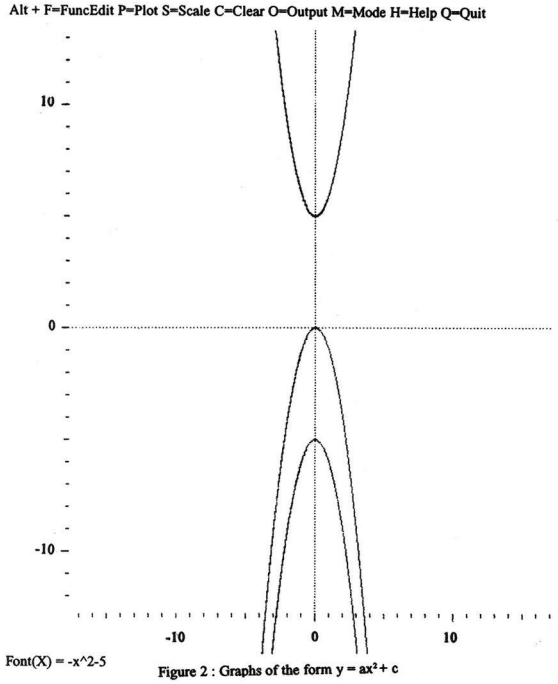

Figure 2 : Graphs of the form $y = ax^2 + c$

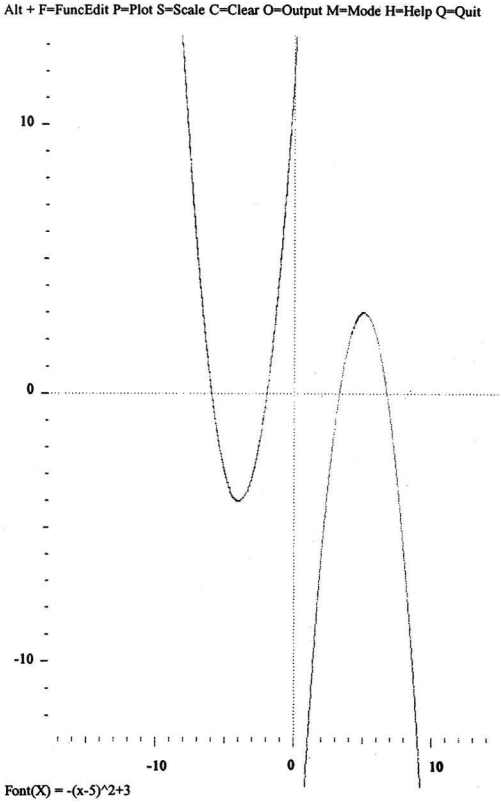

Figure 3 : Graphs of the form $y = a(x-h)^2 + d$

APPROACHES TO TEACHING AND LEARNING IN MATHEMATICS

Peter Etches

Editor's Note: This article is adapted from a foreward to a mathematics curriculum document written for the Cook Islands situation. It was felt, however, that many of the points would be of interest to and possibly applicable in other Pacific countries.

Modern educational research has shown conclusively that students are much more likely to learn and retain the learning of a new concept or skill when they are able to make meaningful mental links with previously learned concepts or experiences. In the context of learning mathematics this means that the teacher should:

- find out what the students have already learned in earlier years and use this as the basis for new learning.
- provide a framework for the new learning to occur.

The discovery of what students have already learnt is perhaps best achieved through the use of short Placement Tests, which can identify the skills and concepts that students already possess and hence determine the starting points for their teaching programme.

The provision of a framework for new learning to occur could be regarded as the major and most significant change from most current Mathematics programmes. The Mathematics that we want our students to learn should be introduced within a framework of familiar everyday experiences that are real and meaningful to the students, and to which they can readily relate the new skills and concepts. It is to this end that each Achievement Objective commences with the phrase "Within a range of meaningful contexts, students should be able to:....."

Most of the suggested student activities, particularly those listed in the Supplementary Activities draw upon the sorts of experiences and environment that are already familiar to the student. Many concern

the kinds of activity that the student may do or experience every day or from time to time. It is upon these experiences and activities that the Mathematics, as stated in the Achievement Objectives, is built around .

Many of the activities integrate well with other subjects, craft work, Social Science, Science, Technology and Language etc. and hence students should come to appreciate that Mathematics is not to be learnt in isolation as a separate subject, but that the skills and concepts learned can be applied and used immediately in their everyday living.

Text Books

Most Mathematics text books that are in use today have very little in common with the approach to learning as outlined above. They have been written by foreign writers, and what may be expected to be an everyday experience of, for example, a 13-year-old student in New Zealand is very different for a 13-year-old Cook Islander living on Pukapuka.

Most exercises in current text books use repetitive examples of the same kind to reinforce what is supposed to have been taught. However, modern research has indicated that repetition of examples that students are unable to link to previous experiences, does not in fact bring about real learning.

Within the framework of this Syllabus document, text books are still, however, expected to play a part.

Firstly, the teacher must create the learning activity or environment which will enable students to make the necessary mental links with their previous experiences. Once this is achieved, the text book may then be used to supplement or reinforce those links. To this end, only those exercises or examples that strictly match the stated Achievement Objectives or which relate to the learning activity are to be used.

Incorporated throughout the syllabus is the Mathematical Processes Strand. This strand should not be taught in isolation rather the stated Objectives of Problem-Solving, Developing Logic and Reasoning, and Communicating Mathematical Ideas will become an integral part of almost all mathematical activity that students are expected to tackle.

Problem-Solving

Students learn mathematical thinking most effectively through applying concepts and skills in interesting and realistic contexts which are personally meaningful to them. Thus, mathematics is best taught by helping students to solve problems drawn from their own experience.

Real-life problems are not always closed, nor do they necessarily have only one solution. The solutions to problems which are worth solving seldom involve only one item of mathematical understanding or only one skill. Rather than students remembering the single correct method, problem - solving requires them to search the information for clues and to make connections to the various pieces of mathematics and other knowledge, experiences and skills they have already learned. Such problems encourage thinking rather than mere recall.

Communicating Mathematical Ideas

An increasing emphasis is placed on the development of students' ability to clearly communicate their thinking and reasoning. Merely obtaining the correct answer is now no longer sufficient. Students are now expected to obtain an answer, by whatever means, and then to explain, write about or demonstrate how they have obtained this answer.

Mastery of Basics

This new approach should not detract from students' ability to master the basic addition and multiplication skills. Indeed within the teacher's scheme, particularly those at the Forms 1 and 2 levels, these basic facts should be continuously maintained. Once again the retention of these will become easier for students if they are able to relate them to real-life problems or everyday situations.

Group Work

Many of the suggested activities or problems are best tackled by students working in small

groups; three per group has been found to be effective for most sorts of activities. Working in group students will

- be more effective in communicating with each other, and hence learn from each other
- be more likely to develop their reasoning and communication skills
- learn to share their ideas and hence learn to co-operate to reach common objectives.

The teacher's role within the group work situation would be to guide the students' thinking, to suggest avenues of exploration-in fact to act as just another resource for students to call upon.

Apparatus

The importance of the use of apparatus to help students form mathematical concepts is well established. Using apparatus provides a foundation of practical experience on which students can build abstract ideas. It encourages them to be inventive, helps to develop their confidence and encourages their independence.

Many primary teachers already use an appropriate range of apparatus to focus the students' thinking on the concept to be developed. These teachers know that students are capable of solving quite difficult problems when they are free to use concrete apparatus to help them think the problem through. Such an approach is equally valid in the more senior levels and teachers of Forms 1 to L5 should be encouraged to use appropriate apparatus wherever possible to enrich their programmes. Apparatus is particularly useful for mathematical modeling where a real life situation can be best approximated by a simpler model that students can work with to reach conclusions.

Technology

Whilst the New Zealand Curriculum statement assumes, that students will have access to both calculators and computers, we recognise that this is not in fact the case within the Cook Islands context. At present calculators are not in use in the primary school and few students have access to one at the secondary level. However, as time goes by more students will own calculators at an earlier age.

We have therefore suggested that calculators should become available from Form 3 on and certainly by L5 all students should have access to a calculator with mathematical functions.

A few secondary schools have access to computers, and these should be utilized wherever possible to stimulate and consolidate concepts. However, the Curriculum Document has been written in a manner that does not presuppose the availability of computers.

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