CHAPTER 5 TEACHING SUGGESTIONS

5.1 Curriculum Strategies

The curriculum strategies include methods of curriculum planning, material writing, teaching and learning to help students work towards the targets. In addressing the needs of our students to face the challenges of the 21st Century, the strategies used in this curriculum put emphases on

- the process of learning;
- catering for learner differences;
- the appropriate use of information technology (IT) in teaching and learning;
- the appropriate use of multifarious teaching resources.

However, it should be noted that no matter what emphasis of strategies is put in this curriculum, **the teacher is the key person** in the classroom teaching. Past studies review that liveliness and clear explanation of the teachers are students' main concerns. Students perceive that teachers have the responsibility of delivering clear explanation, designing and conducting activities in lessons, creating a good environment and showing concern for students' progress. The strategies mentioned below are just to remind teachers to be aware of the emphasis when designing and preparing teaching and learning activities to facilitate students' learning.

5.1.1 Process of Learning

Providing experiences and knowledge constructed in the learning process is considered as important as the end product. Sufficient time should be allocated for students to inquire, communicate, reason and conceptualize mathematical concepts so as to enable them to understand the knowledge thoroughly, to master the skills confidently and to foster a positive attitude towards learning. Students should also engage in the activities that enable them to practise problem-solving skills and to integrate and apply mathematical concepts.

Inquiring involves discovery or constructing knowledge through questioning or testing hypothesis. Posing questions to stimulate students to discover similarities or differences on different rules or asking students to test mathematical conjectures enables students to participate in a more active role in the learning process.

Communicating involves receiving and sharing meanings by using language, symbols, graphs and aesthetic forms. Listening, speaking, reading and writing are the important elements of communication which help students to interpret others' statements, state their ideas, clarify their meanings, refine their strategies to solve problems, hypothesize and construct simple arguments. Activities such as teachers posing questions for students to answer, small-group work, large-group discussions, presentation of individual and group projects (both written and

oral form) provide platforms for students to communicate mathematically. Mathematics in itself can also be considered as other form of language. Teachers can guide students to see the difference of the mathematical language with those languages used in daily life and appreciate the precise nature of the mathematical language.

Reasoning involves developing plausible or logical arguments to deduce or infer conclusions. It is fundamental to the knowing and doing of mathematics. A mathematician or a student makes a conjecture by generalizing from a pattern of observations made in some particular cases (inductive reasoning) and then tests the conjecture by constructing either a logical verification or a counter-example (deductive reasoning).

Conceptualizing involves organizing and reorganizing knowledge through perceiving and thinking about particular experiences in order to abstract patterns and ideas and to generalize from particular experiences. In teaching, teachers should pay due emphasis on helping students master the basic concepts of mathematics and create link between concepts.

The importance of problem solving in mathematics education has well been recognized. It involves

- understanding the problems;
- considering possible strategies and choosing an appropriate one to solve the problem;
- carrying out the plan; and
- justifying or evaluating the solution.

Concepts of mathematics are connected within a framework, which is 'multi-dimensional'. Concepts in one dimension very often are linked to concepts in other dimensions. For example, nearly all concepts in the dimensions, Measures, Shape & Space and Data Handling are inevitably connected with concepts in the Number and Algebra Dimension. Teachers should guide students to see the inter-relationship of mathematical knowledge among different dimensions.

Past studies point out that some people could not apply their mathematical knowledge learnt in schools to solve their real-life problems. Activities to foster students' application of mathematical knowledge to their real-life situations and to be aware of the link between school knowledge and their real-life applications should also be provided. Teachers could ask students to extract some daily-life problems appeared in the newspaper, advertisements, internet and so on for discussion.

5.1.2 Catering for Learner Differences

The curriculum is structured with the Foundation Part identified to facilitate teachers to tailor the curriculum for their students' learning needs. Teachers could focus on teaching the Foundation Part of the whole syllabus so as to provide appropriate quantities and a variety of activities for students to conceptualize, construct knowledge and communicate mathematically. For more able students, activities on enrichment topics could also be provided to broaden students' horizon of mathematical knowledge and enhance their interest in mathematics.

Teachers are advised to give due considerations to various aspects such as grouping students of similar ability together, teaching/learning activities, resources and assessment. Teachers find teaching in mixed ability classes harder than teaching in classes where students are relatively close in ability. However, there can be a negative impact on the self-image of those students placed in lower streams. No matter how the students are organized, it is inevitable that students in a class will differ in abilities, needs and interests. Teachers need to use selectively whole class teaching, group work and individual teaching as appropriate to the task in hand.

In daily classroom teaching, teachers could cater for learner differences by providing students with different tasks or activities graded according to the levels of difficulty, so that students work on tasks or exercises that match their stages of progress in learning. For less able students, tasks should be relatively simple and fundamental in nature. For abler students, tasks assigned should be challenging enough to cultivate as well as to sustain their interest in learning. Alternatively, teachers could also provide students with the same task or exercise, but vary the amount and style of support they give, i.e. giving more clues, breaking the more complicated problems into several parts for weaker students.

The use of IT could also provide another solution for teachers to cater for learner differences. Different levels of exercises or activities are always included in the educational software packages. Teachers could make use of these software packages for students with different abilities to work through at their own pace and at their levels of ability. The facilities to record students' performance in these software packages could also provide information for teachers to diagnose students' misconceptions or general weaknesses so as to re-adjust the teaching pace or re-consider the teaching strategies.

5.1.3 Appropriate Use of Information Technology (IT)

Traditional teaching is always conducted with chalk and talk. Audio-visual devices such as television in the past 2 decades provide another alternative activity for mathematics teaching and learning. The wide spread use of computers and calculators in this decade provides further alternative for the teaching and learning in mathematics. The advantages of using IT

over other tools include:

i. **interactive learning** which enables learners to obtain "immediate" feedback for testing hypothesis, readjust the problem-solving strategies, see connections between formulae and their corresponding graphs by changing the values of relevant parameters;
ii. colourful, attractive and **dynamic graphics** which provide graphical images of various functions, 2-D and 3-D models, animation activities, studying geometry dynamically;
iii. **large memories** that enable students to compute complicated expressions, work with real data, study real-life statistical problems;
iv. **fast speed** which enables students to produce many examples in a short period of time for the observation of patterns so that they are more willing to try different strategies to solve problems.

IT in school mathematics education could be considered as:

i. a **tool** - Teachers could use presentation software as a 'blackboard' to present notes, geometry software to demonstrate graphs and models, zoom-in and zoom-out facilities in some graphing calculators or graph plotter software to approximate the solution of equations from their graphs. Students could use symbolic manipulation software to manipulate complicated expressions, present statistical graphs with graphical facilities in spreadsheet, submit homework through e-mail etc.

ii. a **tutor** - Many mathematical software packages, in the form of CD-ROMs, act as a tutor to teach students mathematical concepts. These software packages illustrate mathematical concepts with texts, graphics, and sound and with graded exercises or tests. Students could use these software packages to revise the contents learnt in the classroom, remedy the weak areas or even learn new topics prior to teachers' teaching. They could further consolidate their learning with appropriate exercises chosen for their levels of difficulty at their own pace.

iii. a **tutee** - Teachers could develop their own educational programs using spreadsheets or other programming languages to suit their own teaching strategies. Students could write programs in the language such as LOGO to explore properties of geometric figures.

Both teachers and students of mathematics at all secondary levels are expected to use IT intelligently and critically. They must be able to decide when to use the available technology. For example, students have to decide whether to use calculator, or work

mentally to solve the equation x^2-3x-4 = 0, and teachers have to decide whether to use computers or the real objects to demonstrate the projections of 3-D models, and which software is more appropriate for the task.

Besides, varieties of group work to facilitate collaborative learning or investigative approach in learning with IT should also be considered. Class-work or home assignment should emphasize upon concept development and understanding instead of manipulating complicated expressions or symbols or just rote memorization of formulae.

5.1.4. Appropriate Use of Multifarious Teaching Resources

Besides IT, there are other teaching resources that teachers could make use of in planning and conducting the teaching and learning activities:

- textbooks or teaching packages
- reference books
- audio-visual tapes such as ETV programs
- instruments and other equipment for drawing shapes and making models
- materials found around such as newspapers, advertising leaflets, maps, etc.
- resources found in libraries / resource centres etc.

Textbooks are one of the key resources for teaching and learning. They should be used to guide students to acquire knowledge, skills and develop attitudes as well as to assimilate concepts and process information in the texts and graphics therein. Textbooks should not be treated as a mean of imparting factual knowledge or just providing exercises to drill students on the manipulative skills. Some textbooks tend to provide exercises more than those required in the syllabus so far as the level of difficulty and the amount are concerned. Teachers should therefore exercise discretion in selecting suitable parts to teach and avoid over-teaching or over-drilling.

Besides textbooks, teachers could make use of teaching packages or references distributed to schools. Some of these teaching packages or references provide ready-made worksheets, notes or information that could be used in the classroom with slight modifications. ETV programs could provide information that cannot be presented vividly by just chalk-and-talk. For instance, it is interesting to watch a video on the historical development in approximating the value of π or the applications of trigonometric ratios in surveying.

Mathematical language is progressively abstract. Different learning theories point out the importance of providing students with rich experiences in manipulating concrete objects as a foundation for the symbolic development. Teachers could make use of teaching aids such as 3-D models, blocks, graph boards, protractors, pairs of compasses, rulers, measuring equipment, etc. to demonstrate the mathematical concepts and allow students to “play”

around before asking students to "structure and apply" the concepts.

Materials around such as advertisement leaflets, statistical reports presented in the media, graphs printed in the newspaper could supply up-to-date information that cannot be found in other sources and they could easily arouse students' interest in learning. In addition, a large quantity of related materials for teachers' reference can be obtained from libraries or various resource centres operated by the Education Department, such as School Based Resource Centre, TOC Resource Centre(s). In 1990s, internet becomes another popular source for sharing and retrieving information. **Gathering and selecting information** from these sources would be another major learning activities in the 21st century.

5.2 Teaching Strategies in Individual Dimensions

5.2.1 Number and Algebra Dimension

In primary school levels, students have learnt different representations of numbers and the inter-conversion of numbers among different representations (refer Annex I for further details). In secondary schools, students are expected to extend the concepts of numbers from positive numbers to directed numbers and then to real numbers. However, teachers should assess and provide consolidation activities, whenever necessary, to ensure that students have firm foundations on the concepts of numbers before proceeding to the study in KS3 and KS4. Students will encounter rational and irrational numbers in KS3 as a natural consequence of introducing "Pythagoras' Theorem" or "Trigonometric Ratios and Using Trigonometry". Teachers could arrange the unit "Rational and Irrational Numbers" together with any one of the above units. Manipulations of surds are confined to techniques sufficient for handling problems related to the above 2 units. Furthermore, it is important to foster students' number sense and to build up habits of checking the reasonableness of results. Teachers should encourage and remind students to apply the concept of estimation throughout their learning process of mathematics.

Regarding algebra, students in primary schools have an intuitive idea of solving linear equations with at most 2 steps in the solution. In KS3, it is important for students to build up a firm transition from number to algebra and to recognize the strength of using algebraic language in solving problems. However, teachers should not ask students to go into tedious manipulations of algebraic symbols. As a base line, teachers should make sure that students possess the technical fluency necessary for tackling equations and inequalities. Teachers could use a variety of instructional formats, such as small cooperative groups, individual explorations, probing 'what-if' questions, etc to allow students to search for patterns, make conjecture in formulating and solving algebraic problems. Various concrete tools such as blocks could be used to demonstrate the equivalence of polynomials or identities. In studying the concept of input-processing-output of polynomials, teachers could make use of tables or spreadsheet software packages to demonstrate the effect on the output by changing

input, and allow students to explore various kinds of polynomials before proceeding to a formal concept of function in KS4.

In KS4, when introducing the shapes and properties of quadratic functions, teachers could provide students with graphs and tables to grasp the idea of symmetries, vertices, and extremum before introducing algebraic methods to find vertices, etc. Graphical tools, such as graph-plot software packages or graphing calculators, provide a ready visualization of relationships. In introducing the concepts of functions, teachers could make use of them for students to explore and visualize the effects on the dependent variable by changing values of the independent variables. In solving equations, students are expected to learn basic algebraic skills to solve linear and quadratic equations and to solve equations of higher-degree by factorization. Through using graphical tools and their zoom-in and zoom-out functions, teachers could guide students to appreciate the power of graphical method in solving equations and recognize their limitations.

5.2.2 Measures, Shape and Space Dimension

Spatial sense is one of the capabilities emphasized in this curriculum. It includes the recognition of plane figures and the manipulation of three-dimensional spatial objects. Students are expected to have rich experiences in manipulating objects with activities like paper-folding, construction of models, transformations of figures, geo-boards, visual arts by hand or by computer in both primary and junior secondary school levels. Teachers could also provide students with experiences in exploring and visualizing the geometric properties of figures with the aid of dynamic geometry software packages. With these experiences, students could understand the properties of figures and then gradually proceed to derive the proof with deductive reasoning.

The unit “Transformation & Symmetry” could be introduced with figures found in real-life situations. Teachers could then ask students to explore the effects of transformations on the shapes by moving objects with the help of software packages in computers or moving real-objects. Teachers should link the idea of transformations with proofs in plane geometry, and with the units “Introduction to Coordinates” and “Functions and Graphs”. For 3-D objects, teachers could provide students with experiences in visualizing the net and the cross-sections of the solids and different views of the solids with real models, or moving the solids around in the computer. The relations between lines and relations between planes in space should only be treated qualitatively. These intuitive ideas could be elaborated further by the study of trigonometry in solving 3-D problems in KS4.

In KS4, students are expected to compare different approaches in studying geometric problems. Teachers should guide students to appreciate the importance of inductive reasoning and deductive reasoning in studying the properties of geometric figures and also observe their limitations. The significance of using analytic geometry in linking algebra and

geometry should also be highlighted. Graphical software packages or graphing calculators could also be used for students to explore the locus of moving objects under a given condition before proceeding to the coordinate treatment of some specific locus.

5.2.3 Data Handling Dimension

In the primary school level, students have learnt various statistical diagrams to present discrete data. In KS3, students are expected to extend the idea of discrete data to continuous data. For construction of statistical diagrams, it is appropriate to have students to draw graphs manually for some small data sets. For other situations, the emphasis should be put on the use of calculators or computers so as to minimize the drudgery involved. With the aid of software packages, students should be guided further to explore and choose the appropriate method or diagram to organize and present a given set of data. For example, a pie chart is more appropriate to present the idea of portion and whole than using a bar chart. It should further be noted that emphasis should be laid on interpretation rather than construction of graphs. Teachers could also ask students to interpret different statistical diagrams or graphs gathered from newspapers first and to construct statistical diagrams afterwards. Lastly, teachers should arrange students to undertake projects which involve all of the stages of data handling, namely collecting, organizing, presenting and interpreting, whenever appropriate.

In KS4, students are expected to discuss the statistical reports presented in various media. An intuitive idea on sampling techniques and different data collection methods should be introduced in order to provide background knowledge for students to study the reports. Students should not go into details of sampling techniques nor sophisticated method in designing questionnaires. Teachers could also arrange students to conduct surveys as enrichment and cross-curricular activities so that students could integrate knowledge learnt in various subjects to study problems they are interested in. Students could use software packages like spreadsheet to explore the effect on the measures of central tendency and dispersion when changing values of the data set, or analyze and present reports of surveys they have conducted.

In investigating probability in KS3, simple games and real-life activities could be used. Students should experiment with, discuss and compare the results of different experiments and note that separate experiments will usually produce somewhat different results. Besides hands-on activities, computers or calculators could be used to facilitate the simulation of large number of trials so as to enable them to develop an understanding of probability as the long-run relative frequency. Teachers should not introduce the addition nor multiplication laws to students in KS3. In KS4, teachers should guide students to see the benefits of using addition and multiplication laws in finding probability of wider variety of activities. The notion of conditional probability will be introduced as a direct consequence of finding

probability of dependent events.

5.2.4. Further Applications Module

As students are growing mature in KS4, the module "Further Applications" is included so as to encourage students to **further apply** mathematical knowledge to solve problems in a **more complex real-life and/or mathematical context.** In this module, teachers should use real-life problems, as far as possible, to encourage students to discuss and explore the ways of applying mathematics in various real-life situations. Articles in the newspaper, statistical reports presented, advertisement brochures, etc. could be used for discussion. Teachers could guide students to use different approaches in tackling the real-world situations.

Although this module is categorized as non-foundation, teachers should select some topics that are relevant to their students' interest and ability. Furthermore, cross-dimensional problems should be introduced so as to encourage students to **integrate** mathematical knowledge in solving problems.