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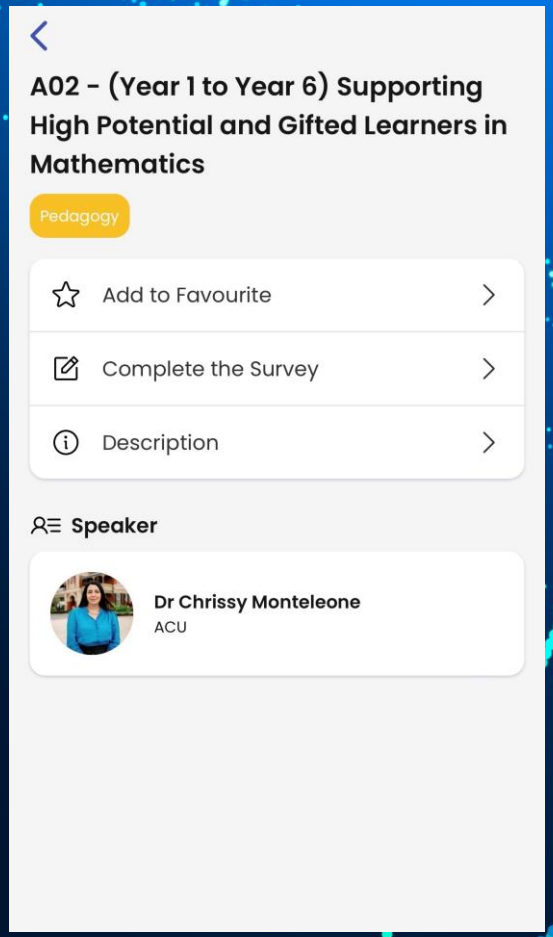

CURRICULUM, PEDAGOGY AND BEYOND

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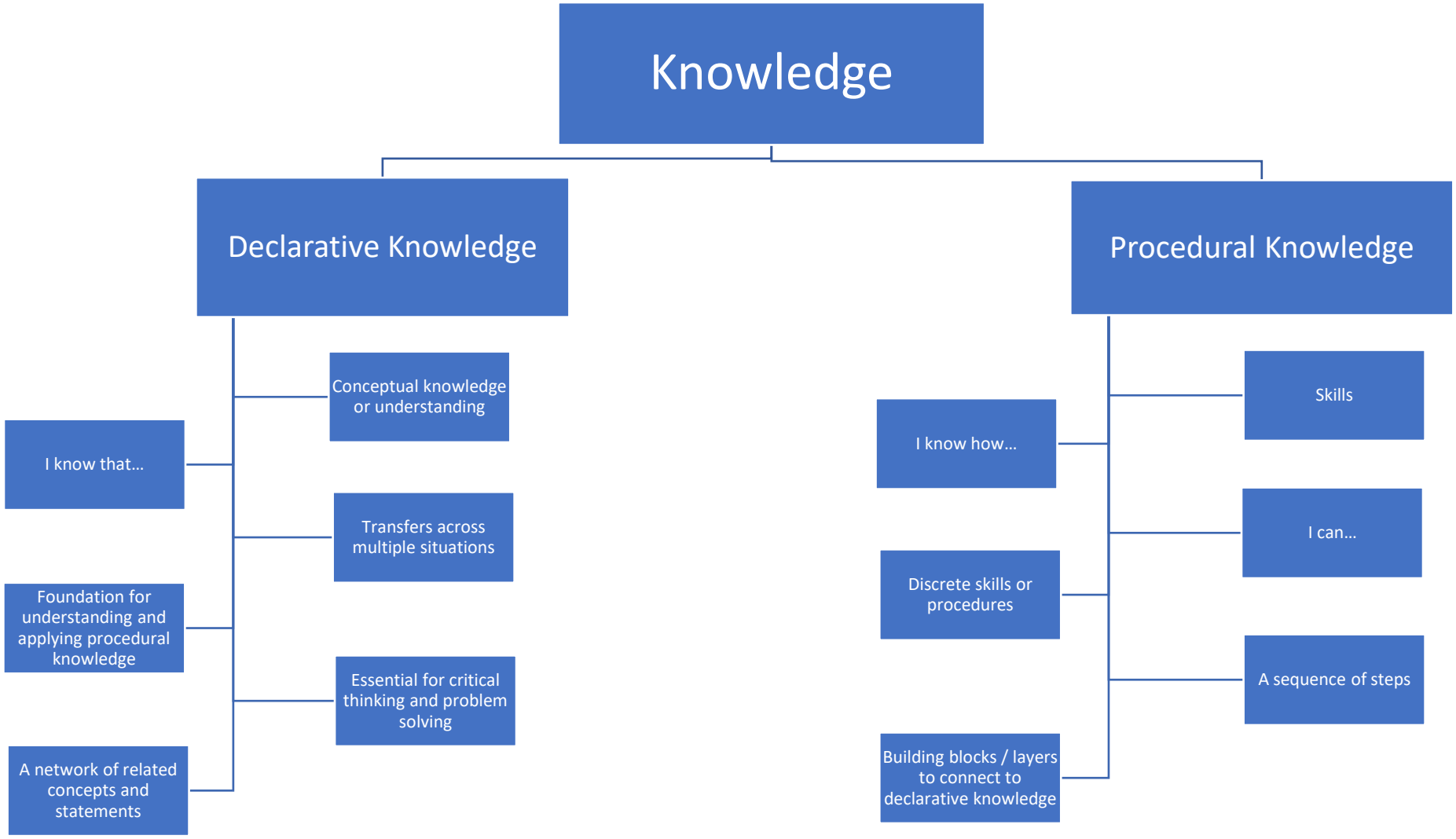
Differentiation through a focus on KNOWLEDGE and SKILLS

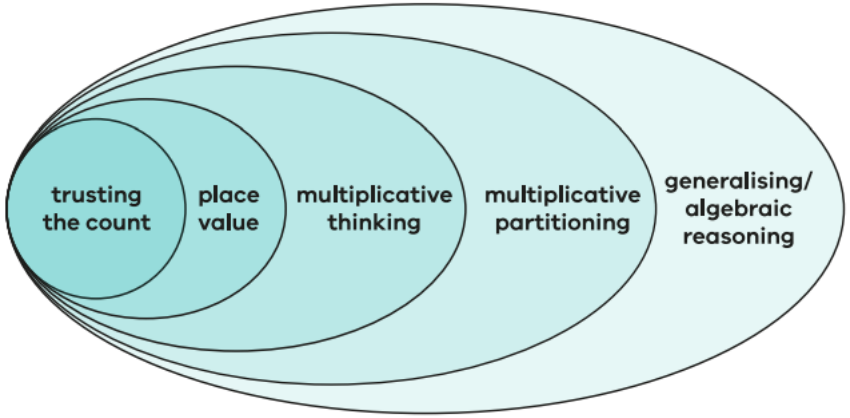
Zahra Harvey
Lysterfield Primary School

Types of Knowledge



Declarative Knowledge in Mathematics

Big Ideas in Number by Di Siemon



"a statement of an idea that is central to the learning of mathematics, one that links numerous mathematical understandings into a coherent whole"

Example Knowledge Statements

- Counting tells how many items there are altogether. When counting, the last number tells the total number of items; it is a cumulative count. (cardinality)
- Numbers can be represented using objects, words, and symbols
- Some basic addition and multiplication facts can be found by breaking apart the unknown fact into known facts. Then the answers to the known facts are combined to give the final value.
- Two numbers can be added in any order; two numbers can be multiplied in any order (commutativity)

Charles, 2005

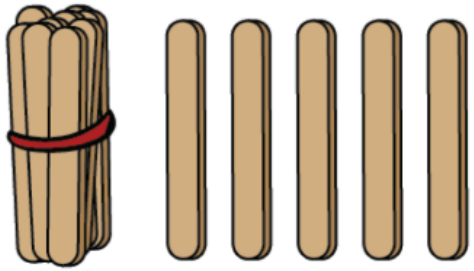
Differentiation practices

- Scaffolding / supports / tools
- Concrete – Representational – Abstract
- Differentiating the process, product, approach to task
- Questions / prompts that extend thinking and connections

- All developing the same declarative knowledge – the same conceptual understanding about mathematics

Differentiated Whole Class Instruction

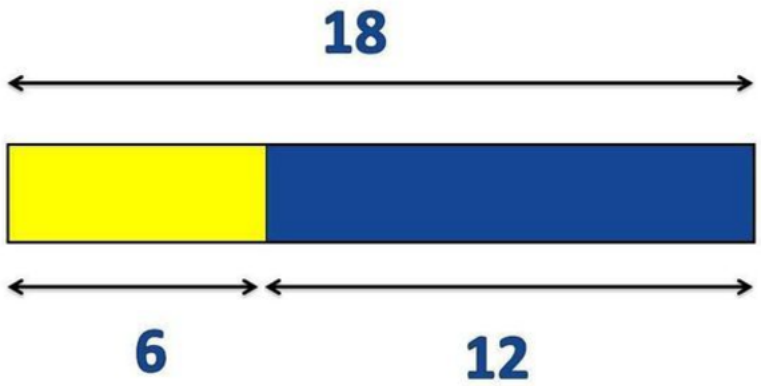
Big Idea – Numbers can partitioned into their place values



$$647 = (6 \times 100) + (4 \times 10) + (7 \times 1)$$

Differentiated Whole Class Instruction

Big Idea – Part-total relationships link addition and subtraction

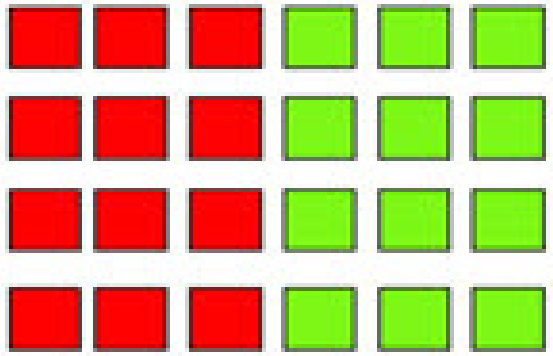


	8	9	5	6	3
+	4	□	5	□	9
	□	□	3	□	2	2

□ + 9 = 16

Differentiated Whole Class Instruction

Big Idea – Numbers can be partitioned to multiply



	200	40	8
80	16000	3200	640
1	200	40	8

$$
\begin{array}{r}
{\scriptstyle 1}\quad {\scriptstyle 1}\quad {\scriptstyle 1} \\
1.25 \\
\times\ 3.33 \\
\hline
375 \\
3750 \\
37500 \\
\hline
4.1625
\end{array}
$$

Connecting skills to Big Ideas (Knowledge statements)

Additive Thinking – Grade 1

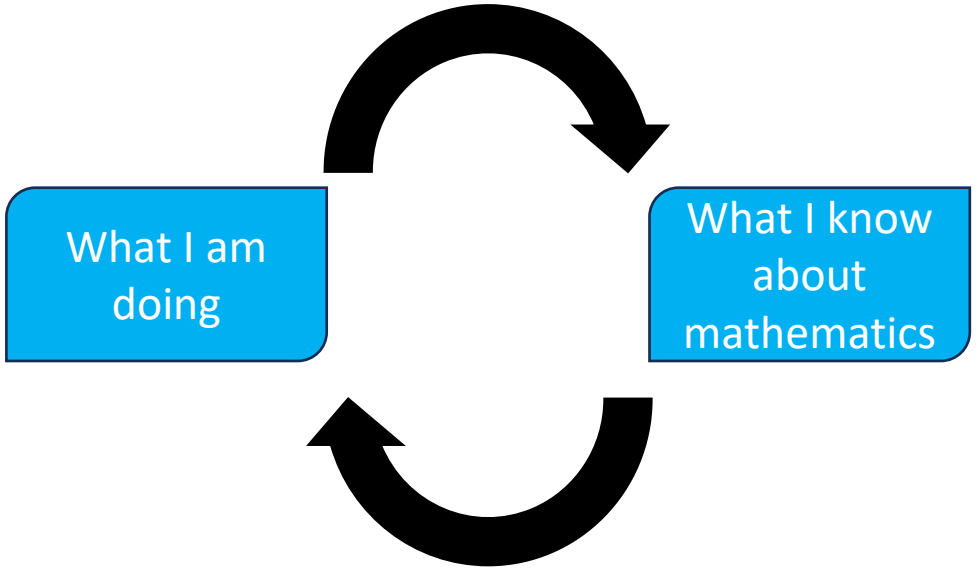
	Knowledge / Understanding (KNOW)	Skill / Strategy (DO)	Vic Curriculum 2.0
Lvl	*I know that….*	*I can…*	*Content Descriptor*
One	Addition is putting **parts** together to make a **total** Numbers can be added in any order = means 'the same as' Subtraction is taking **parts** away from a **total**, or finding an unknown **part** Addition and subtraction number sentences can describe real situations	Add and subtract numbers **up to 100** Represent and solve number sentences and one step worded problems/real life stories (read out by teacher) using: - concrete materials - drawings - fingers Use concrete materials (eg. 2 colours) to show the **commutativity** (eg. 2+4=6 and 4+2=6) and patterns (eg. 6+1=7 5+2=7 4+3=7 or 9-1=8 9-2=7 9-3=6) Use the following addition strategies: - count on from the bigger number to find the total - friends of 10 - dice doubles facts Use the following subtraction strategies: - count back to 'take away' - count up to find the unknown part - flip a friend of 10 or dice doubles fact	add and subtract numbers within 20, using physical and virtual materials, part-part-whole knowledge to 10 and a variety of calculation strategies (VC2M1N04) use mathematical modelling to solve practical problems involving additive situations, including simple money transactions; represent the situations with diagrams, physical and virtual materials; use calculation strategies to solve the problem (VC2M1N05)

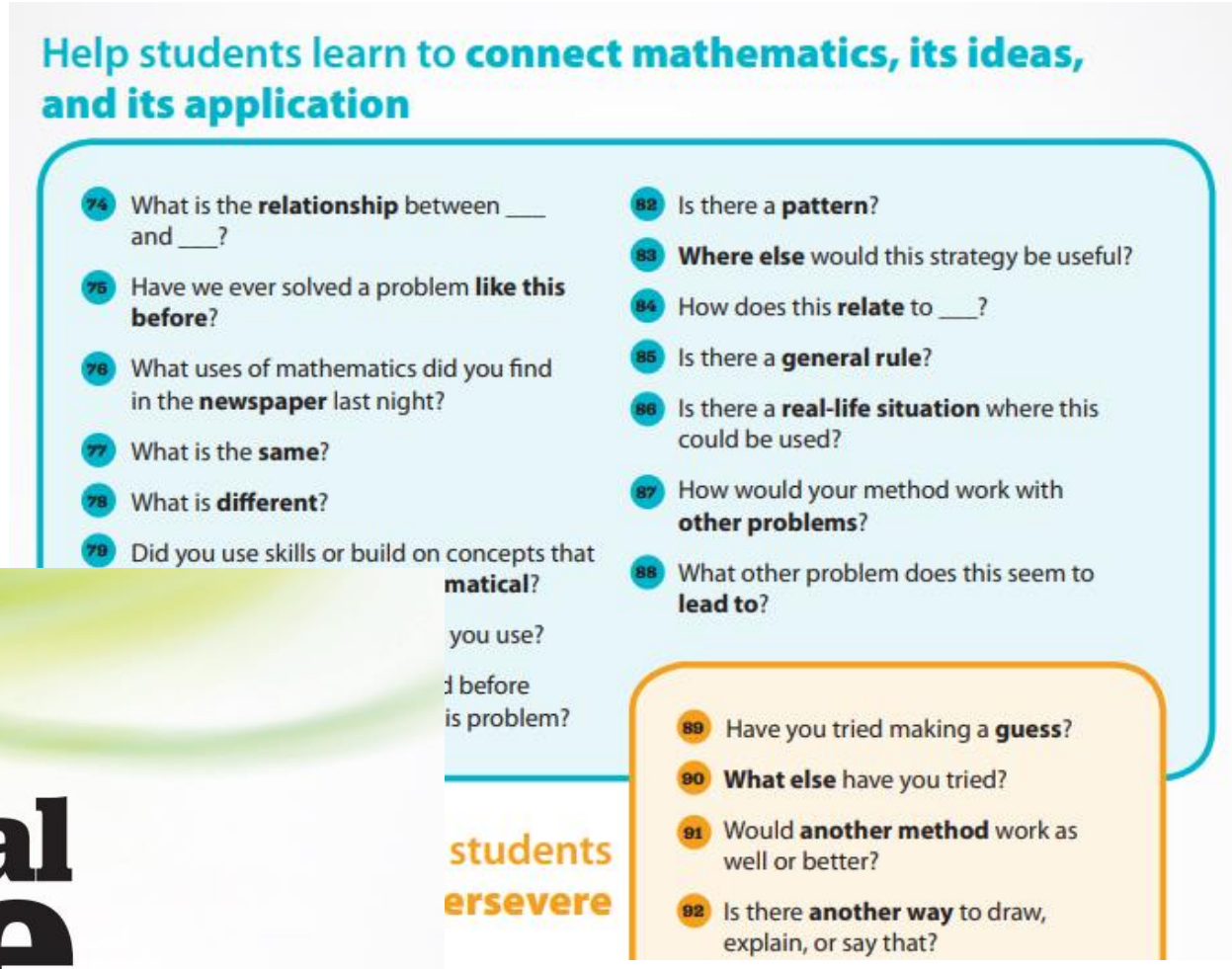
Connecting skills to Big Ideas (Knowledge statements)

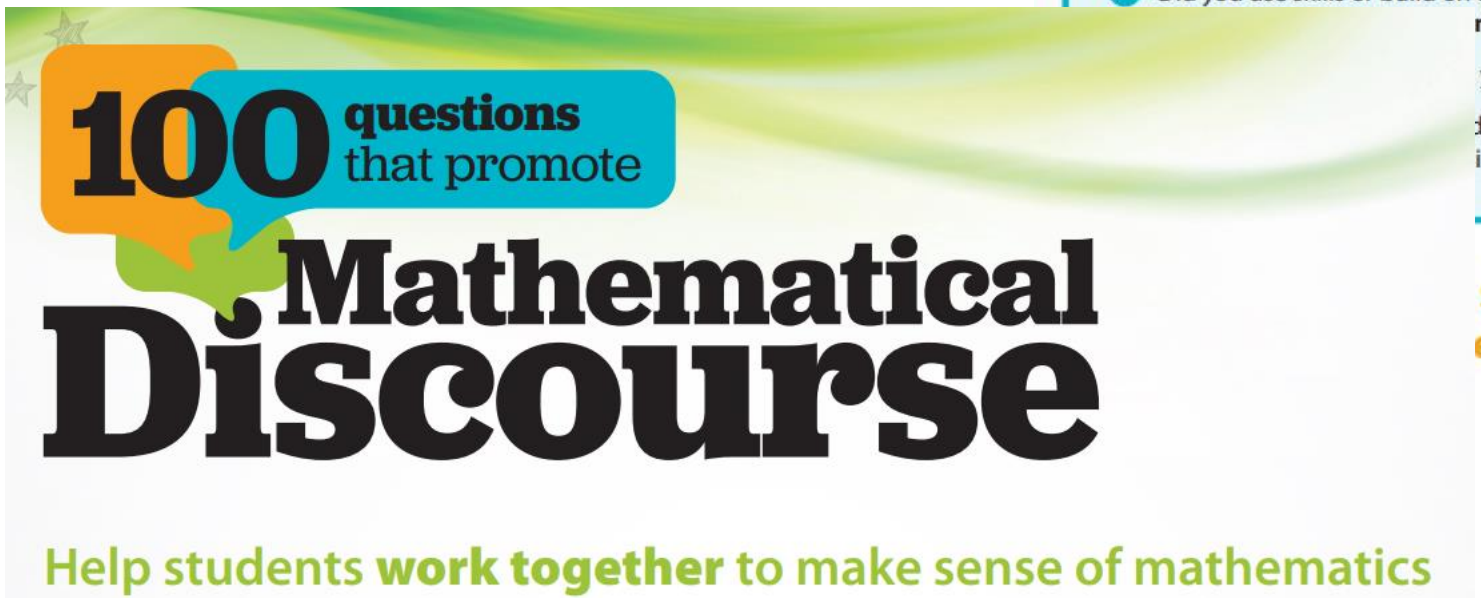
Multiplicative Thinking – Grade 3

	Knowledge / Understanding (KNOW)	Skill / Strategy (DO)	VC 2.0
Lvl	*I know that….*	*I can…*	*Content Descriptor*
Three	Numbers can be multiplied in any order eg 2x5=5x2 Numbers can be partitioned to multiply eg; 6x4=3x4+3x4 (x) means groups of and how many times you see that number eg 3x6 is seeing 6, 3 times, or 3 6s There are connections between times tables eg 10x table is double the 5x table Multiplication and division are inverse operations Division is about sharing (into equal groups) to find **how many in each group** ÷ means 'shared between' eg 15 ÷ 5 is 15 shared between 5 groups Division is about grouping (making groups of) to find **how many groups** ÷ means 'split into groups of/how many groups of' eg 15 ÷ 5 is 15 split into groups of 5/how many groups of 5 Division can be solved by repeated subtraction (as part of grouping)	Think multiplicatively with numbers **up to 100** Use the following multiplication strategies: - make/draw an array - model multiplication as repeated addition on a number line - skip counting - known facts, using what you know (5x5 to solve 6x5) - **doubling** (e.g. the connection between 2's and 4's, 3's and 6's, 5's and 10's) - split strategy (partitioning using addition (9 x 5 = 4 x 5 + 5 x 5) - show using arrays Use the following division strategies: - model division as on a number line through skip counting forwards (or backwards) - **halving** - flip a known multiplication fact (using arrays to show) - skip counting to find how many of that number eg 12÷3 = 3, 6, 9, 12 - 4 lots of 3 Connect multiplication and division using fact families	multiply and divide one- and two-digit numbers, representing problems using number sentences, diagrams and arrays, and using a variety of calculation strategies (VC2M3N05) use mathematical modelling to solve practical problems involving additive and multiplicative situations, including financial contexts; formulate problems using number sentences and choose calculation strategies, using digital tools where appropriate; interpret and communicate solutions in terms of the situation (VC2M3N08)

The critical importance of reflection







Pause - Reflection

- In what way/s are you or your school currently addressing the following:
  - Big Ideas in maths / Conceptual Development
  - Differentiating during whole class teaching

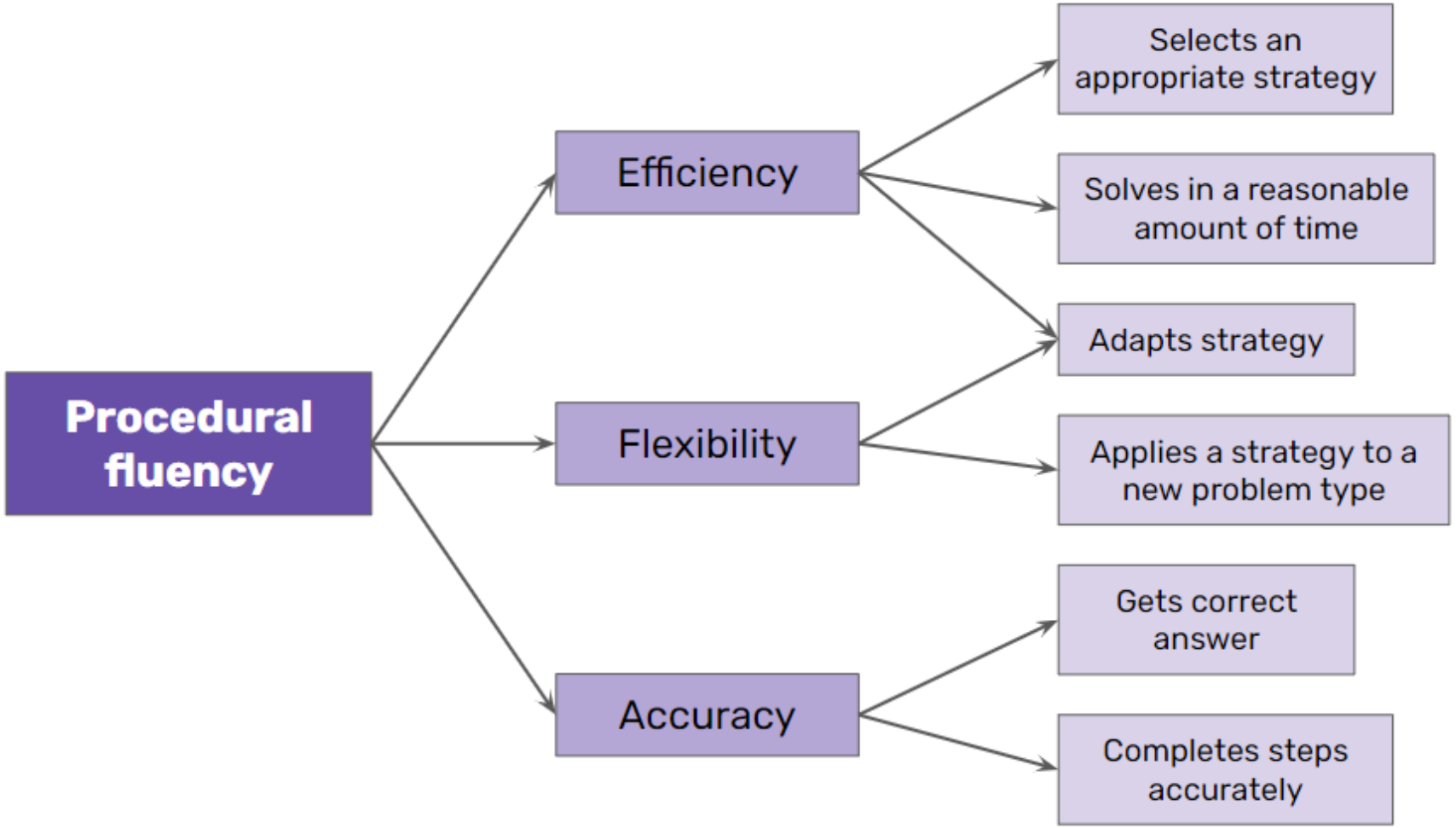
- What changes could / would you like to make based on what you have heard so far?

Procedural Knowledge (Skills) in Mathematics

- Can be referred to as procedural fluency
- Understanding of the rules and routines of mathematics
- Knowing the series or sequence of steps to follow to solve problems
- Knowledge of the algorithmic skills, techniques and methods
- WHAT to use, HOW to use it and WHEN to use it

Nahdi and Jatisunda, 2020

Procedural Knowledge (skills) in Mathematics



Graphic Source: Innovamat

Guided / Independent Practise

Teacher

- Explicitly teaching student/s about skill
- Guiding student/s to practise skill
- Connecting skill to big idea / knowledge statement

Student/s

- Working with the teacher to learn about a skill
- Independently or collaboratively practising skill to achieve procedural fluency

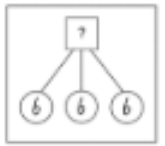
Skill Progressions

- Addition skill progression

Year	Grade 2	Grade 2	Grade 2	Grade 3	Grade 3	Grade 3	Grade 3	Grade 3
GOAL	*I can identify doubles up to 20*	*I can use my near doubles*	*I can connect addition and subtraction*	*I can make a friendly number*	*I can use the jump strategy to add 3 digit numbers*	*I can use the split strategy to add 3 digit numbers*	*I can use vertical addition*	*I can apply the connection between addition and subtraction*
KEY DETAILS	Using different strategies to solve doubles facts up to 20+20 Not necessarily mentally fluent, but can work it out using known strategies	Breaking up numbers that are similar to create doubles facts 17+15 = 15+15+2	Part-part-total - use cuisenaire rods (concrete) and bar models, cherry diagram (visuals) Fact families with totals less than 20 Missing number problems less than 20 - counting on to find the missing number E.g. 7 + ? = 12	Moving numbers around to create 'friendly' numbers that assist mental calculations - usually, but not always, a multiple of 10 48+5 = 50+3 25+29 = 24+30	Jump in place values on a number line 553+226= 553+200 753+20 773+6 779 Can start with jumps of 100 and 10 if needed. Increase efficiency with bigger jumps. *When bridging the next 10 or 100, show students how taking 2 jumps can help	Split in place values to add. Record vertically Without regrouping first E.g. 157+221= 100+50+7 200+20+1 300+70+8 = 378 With regrouping 328+236 300+80+8 200+30+6 500+110+14 = 624	With internal zeros **Without regrouping** Answers can initially be recorded in steps E.g. 242 347 9 80 500 589 Then can increase efficiency without recording each individual step	Solving missing number problems within fact families without calculating (using reasoning) E.g. Given that 25+13=38 Then I can solve 38-?=25 Creating equivalent number sentences and explaining their connections E.g. 20+53 = 10+63 53-20 = 63-30

Skill Progressions

- Multiplication skill progression

Year	Prep	Prep	Grade 1	Grade 2	Grade 2	Grade 2	Grade 3	Grade 3
GOAL	*I can identify groups that are equal and unequal*	*I can make equal groups and find the total*	*I can skip count collections to find the total*	*I can make equal groups to represent and solve multiplication*	*I can make arrays to represent and solve multiplication*	*I can identify multiplication as how many times you have a number*	*I can use the SPLIT strategy (addition)*	*I can use what I know to solve what I don't*
KEY DETAILS		Counting by 1s to find the total amount of objects in all groups	Skip counting collections by 2s, 5s and 10s Organising collections into groups, and then rows and columns to make counting easier (x) symbol introduced to mean 'groups of' e.g. 2 x 5 = 2 groups of 5	Finding the total by: - Skip counting (by 2s, 5s, 3s and 10s) - Repeated addition 	Finding the total by: - Skip counting (by 2s, 5s, 3s and 10s) - Repeated addition 	E.g. 3 x 6 = 6, 3 times = 6 + 6 + 6 = 3 6s Finding the total by: - Skip counting (by 2s, 5s, 3s and 10s) - Repeated addition Moving to composite units e.g. not each item in a group 	Partitioning using **addition** E.g. 7 x 6 = 2 x 6 + 5 x 6 **Show partitioning using arrays** Partitioning to make numbers /groups smaller and easier to calculate *Working towards fluency of multiplication facts multiplying by 2, 3, 5, 10*	Use what you kn (known facts) and add or subtract groups E.g. 3 x 6 = 2 x 6 + 6 9 x 5 = 10 x 5 - 5 **Show using arrays** Explore commutativity with arrays - if you know 2 x 5, then you know 5 x 2 *Working towards fluency of multiplication facts multiplying by 2, 3, 5, 10*
	Worded problems to be taught throughout unit							

Identifying point of need -

EssentialAssessment™
Assessment and Curriculum made easy
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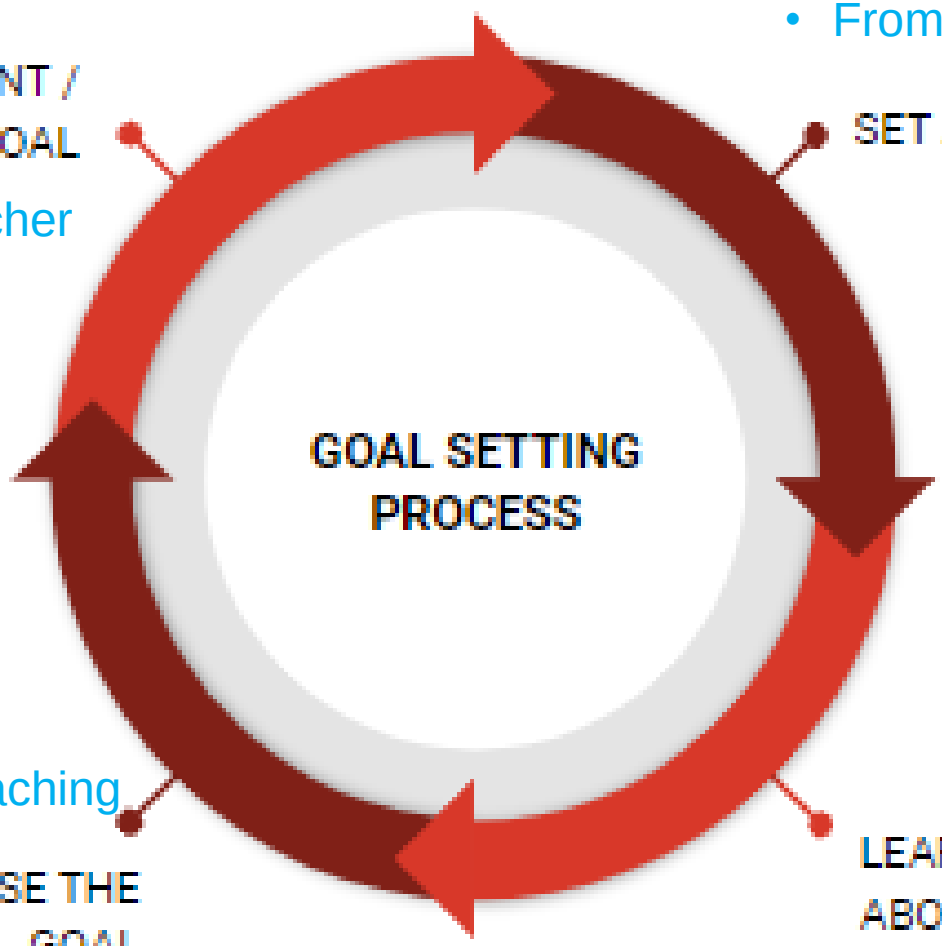
Level	Prep	Grade 1	Grade 2	Grade 2	Grade 3	Grade 3	Grade 4	Grade 5
VC Content Descriptor	Represent practical situations to model addition and subtraction (VCMNA073)	Represent and solve simple addition and subtraction problems using a range of strategies including counting on, partitioning and rearranging parts (VCMNA089)	Explore the connection between addition and subtraction (VCMNA106)	Solve simple addition and subtraction problems using a range of efficient mental and written strategies (VCMNA107)	Recognise and explain the connection between addition and subtraction (VCMNA132)	Recall addition facts for single-digit numbers and related subtraction facts to develop increasingly efficient mental strategies for computation (VCMNA133)	Apply place value to partition, rearrange and regroup numbers to at least tens of thousands to assist calculations and solve problems (VCMNA153)	Use estimation and rounding to check the reasonableness of answers to calculations (VCMNA182)
EA Learning Goal	I can add and subtract	I can solve addition and subtraction problems	I can connect addition and subtraction	I can solve addition and subtraction problems	I can connect addition and subtraction	I can use addition and subtraction facts	I can solve problems with place value to tens of thousands	I can use estimation and rounding
LPS Learning Goal/s	*I can count all* *I can count on* *I can find friends of 5*	*I can find friends of 10* *I can count on from the bigger number* *I can identify dice doubles*	*I can connect addition and subtraction*	*I can make 10* *I can identify doubles up to 20* *I can use my near doubles* *I can add the 1s and add the 10s*	*I can apply the connection between addition and subtraction*	*I can make a friendly number* *I can use the jump strategy to add 3 digit numbers* *I can use the split strategy to add 3 digit numbers* *I can use vertical addition*	*I can use the jump strategy to add 4 digit numbers* *I can use the split strategy to add 4 digit numbers* *I can use the compensation strategy* *I can use vertical addition* *I can solve equivalent number sentences* (VCMNA163)	*I can estimate to check the reasonableness of my answers*

Identifying point of need – prove its

	Question 1	Question 2	Question 3	Question 4
Goal: I can connect addition and subtraction	9 + ? = 16 **Show your working out in the space below:**	11 - ? = 8 **Show your working out in the space below:**	? - 5 = 13 **Show your working out in the space below:**	15 + ? = 23 **Show your working out in the space below:**
Goal: I can use the jump/split numbers strategy to subtract numbers	368 - 142 = **Show your working out in the space below:**	727 - 354 = **Show your working out in the space below:**	4,534 - 1,622 = **Show your working out in the space below:**	5,934 - 3,787 = **Show your working out in the space below:**
Goal: I can use vertical addition with regrouping	326 - 135 = **Show your working out in the space below:**	953 - 278 = **Show your working out in the space below:**	6,932 - 1,581 = **Show your working out in the space below:**	7,541 - 2,861 = **Show your working out in the space below:**

Goal setting process

- Based on assessment data
- From the learning progression



- When working with the teacher
- Prove its
- EA post tests

- Independent Practise
- Practise during whole class teaching

- Targeted explicit teaching
- Making connections to big ideas

Planning in action

Goals	*I can make arrays to represent and solve multiplication*	*I can identify multiplication as how many times you have a number*	*I can use what I know to solve what I don't*
Students			
Session 1	**TEACHER** Provide a multiplication number sentence (like 3 groups of 5 or 3x5) and show students how to make an array that represents that number sentence. Then model how to use skip counting to quickly find the total. Focus on skip counting by 2s, 3s, 5s and 10s, so focus on multiplication by 2, 3, 5 and 10 when giving problems. Explicitly teach language of columns and rows	**PRACTISE (arrays goal from week 2)** • Roll 2 dice to make an array with counters. E.g. roll 3 and 4 and make an array with 3 rows of 4 counters in each. Calculate the total number of counters by skip counting. Record the number sentence in your maths book. Encourage students to write as a number sentence, 'groups of' and repeated addition.	**MY NUMERACY** 
Session 2	**PRACTISE** Roll 2 dice to make an array with counters. E.g. roll 3 and 4 and make an array with 3 rows of 4 counters in each. Calculate the total number of counters by skip counting. Record the number sentence in your maths book. Encourage students to write as a number sentence, 'groups of' and repeated addition. Option to have cards 2, 3, 5 and 10 to encourage the skip counting by 2s, 3s, 5s and 10s	**MY NUMERACY** 	**TEACHER** Show students how number facts can be connected (by adding or taking away a group) using the multiplication subitising cards Flip a subitising card - what multiplication fact is it representing? Do you know this fact already? If not, do you know a fact that is close or near this one? Can you use that and then add or subtract groups? E.g. show the card for 6 x 3. If you already know this fact, great, if you don't, do you know 5 x 3? Can you use that to solve 6 x 3? Model how 5 x 3 is one less group of 3, so you can solve that, then add on the 6th group of 3. 6 x 3 = 5 x 3 + 3
Session 3	**MY NUMERACY** 	**TEACHER** ***3x6 symbol means 'Groups of' so 3 groups of 6.*** Provide a problem and students show ~~this using counters~~ - 3x4 show 3 groups of 4 - the skip count • Show with cherry model - draw square at top and leave blank, then draw 3 circles and write 4 in each (or draw 4 dots), then skip count to find the total (write in square at top). Link to repeated addition. **IF KNOW ABOVE, MOVE ON TO SPLIT STRATEGY:**	**PRACTISE** • Students roll two dice and make a multiplication equation and record. Students draw the array and add an extra group or groups (rows) using a different colour, OR cross out a group (row) to find the answer.

Possible structure to address knowledge and skills

- 10 minutes — Daily Review of foundational year level skills
- 20 minutes — Whole Class
  Explicit Teaching of Knowledge / Concepts
  Differentiated student work addressing the SAME Big Idea
- 20 minutes — Small group / Individual
  Explicit Teaching of Skills to small groups / individual students based on point of need
  Independent Practise

Alternative structure to address knowledge and skills

- 10 minutes — Daily Review of foundational year level skills
- 10-15 minutes — Whole Class
  Explicit Teaching
  Concept Development
- 10-15 minutes — Whole Class
  Explicit Teaching and Guided Practise
  Skill Development
- 10-15 minutes — Small group / Individual
  Explicit Re-teaching of Skills to small groups / individual students based on point of need
  Independent Practise

Non-negotiables

- KNOWLEDGE
  - Breakdown of the knowledge statements explicitly taught at each year level
  - Statements are repeated and layered – the same knowledge statement is taught with an increasing expectation of understanding or related skill
  - Knowledge statements are connected to relevant skills – across all year levels
  - Increasing understanding of knowledge develops over time
- SKILLS
  - Breakdown of the skills into a granular level
  - Clear expectations of achievement for each goal
  - Develop in a sequential progression
  - Linked to year levels / curriculum
  - Linked to assessments
  - Taught at point of need
  - Require practise to achieve procedural fluency

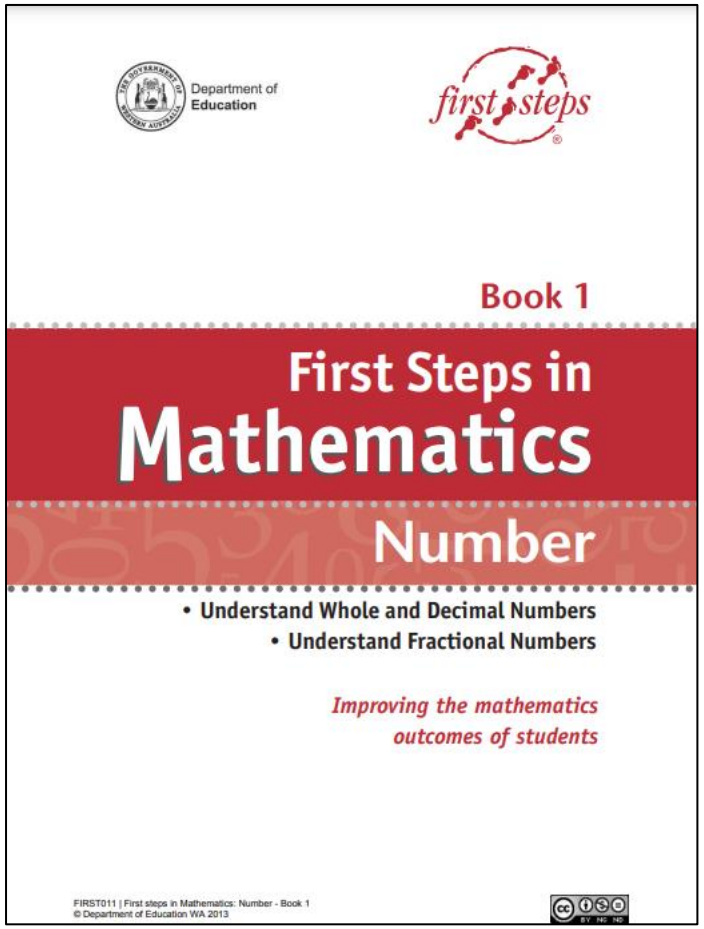
Pause - Reflection

- Looking at the non-negotiables for both knowledge and skills:
  - What might be a starting point for you or your school going forward?
  - Will your focus be on developing practice with teaching knowledge or skills, or are you ready to tackle both?
  - What current practices can you leverage to make small changes that may have a large impact?

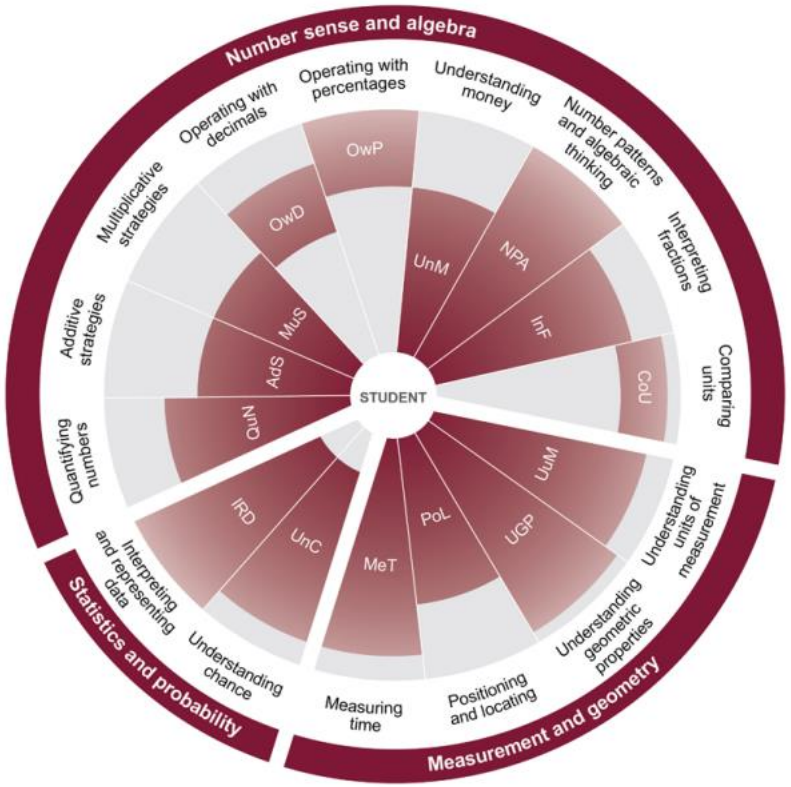
Recommended Further Reading – Big Ideas

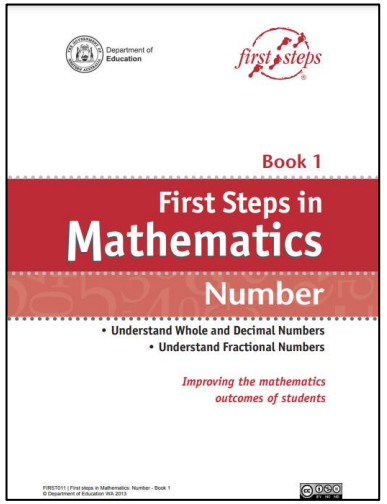
Big Ideas and Understandings as the Foundation for Elementary and Middle School Mathematics

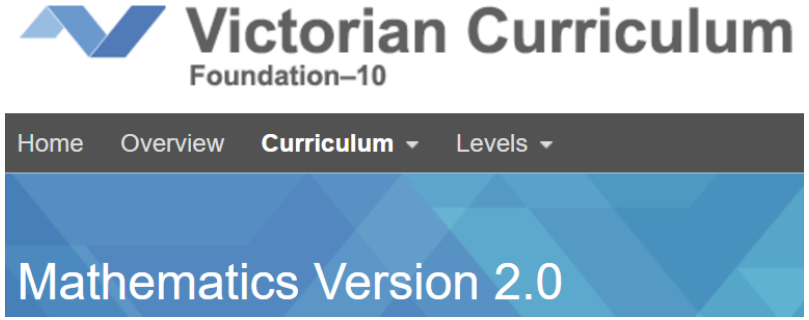
Randall I. Charles, Carmel, CA

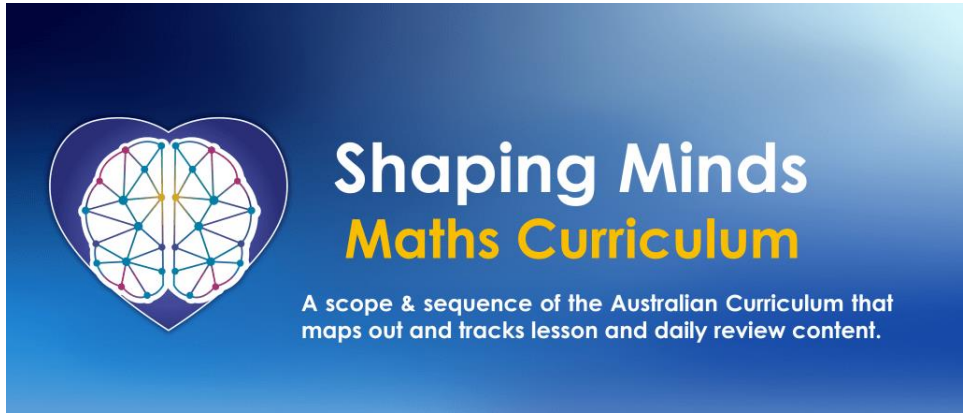


Recommended Further Reading – Skill progression









Questions?

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