Principles of Teaching and PR1ME Mathematics

PRIME is based on a composite of approaches, used by the top-performing nations in mathematics, and based on Singapore Maths used by over 58 nations globally.

If you want to start to understand how the top performing nations in primary maths education get great results, being aware of some of the stated Principles of Teaching used in Mathematics education in Singapore might help.

**Principle 1**
Teaching is for learning; learning is for understanding; understanding is for reasoning and applying and, ultimately problem solving.

**Principle 2**
Teaching should build on students’ knowledge; take cognizance of students’ interests and experiences; and engage them in active and reflective learning.


No doubt, many New Zealand schools and teachers also have these principles central to their maths teaching.

How are these teaching principles delivered so successfully in Singapore?
The Ministry of Education believes that many teachers need support to deliver the curriculum, and acknowledges the role that textbooks play in providing some of the support required. As a result, it assesses all published materials made available to teachers and students in Singapore. It is the way they ensure the integrity of their curriculum is delivered the way they want it to be.

PRIME Mathematics is a collaboration between the Singaporean Ministry of Education and Scholastic. It is designed to give schools outside of Singapore, the benefit of the world-class curriculum and teaching/learning experiences used in Singaporean schools.

**Teaching Principle 1: Problem solving**
“The learning of mathematics should focus on understanding, not just recall of facts or reproduction of procedures. Understanding is necessary for deep learning and mastery. Only with understanding can students be able to reason mathematically and apply mathematics to solve a range of problems. After all, problem solving is the focus of the mathematics curriculum.”


There is no doubt that for many years, New Zealand teachers have been emphasising the critical importance of problem solving. This is not new. Problem solving is at the heart of the New Zealand Curriculum: Mathematics.
How is problem solving treated in PRIME?

As expected in the New Zealand Curriculum, problem solving in PRIME is used so that students are able to demonstrate their understanding of concepts through applying them to problems.

The approach in PRIME is that the teacher explicitly models examples of ways problems can be solved using a combination of the problem solving process and strategies (or heuristics).

The teaching models ‘thinking through’ the solution, so thought bubbles are used as samples of metalanguage that could be used.

Sample from PRIME Coursebook 2A, Chapter 2, Addition and Subtraction without Regrouping, p40

Mind stretcher

Let’s Learn

A train left the first station with some passengers. At the second station, 100 passengers got off and 156 passengers got on the train. There were 788 passengers left on the train. How many passengers were there at the beginning?

1 Understand the problem.

How many passengers were left on the train?
How many passengers got off?
How many passengers got on?
What do I have to find?
What should I do?

2 Plan what to do.

I can work backwards.

3 Work out the Answer.

? passengers  ? passengers  788 passengers

− 100 passengers + 156 passengers

By working backwards:

788 − 156 = 632
632 + 100 = 732

There were 732 passengers at the beginning.

4 Check

Did you answer the question? Is your answer correct?

732 − 100 = 632
632 + 156 = 788
My answer is correct.
Lesson 2  Problem Solving  
Mind stretcher

Let’s Learn
Color 4 squares in the figure below to form a symmetric pattern with the dotted line as a line of symmetry.

1 Understand the problem.  
Where is the line of symmetry?  
What is a symmetric pattern?  
How many squares do I have to color?

2 Plan what to do.  
I can act it out. First, I copy the figure on a piece of square grid paper. Then, I fold the figure along the dotted line to see which squares I have to color.

3 Work out the Answer.  
The pattern is symmetric now but I have colored only 3 squares. I have to color another square.

I can color any one of the squares along the line of symmetry to form a symmetric pattern.

4 Check Did you answer the question? Is your answer correct?  
I have colored 4 squares. The pattern is symmetric along the line of symmetry. My answer is correct.
Solving problems with the ‘bar model’
One problem solving strategy that is unique to the approach used in Singapore is the ‘bar model’. It is part of the strategy ‘draw a picture’.

It is used as a way to **represent number relationships**. It starts with simple part-part-whole relationships and later is used to conceptualise more complex situations.

Sample from PRIME Coursebook 3B, Chapter 12, Time, p134

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**Mind stretcher**

**Let’s Learn**

Kelly is 9 years old. Her brother, Ryan, is 29 years old. How many years later will Ryan’s age be twice Kelly’s age?

1. **Understand the problem.**
   - How old is Kelly now?
   - How old is Ryan now?
   - What do I need to find?

2. **Plan what to do.**
   - I can draw a bar model.

3. **Work out the Answer.**
   - Ryan: 29
   - Kelly: 9
   - The difference in age between Kelly and Ryan is 20 years.

   When Ryan’s age is twice that of Kelly’s age:
   - Ryan: 20
   - Kelly: 20

   \[20 \times 2 = 40\]
   Ryan will be 40 years old when he is twice Kelly’s age.
   \[40 - 29 = 11\]
   Ryan will be twice Kelly’s age 11 years later.

4. **Check**
   - Did you answer the question?
   - Is your answer correct?
   - \[9 + 11 = 20\]
   - Kelly will be 20 years old 11 years later.
   - \[40 + 20 = 60\]
   - Ryan will be twice Kelly’s age.
   - My answer is correct.
Principle 2:
“Mathematics is a hierarchical subject. Without understanding of pre-requisite knowledge, foundation will be weak and learning will be shallow. It is important for teachers to check on students’ understanding before introducing new concepts and skills.”


How is concept development treated in PRIME?
Teachers know that mathematical concepts and skills build on one another. Sequencing learning experiences so that students have appropriate pre-requisites so they are able to develop new understandings is not always easy for teachers.

In PRIME, concept development is carefully scaffolded. A chapter in PRIME takes a concept and develops it through a series of several lessons – each on building carefully on previous conceptual understandings.

It takes a “deep-dive” into building conceptual understanding, particularly around number and operations.

Concept development of addition and subtraction – PRIME 1A and 1B

Take a look at the following sample pages to see the progression of concept development for addition and subtraction in PRIME 1.

1A Chapter 2: Number Bonds, p 23

Lesson 1  Telling Number Stories

You will learn to...
• tell number stories
• make and complete number bonds

Making 5
Let’s Learn

There are 5 penguins.
3 are swimming.
2 are not swimming.

3 and 2 make 5.

This is a number bond.
Lesson 1: Addition Within 20

You will learn to:
- add two 1-digit numbers using the ‘make 10’ method
- add a 1-digit and 2-digit number
- add using the ‘counting on’ method
- add two 1-digit numbers using doubles facts

Adding two 1-digit numbers by making 10

Let's Learn
There are two groups of buttons. How many buttons are there altogether?

9

4

Make a group of 10 buttons.

10

3

9 + 4 = 13

First, add 9 and 1 to make 10. Then, add 3.
9 + 4 is the same as 10 + 3.

9 + 4 = 13

There are 10 buttons altogether.

Lesson 2: Addition and Subtraction with Regrouping

You will learn to:
- add a 1-digit number and a 2-digit number
- add two 2-digit numbers
- subtract a 1-digit number from a 2-digit number
- subtract a 2-digit number from a 2-digit number

Adding ones with regrouping

Let's Learn
Add 29 and 3.

a) We can add by counting on.

26 27 28 29 30 31 32

29 + 3 = 32

b) We can add using number bonds.

First, add 29 and 1 to make 3 tens. Then, add 2.

29 + 3 = 32
Adding two 2-digit numbers with regrouping

Let's Learn

Add 47 and 15.

47 + 15 = 62

1. Add the ones.

<table>
<thead>
<tr>
<th>Tens</th>
<th>Ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>+</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

7 ones + 5 ones = 12 ones
Regroup the ones.
12 ones = 1 ten 2 ones

2. Add the tens.

<table>
<thead>
<tr>
<th>Tens</th>
<th>Ones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>+</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

47 + 15 = 62
PRIME in action

The approach used in PRIME works for many reasons. As discussed, some of those are based on the Teaching Principles used in Singapore Maths. They include:

- teachers developing students’ conceptual understandings through carefully scaffolded lessons, and
- students being explicitly taught to apply what they know to problem solving situations.

PRIME provides explicit and comprehensive support for teachers and students

There are many great teachers of maths who may not need the explicit level of support that PRIME provides. But, there are also teachers who might benefit from the comprehensive approach – that is proven to work. For some teachers – it will be an ‘on-the-job’ source of professional learning.

How does it work in classrooms?

PRIME is made up of student Coursebooks (sample pages shown) and Practice Books. There is inbuilt pedagogy in the Coursebooks – the main source of modelled and guided lessons for teachers and students.

Continual assessment is part of the teaching approach used in PRIME.

The Practice Books ensure that students have a deep understanding of concepts. They also provide essential feedback to teachers on how well students have understood what they’ve been taught.

In addition, comprehensive Teacher’s Guides are coming very soon.

Take a look

So – if you’re wondering whether PRIME would be right for you – we’d really suggest you take a look at some of the books.

There is an order form below.

REMEMBER – PRIME dives deep into each mathematical concept, and concept understanding is built on from one level to the next. So, if you plan to introduce it to some upper primary year levels, you may need to consider whether students will have the background prerequisites to pick up the topics in PRIME at the level taught in Singapore.