz-P6-2-L)
> Mathematics is made up of numbers and then we do computations based on those numbers. (Sz-P6-4-L)

5.3.1.3. Secondary Three

More students at this level started to look at the intrinsic nature of mathematics. This is an important theme in this group of responses:

> Mathematics is a subject that emphasises understanding rather than memorisation and requires a lot of practice. (Wg-S3-3-H)
> Mathematics is what we use to do computation on numbers. (Le-S3-1-M)
> Mathematics requires strong comprehension power in order to understand. (Lee-S3-4-M)
> Mathematics is about computation of numbers. (Lo-S3-1-L)
> Mathematics is a subject that requires thinking. (Lo-S3-3-L)
> Mathematics is a subject that requires exercising of the brain. (Lo-S3-4-L)

Students who looked at the intrinsic nature of mathematics focused mostly on the requirement of understanding, thinking and practice in the subject.

A newly emerged theme was that students started to look at the applications and uses of mathematics:

> Mathematics is something that has a lot of applications in daily life. (Wg-S3-1-H)
> Mathematics is something that is indispensable and it has a lot of applications in engineering. (Wg-S3-2-H)

There was a further decrease in the number of responses that perceived mathematics as "interesting". No students perceived mathematics as "difficult". On the other hand, results showed that S.3 students were focusing more on the learning aspect of mathematics than students of the two primary levels.

5.3.1.4. Secondary Four

Compared with P.3, P.6 and S.3, there was stronger focus on learning. We have,

> Mathematics is a discipline. (SP-S4-1-H)
> Mathematics consists of very deep knowledge. (SP-S4-2-H)

Compared with S.3 students' responses, S.4 students also emphasised the intrinsic nature of mathematics. S.4 students' responses showed that they were looking much more deeply than S.3 students at the intrinsic nature of the subject. Here are some of the responses:

> Mathematics makes use of quantitative data and formulae to work out unknown solutions through computation. (SP-S4-3-H)
> Mathematics is a subject that translates abstract principles into concrete computation. (Mk-S4-2-M)
> Mathematics is a collection of formulae. (Mk-S4-3-M)
> Mathematics is a subject that requires a good and solid foundation in basics and learning in this subject is accumulative. (Mk-S4-4-M)
> Mathematics is about computation and computation tools. (Sm-S4-2-L)
> Mathematics is a tool for logical thinking and a tool for data organization and analysis. (Sm-S4-3-L)

The functional aspect of mathematics first appeared in P.6 student responses and appeared again in these S.4 responses:

> Mathematics is a subject that trains and exercises our brain. (Mk-S4-1-M)
> Mathematics is a subject that can promote intellectual development. (Se-S4-1-L)
> Mathematics can promote thinking. (Sm-S4-4-L)

Again, the most prominent functional aspect was training in thinking.

Compared with S.3 student responses, there was a slight increase in the number of students who described mathematics as "interesting".

S.3 students started to look at the applications of mathematics. This theme appeared again in this group of responses. At the S.4 level, the number of students who focused on the applications of the subject was slightly more than that of S.3 students.

5.3.1.5. Secondary Six

In this group of responses, there was an obvious drop in the focus on learning. Most S.6 students focused on the intrinsic nature of mathematics, but the number of students who did so was less than that in S.3 and S.4. No students described mathematics as "interesting". There were students who described mathematics as "difficult" and "challenging". A new category was that some students described mathematics as something "abstract."

5.3.2. Perception of mathematics learning

5.3.2.1. Primary Three

As in the previous case, most P.3 students perceived mathematics learning as interesting. One student perceived this learning as "acquiring more knowledge in mathematics" (Tg-P3-4-M). Another student focused on the intrinsic nature of mathematics and saw mathematics learning as something involving computation (Sz-P3-1-L). One student saw mathematics learning as a way of "getting good (academic) results" (Sz-P3-4-L).

5.3.2.2. Primary Six

Most P.6 students perceived mathematics learning in terms of the content of this learning:

Mathematics learning is about enhancing our computation ability. (Md-P6-1-H)

Mathematics learning shows us how to approach mathematical problems. (Tg-P6-2-M)

Mathematics learning teaches us how to compute using different methods. (Sz-P6-2-L)

Mathematics learning teaches us different computational methods. (Sz-P6-4-L)

Most P.6 students were equally concerned about the functions of mathematics learning. We have:

Mathematics learning promotes our thinking. (Md-P6-2-H)

Mathematics learning prepares us for the society. (Md-P6-3-H)

Mathematics learning makes us use our brain and think. (Tg-P6-3,4-M)

Some students saw mathematics learning as "knowing" and "understanding":

Mathematics learning reveals to us the secret of numbers. (Md-P6-2-H)

Mathematics learning gives us a better understanding of mathematics. (Md-P6-4-H)

Some students looked at mathematics learning in terms of its applications:

Mathematics learning enables us to know how we can apply it in our everyday life. (Tg-P6-1-M)

Though mathematics does not have a lot of uses, sometimes it is useful. (Tg-P6-2-M)

While most P.3 students perceived mathematics learning as interesting, only one P.6 student found mathematics learning interesting. This is an indication of a drop in the interest level.

5.3.2.3. Secondary Three

Most S.3 students perceived mathematics learning in terms of the various components of this learning. These components included "understanding",

"putting in a lot of hard work", "consulting people", "doing a lot of exercises" and "thinking":

> Mathematics learning emphasises understanding. (Wg-S3-1-H)
> Mathematics learning involves a lot of hard work.... When we come to something we do not understand, we have to consult people and follow it up with a lot of exercises. (Wg-S3-3-H)
> Mathematics learning involves a lot of thinking before coming to an answer or a way of dealing with a problem. (Wg-S3-4-H)
> Mathematics learning is thinking. (Lo-S3-2-L)

Some S.3 students perceived mathematics learning in terms of its functions, in particular, the function of training a person's thinking abilities:

> Mathematics learning is a training of the mind. (Wg-S3-1-H)
> Mathematics learning trains people's thinking and comprehension abilities. (Wg-S3-4-M)
> Mathematics learning prepares a person for the future. (Lo-S3-3-L)

Some students were concerned about the applicability of knowledge gained in mathematics learning.

> Mathematics learning can be used in daily life. (Le-S3-1-M)
> Mathematics learning makes our daily life more convenient. (Le-S3-2-M)

Again, only one student perceived mathematics learning as interesting.

5.3.2.4. Secondary Four

Most S.4 students were concerned about the various aspects of mathematics learning. They perceived mathematics learning as "understanding", "an opportunity to accumulate experience", "requiring a high degree of discipline", and "broadening the scope of thinking."

In addition, many S.4 students looked at mathematics learning in terms of its content:

> Mathematics learning helps us understand mathematical principles. (SP-S4-1-H)

Mathematics learning is acquiring the techniques of solving mathematical problems. (Mk-S4-4-M)

Mathematics learning is learning methods and applications in mathematics. (Sm-S4-2-L)

Some students looked at mathematics learning in terms of its functions in developing logical thinking, analytical power, and independent thinking. One student saw mathematics learning in terms of its applicability in daily life: "Mathematics learning is for applications in daily life" (SP-S4-2-H). Only one student perceived mathematics learning as interesting.

5.3.2.5. Secondary Six

Most S.6 students were concerned about the functional aspect of mathematics learning, with particular focus on the cultivation of thinking abilities. We have,

Mathematics learning trains logical thinking. (Yg-S6-1-H)

Mathematics learning trains and develops thinking and interest. (Yg-S6-3-H)

Mathematics learning is a method of cultivating thinking abilities. (Yg-S6-4-H)

Mathematics learning trains our thinking. (Hn-S6-2-M)

Mathematics learning exercises the brain. (Hn-S6-4-M)

Mathematics learning exercises the brain and trains our thinking. (Cn-S6-2-L)

In addition, many students saw mathematics learning in terms of its various aspects.

Mathematics learning is a process of analysis and comprehension. (Hn-S6-3-M)

The process of mathematics learning takes time. (Hn-S6-4-M)

Mathematics learning does not require a lot of memorization. (Cn-S6-4-L)

One student looked at mathematics learning in terms of its content: "Mathematics learning is learning computational methods" (Hn-S6-2-M). Another student looked at mathematics learning in terms of its applications. "Mathematics learning is for applications in daily life" (Cn-S6-3-L). Yet another student looked at mathematics learning in terms of academic achievement: "Mathematics learning is

very special. You can get a pass even without doing much revision. But if you want to get good results, there is a certain degree of difficulty" (Hn-S6-1-M).

Only one student perceived mathematics learning as interesting.

5.3.3. Perception of mathematics classroom

5.3.3.1. Primary Three

P.3 students perceived the mathematics class mainly as a time for learning mathematics. It is interesting to find that homework was a prominent feature in the answers of two students.

> The mathematics class is about a lot of difficult homework. (Tg-P3-1-M)
> The mathematics class is about very little homework. (Tg-P3-2-M)

Two students perceived the mathematics class as "very interesting".

5.3.3.2. Primary Six

The theme of learning dominated the answers of P.6 students. They saw the mathematics class as a time for "learning", "knowing", "understanding", and "revising" mathematics. All of these are aspects of learning. There was one student who looked at the mathematics class from the perspective of teaching, rather than learning: "The mathematics class takes place when the teacher teaches us mathematics" (Tg-P6-2-M).

Students expressed a mixed feeling, both positive (i.e., "interesting", "meaningful") and negative (i.e. "relatively boring"), towards the mathematics class. However, students, in general, felt positively about the mathematics class. One student saw the mathematics class as an opportunity to approach their teachers when they had queries: "The mathematics class is a place where we can ask our teacher if we cannot understand some of the content" (Md-P6-2-H).

5.3.3.3. Secondary Three

Learning was a dominant theme in the responses of S.3 students. They perceived the mathematics class as a time for learning mathematics. S.3 students expressed both positive and negative feelings towards the mathematics class, but it seems that negative feelings (i.e., "very plain", "boring", "relatively difficult") outweighed positive feelings (i.e., "quite lively", "quite interesting", "interesting").

Some students looked at the mathematics class in terms of their functions (e.g., consulting teachers about difficult problems) and content (e.g., learning different mathematical concepts and computational methods).

5.3.3.4. Secondary Four

The theme of learning dominated the responses of S.4 students. In general, S.4 students perceived the mathematics class as a time for learning, knowing and applying mathematics. Another salient theme was that S.4 students expressed more positive feelings than negative feelings towards the mathematics class. They found the mathematics class "lively and interesting", "filled with imagination", and "interesting, happy and challenging". The negative feelings included "very boring" and "most hated". One student expressed other emotions towards the mathematics class: "In the mathematics class, I have two very extreme feelings - achievement and failure". (Sm-S4-3-L)

In addition, students perceived the mathematics class in terms of their functions and content and the applications of what was learned in those lessons. We got:

> The mathematics class is for examinations and for daily life applications. (SP-S4-2-H)
>
> In the mathematics class, we learn different computational methods. (SP-S4-3-H)
>
> The mathematics class teaches us to apply mathematics in daily life. (SP-S4-1-H)

5.3.3.5. Secondary Six

The theme of learning also dominated the responses of S.6 students. S.6 students generally perceived the mathematics class as a time for learning and understanding mathematics. On the other hand, one student saw the mathematics class from the perspective of teaching: "In the mathematics class, the teacher instructs the students on computation". (Hn-S6-2-M)

Most S.6 students perceived the mathematics class in terms of their content - what was learned or taught. These responses included "learning basic principles in mathematics", "learning computation methods", and "learning the teacher's ways of thinking". Students expressed both positive and negative feelings towards the

mathematics class, but positive responses (i.e., “happy”, “lively”, “not boring”) outnumbered negative ones (i.e., “can be boring”). One student expressed other feelings towards the mathematics class: “In the mathematics class, students experience highs and lows according to how well they cope with the subject” (Ying-S6-2-H).

5.3.4. Summary

In sum, P.3 students generally perceived mathematics as something interesting. They perceived the mathematics class as a time for learning mathematics and saw homework as an important component of mathematics learning. The theme of mathematics being a difficult subject began to emerge at P.6. In fact, negative feeling about the mathematics classroom intensified at this grade level. As the student moved up the grade levels, mathematics was found to be more and more abstract and academically oriented. In general, mathematics was perceived as “calculable”, useful to daily life and involving thinking. The theme was more marked at higher levels such as S.4 where the students made explicit expositions such as “mathematics makes use of quantitative data and formulae to work out unknown solutions through computation”, “mathematics is a subject that translates abstract principles into concrete computation”, and “mathematics is a tool for logical thinking and a tool for data organization and analysis”. This was consistent with what was found in previous studies (Wong, Lam, & Wong, 1998).

5.4. Results: interviews

5.4.1. 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 P.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 aforementioned features, students in P.6 and above mentioned the following characteristics of good teaching: (i) the presentation is clear and lively; the teacher is responsive to students' questions and allows time for peer discussion; (ii) sufficient practice, challenging tasks and exercises that provoke thinking are provided; (iii) the pace of teaching is 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 the label of weak students. 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 organized, consisting of activities with clear procedures such as teacher's talk, students' seatwork, and checking of answers. Examples and problems should be taken from within and outside textbooks, and they should help students link the usage of mathematics with the real world.

It is worth noting that the S.3 students also mentioned the characteristics of an undesirable teacher as 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 like 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 good questioning was for testing students’ understanding and exercising students’ thinking skills. They preferred to have an opportunity to organize materials before answering questions. Classwork was seen as important because it provided opportunities for them to think and understand, and asking 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 S.6 students, their perception of good teaching was very similar to that mentioned by S.3 and S.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, following the book strictly and, giving too fragmented information.

5.4.2. Understanding

A teacher’s ability to help students understand the content was very important. This was mentioned in two schools at P.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 S.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.

5.4.3. Attitude

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 whether they could manage 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 manage 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 that the teacher was one of the reasons why they liked the subject.

Reasons given by P.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 S.3, S.4 and S.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 S.4 students liked mathematics because the subject helped them in other disciplines such as geography and economics. For students who enjoyed thinking, they highlighted the requirement of thinking and logic in the subject. This was very obvious in S.6.

Another very important reason for liking mathematics was confidence in managing the subject. It was mentioned at all levels in all schools. This was mentioned in many examples of individual experience. For example, one S.3 student started to like the subject in secondary school because he learned to manage and understand the subject. A S.4 student said that he used to be scared of the subject when studying in the Mainland but changed his attitude when he began to handle the subject confidently in Hong Kong. One S.4 student said that he was not good at the thinking process that was required in mathematics, thus, he was not interested in the subject. Secondary 6 students described learning difficulties as instances in which they failed to find a solution or make use of what was learnt after a lot of thinking and trials.

5.4.4. Curriculum

5.4.4.1. 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 P.6 students were more divergent than those of P.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 P.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 repetition in P.3, e.g., bar charts. Some found that there was a sudden

increase in the difficulty level in P.5, e.g. greatest common divisor and least common multiple which they had not learned before. The time allowed for teaching in P.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 P.1-4.

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

5.4.4.2. 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 generally thought that mathematical skills were acquired through practice. They thought that breadth was more important than depth and the current curriculum was 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 be aimed to help their learning of physics. Helping them see the link between some topics (e.g., quadratic equations) and real life was important. 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 S.4.

5.4.4.3. Secondary Four

In general, students found the mathematics syllabus for S.4-5 far too long for the time allocated to the syllabus.

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 who immigrated from the Mainland found that certain topics taught in Hong Kong were easier than those taught in Mainland, 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.

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

As far as suggestions for changes were concerned, they suggested 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 S.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 S.3 and therefore should not be repeated in S.4-5. Some would like to move some S.4 topics such as functions, proportions and quadratic equations to S.3 to allow more time for other topics. Similarly some S.4 topics could be taught in S.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.

5.4.4.4. 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 variations. When compared with mathematics at lower grade levels, the S.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 non-favorite topics 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 (having to be correct at the beginning), 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 S.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 because the subject emphasized a great deal of thinking. One student commented that students with background in S.4-S.5 Additional Mathematics would find integration and differentiation in Mathematics and Statistics easier to manage. Another student shared the same view, saying that Applied Mathematics background 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.

5.5. Discussions

The results obtained from the student interviews, the student questionnaire and open-ended responses from both the students and parents were very consistent. Altogether, these data gave a clear picture of an ideal learning environment which students longed for. In sum, both students and parents showed high regards for mathematics. They 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 and parents 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, should 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 deep understanding as against rote-memorisation throughout their responses. They wished that teachers could immediately show them the correct way of tackling mathematical problems. Students' understanding and interest were parents' concern too.

Students began to face learning difficulties at P.6 and at this time the question of the practicability of the learning content emerged. They felt the pressure of homework at this level too. Students and parents were also concerned about the disruption resulting from preparations for the Academic Aptitude Test. Secondary 3 students found the junior secondary mathematics fragmented. The repetition of S.1 topics that had already appeared at primary levels and recurring topics at junior secondary distracted the students from seeing the mainline progression. We discovered that the greatest percentage of drop-outs occurred at the S.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. Continuation of subject matter between sixth-form mathematics and senior secondary mathematics was queried too.

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

A significant theme emerged throughout the study of both parents and students: the teacher was of the utmost importance to learning. A good teacher, according to their description, is one who is conscientious, who prepares his/her lessons well, who is skillful in creating a relaxed atmosphere yet keeping good order of 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 concern and his/her ability to give clear explanations were also seen as important. Both the students and parents 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 understand 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 and Shaprio, 1989, p. 292; Wong, 1993a, 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 focussed 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.

(This is a blank page)