

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**.

Primary Mathematics Teaching and Learning Syllabus, Ministry of Education, Singapore, 2012, pp21-22

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.**"

Primary Mathematics Teaching and Learning Syllabus, Ministry of Education, Singapore, 2012, p21

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.

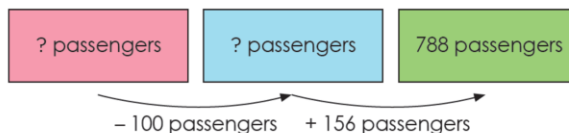
How many passengers were left on the train?
How many passengers got off?
How many passengers got on?
What do I have to find?
What should I do?



2 Plan what to do.

I can **work backwards**.

3 Work out the Answer.



By working backwards:

$$788 - 156 = 632$$

$$632 + 100 = 732$$

There were 732 passengers at the beginning.

$$\begin{array}{l} \text{■} + 156 = 788 \\ \text{■} - 100 = 632 \end{array}$$



4 Check
Did you answer the question?
Is your answer correct?

$732 - 100 = 632$
 $632 + 156 = 788$
My answer is correct.



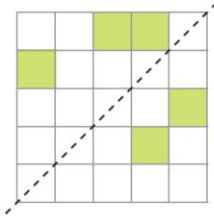
- ☒ 1. Understand
- ☒ 2. Plan
- ☒ 3. Answer
- ☒ 4. Check

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.



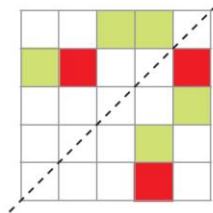
1 Understand
the problem.

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

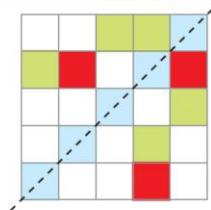
2 Plan what to do.

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

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.

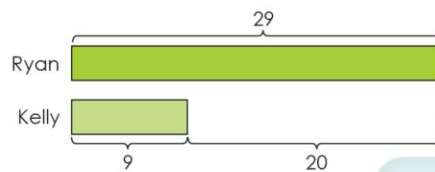
How old is Kelly now?
How old is Ryan now?
What do I need to find?



- 2 **Plan** what to do.

I can **draw a bar model**.

- 3 **Work out the Answer.**



The difference in age between Kelly and Ryan is 20 years.

When Ryan's age is twice that of Kelly's age:



The difference in age will always remain the same.



$$20 \times 2 = 40$$

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.
 $40 \div 20 = 2$
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**."

Primary Mathematics Teaching and Learning Syllabus, Ministry of Education, Singapore, 2012, p21

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

Math Lab

Picture It



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



3 and 2 make 5.



3
part
5
whole
2
part

This is a **number bond**.

1A Chapter 7: Addition and Subtraction Within 20

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?



Make a group of 10 buttons.



$$\begin{array}{r} 9 + 4 = \square \\ 1 \quad 3 \end{array}$$

First, add 9 and 1 to make 10.
Then, add 3.

$9 + 4$ is the same as $10 + 3$.

$$9 + 4 = \square$$

There are \square buttons altogether.

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$$\begin{array}{l} 9 + 1 = 10 \\ 10 + 3 = 13 \end{array}$$

9 and \square
make 10.

1B Chapter 15: Addition and Subtraction Within 40, p 82

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.

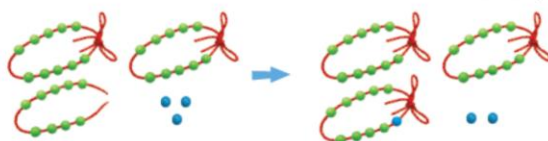
a) We can add by counting on.



Count on from 29.
29, 30, 31, (32)

$$29 + 3 = \square$$

b) We can add using number bonds.



$$\begin{array}{r} 29 + 3 \\ 1 \quad 2 \end{array}$$

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

$$29 + 3 = \square$$

$$\begin{array}{l} 29 + 1 = 30 \\ 30 + 2 = 32 \end{array}$$

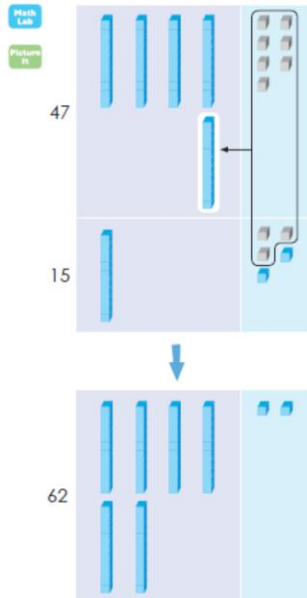
1B Chapter 19: Addition and Subtraction Within 100, p 146

Adding two 2-digit numbers with regrouping

Let's Learn

Add 47 and 15.

$47 + 15 = \square$



1 Add the ones.

| Tens | Ones |
|------|------|
| 4 | 7 |
| 1 | 5 |
| | 2 |

7 ones + 5 ones = 12 ones

Regroup the ones.

12 ones = 1 ten 2 ones

2 Add the tens.

| Tens | Ones |
|------|------|
| 4 | 7 |
| 1 | 5 |
| 6 | 2 |

$47 + 15 = 62$

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.

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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.

SCHOLASTIC

PRIME
Mathematics