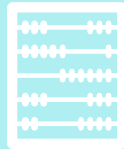


DR ANGE ROGERS

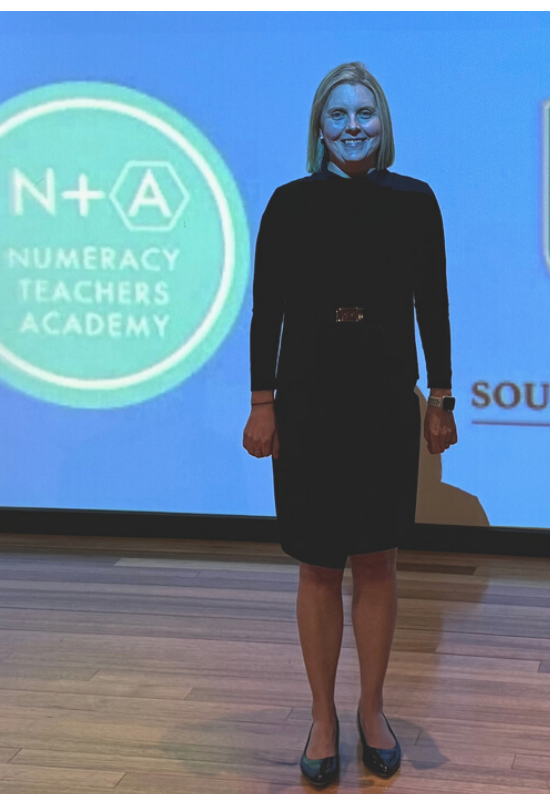


Place Value: What really matters?

BMM Virtual Summit 2024

ange@numeracyteachersacademy.com

WELCOME



Hi, my name is Dr Ange Rogers. I am a Maths Education Consultant from Melbourne Australia and I LOVE place value. I spent four years researching the teaching, learning and assessment of place value throughout my PhD.

In the 9 years since then I have continued to research and refine the resources I provide to support teachers and students.

I hope you find my session at the BMM Virtual Summit engaging and informative. In this workbook you will find resources that summarise the main areas I will cover and suggest some places to go for further learning.

If you have any questions, feedback or suggestions, please don't hesitate to reach out to me via email

ange@numeracyteachersacademy.com

Many Thanks,

Ange Rogers

Dr Ange Rogers

Notes

Record any notes as we move through the session



Notes



Ideas



Reflection

The 6 Aspects of Place Value

Use the 6 aspects to guide your teaching of whole number and decimal place value

The 6 aspects form a structure to base place value teaching around. They provide a shared definition of place value and encourage everyone to use the same language across the school.



Place Value Unit Structure

When you are teaching place value you can use this 6 week structure

1

NAME/RECORD

- Read and write a number in words and figures
- Identify the names of each place value column
- Identify the value of digits in a number

2

COUNT

- Counting forwards and backwards in place value parts
- Bridging forwards and backwards over place value segments
- Identify the number before, after, next in a sequence
- Understand the idea of more, less, greater, larger, between

3

MAKE/REPRESENT

- Make, represent or identify the value of a number using a range of materials or manipulatives.
- proportional e.g., base-ten blocks), non-proportional (e.g. coloured counters)
- canonical (e.g., 3 tens and 9 ones is 39) or non-canonical (e.g., 2 tens and 19 ones is 39)

4

RENAME

- Rename numbers in multiple ways in terms of place value parts without the use of manipulatives
- 47 is equivalent to 3 tens 17 ones, 2 tens 27 ones etc

5

COMPARE/ORDER

- Compare numbers to determine which is larger or smaller
- Compare numbers in a multiplicative manner. e.g. tens times larger
- Locate numbers on empty, partially marked or complete number lines.
- Rounding numbers to the nearest place value part.

6

CALCULATE

- Apply knowledge and understanding of the place value system when completing calculations using the four operations

THINKING MISTAKE

When students attempt to record numbers, they often completely ignore place value conventions and simply write the numbers they recognize (in this case four hundred and seventy-three). Or as you can see below, they concatenate numbers, writing each part in sequence, for example (four hundred thousand, then 73).

Write in numbers:
Four hundred thousand and seventy three.

473

400,00073

TEACHING TIP

When we teach reading and writing numbers, we should encourage students to chunk (within the periods) and observe patterns (between the periods). Just as in literacy it is ok for students to be able to read some words they don't understand, it is perfectly ok for students to read and write numbers they have no comprehension of... yet! This place value houses template is very useful to teach the structure of our number system. Once students see the structure and conventions of recording numbers, they rarely make the errors seen above.

Billions			Millions			Thousands					
H	T	O	H	T	O	H	T	O	H	T	O

Reference: www.nzmaths.co.nz

Count

THINKING MISTAKE

We all know there are 'flash points' that cause difficulties for students when they count. Going forwards or backwards over a place value part, whether it be tens, hundreds, or thousands is a challenge. The sample below illustrates this difficulty

Continue the following pattern . . .

178, 168, 158, 148, 138, 128, 118, 108, 100, 92

TEACHING TIP

Pattern is critical in counting. Whenever you count, provide students the chance to observe the pattern they are creating. In the above example, you could ask questions like: what do you notice is happening in the tens column? ones column? I also like to link renaming with counting. For example, 13 tens 8 ones, 12 tens 8 ones, 11 tens 8 ones, 10 tens 8 ones,. What comes next? Don't assume students notice patterns- often they are just rote counting-make them think!

138, 128, 118, 108, 98, 88

138 is 13 tens, 8 ones

128 is 12 tens, 8 ones

118 is 11 tens, 8 ones

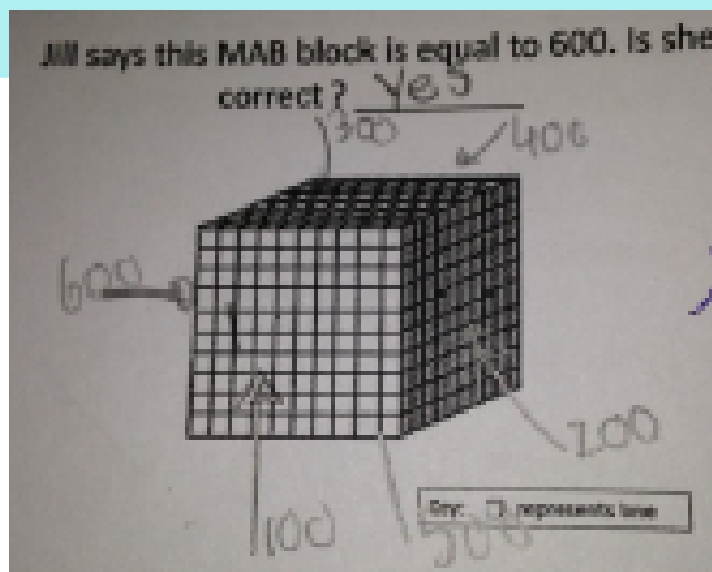
108 is 10 tens, 8 ones

98 is 9 tens, 8 ones

88 is 8 tens, 8 ones

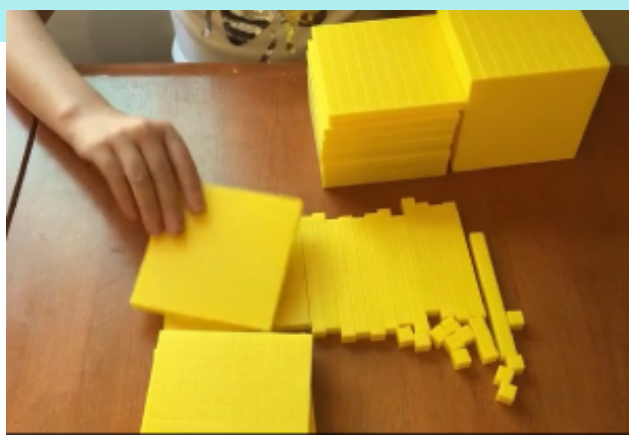
THINKING MISTAKE

In my research I found around 24% of Year 3-6 students believe (or are not convinced otherwise) that the MAB (Base 10) thousand block has a value of 600 below. This thinking mistake stems from students counting each face of the thousand block as 1 hundred, so 6 by 1 hundred is 600.



TEACHING TIP

Avoid plastic MAB (Base 10) thousand blocks- these are not weighted like the wooden sets, and feel hollow, reinforcing the 600-block issue. Let students discover the value of the MAB thousands block themselves. Hand them the block and simply say, 'I want you to discover and prove to me the value of this block'. Sticking together hundred blocks with blu-tac is a highly valuable part of this activity.



THINKING MISTAKE

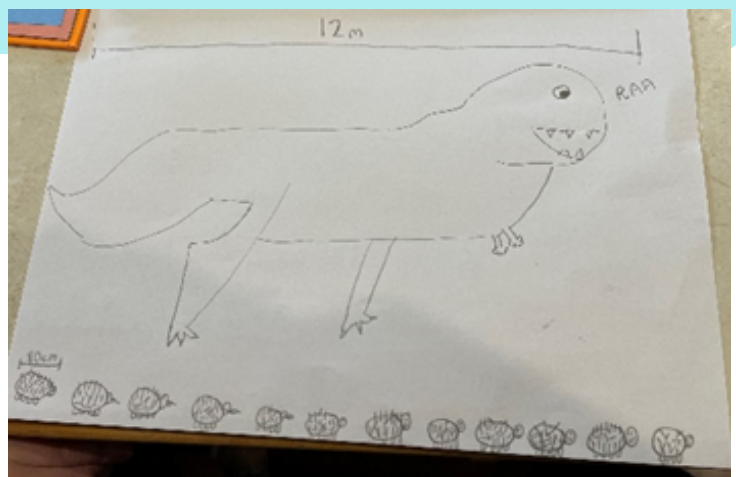
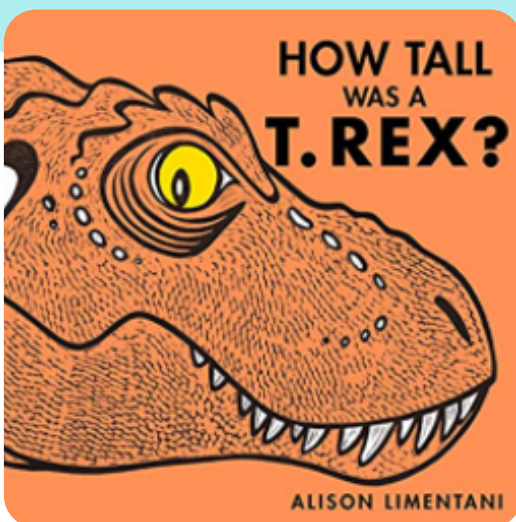
Students find multiplicative comparisons (x times larger or smaller) a difficult idea. Below you can see the student is thinking in an additive way and simply subtracts ten. They do not comprehend the meaning of the word “times”.

What number is ten times smaller than 440?

430

TEACHING TIP

A fabulous book and activity to reinforce this idea is to read “How Tall was a T.Rex” by Alison Limentani (see below). In this book students are prompted to consider multiplicative comparison scenarios. For example, ‘a T-Rex is as long as 6 lions’. This presents an authentic context to talk about the lion being 6 times smaller than a T.Rex or a T.Rex being 6 times larger than the lion.



Rename

THINKING MISTAKE

My research found that up to 80% of Year 3 students, 48% of Year 4 students, and 15% of students in Years 5 and 6 display the characteristics of Independent Column Thinkers (Rogers, 2014). These students believe each place value column does not relate to the others. This stems from an over-emphasis on the idea that “this is the hundreds column and hundreds live in there”. From this, students fail to understand the multiplicative idea that hundreds are composite units with smaller ‘tens’ and ‘ones’ units ‘hiding’ within them. The figure below shows the typical response of an Independent Column Thinker- they simply ignore the fact that 1 hundred can be renamed as 10 tens.

1 hundred, 6 tens, 7 ones is the same as . . .

6 tens 7 ones

TEACHING TIP

We know renaming is an abstract concept for students, but visualisation can assist students to develop their understanding. To introduce this idea, I use Russian nesting dolls. These dolls help to reinforce the idea that in place value there are smaller units within larger units. I encourage the students to close their eyes. If we are talking about the number 356, I ask them to imagine 3 of the ‘hundreds dolls’. I then ask how many smaller ‘tens dolls’ would be inside each, and ask them to visualise them being ‘let out’. There would be 10 tens in each hundred, so 30 tens. This visualisation assists students to appreciate there are units within units and that each column is related to the others.



Calculate

THINKING MISTAKE

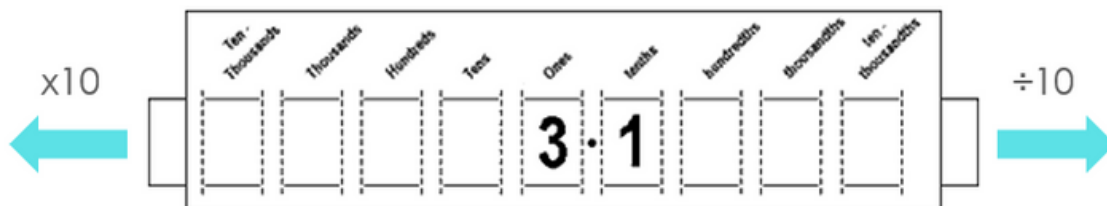
Students need scaffolding to see that if we are multiplying or dividing by a place value unit (10,100,1000) we can simply move the digits (the decimal point does NOT move). For example, in the equation below, we want students to recognise it is highly inefficient to use the traditional algorithm.

10 x 23 406 =

$$\begin{array}{r} 23406 \\ \times 10 \\ \hline 00000 \\ 234060 \\ \hline 234060 \end{array}$$

TEACHING TIP

A Number Slide (see below) is a perfect resource to help students visualise the idea that the digits are moving when you multiply or divide.



Reference: <https://extranet.education.unimelb.edu.au/SME/TNMY/Decimals/Decimals/teaching/models/numslide.htm>

PVAT

Place Value Assessment Tool
Form A

CLASS

before 88

OR HERE

P1

Place a number from
to order these numbers
to large

2
7
10
5

How many counters



P3

PVAT Form A

Form A of the PVAT is a paper and pen assessment used to measure student achievement in whole number place value.

- ✓ 4 practice items
- ✓ 58 items
- ✓ Valid and reliable measure of whole number place value in Years 2-6
- ✓ Addresses 6 aspects of place value
- ✓ Equivalent in difficulty to Form B

You can download the PVAT
Form A Assessment [here](#)

Further Readings

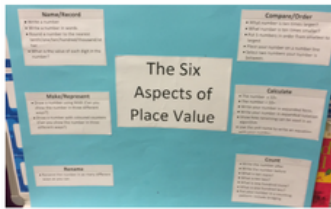
The following are short articles Ange has written for teachers. You can access these on the NTA website:
<https://www.numeracyteachersacademy.com/DrAnge-FREE-Resources>.
She also has written many blogs related to place value which you can find on her [website](#).

TEACHING PLACE VALUE: A FRAMEWORK

Angela Rogers
RMIT University

It is safe to say I love place value! My interest was sparked when I started teaching in junior school classrooms. I was shocked by the obvious difficulty students displayed coming to understand the 'basic' skills of place value. When I eventually moved to work with middle and upper primary school students I again observed students struggling with their understanding of the structure of our number system. Many of my students could be described as 'apparent experts'. These students appeared to understand place value, yet when their knowledge is probed with deeper questioning. For example, if I asked them how many tens and ones were in 75 and to represent the number using Base 10 blocks, they did so confidently. However, if I asked them to represent the number in another way, for example 6 tens and 15 ones, they looked at me blankly.

As a teacher I could see that place value was like the frame of a house. I held everything up. Clearly the students' lack of place value understanding was hindering their progression in all aspects of



The poster used in all classes to develop a shared language in place value.

In discussions with teachers I noted much confusion surrounding these words. What was the difference between grouping and partitioning? How did reorganising fit in my observations, the ambiguity of this vocabulary led teachers to focus more on the visible, and hence, 'concrete' Count. Counting forwards and backwards in place value parts (e.g., 45, 50, 55 or counting using the unit ten). Bridging forwards and backwards over place value segments such as decades and centuries (e.g., 995 and one more ten becomes hundreds forwards over hundreds

1 | Teaching Place Value: A framework.

This article details a structure to follow when you are teaching your place value unit. It explores the 6 aspects of place value.

DO YOUR STUDENTS HAVE THE 600 BLOCK MISCONCEPTION?

Angela Rogers
RMIT University

When I work with students, I love to celebrate mistakes and promote a growth mindset (Dweck, 2016). I encourage students to see that through mistakes come learning. I consider misconceptions 'thinking mistakes'. I explain to students that these are errors made on the journey towards mastery of a topic. 'Thinking mistakes' are in direct contrast to 'silly mistakes' - ones which I encourage my students to consciously avoid - these are made when our brain is not 'switched on'. In stark contrast, 'thinking mistakes' are made when our brain is working hard, struggling to make thoughtful and logical conclusions - it is during these times that real brain growth occurs.

In this article I will present a common misconception that I have identified through my place value research with Year 3-6 students. I call this the 600 block misconception (Rogers, 2014). I will explain the misconception to you so that you can use it in your classroom and provide suggestions to overcome the misconception and in a follow-up article will share a practical tool called 'The 600 Block' that can be used

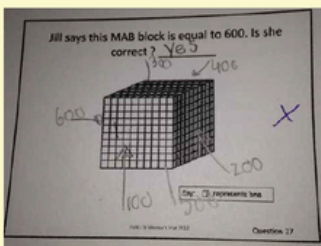


Figure 1. A work sample from a Year 4 student with the 600 block misconception.

2 | Do your students have the 600 block misconception?

This article explores the 600 block misconception. This is a common misconception students have with the Base 10 thousands block.

DO YOU HAVE INDEPENDENT COLUMN THINKERS IN YOUR CLASS?

Angela Rogers
RMIT University

One of the most important skills a mathematics teacher can have is the ability to recognise student misconceptions. Once teachers have recognised a misconception they then must 1) challenge the misconception and 2) scaffold students to move on in their understanding.

In this article I will present a common misconception I identified through my place value research with Year 3-6 students and suggest ways we can avoid students falling into this way of thinking.

THE INDEPENDENT COLUMN THINKERS

My research found that up to 80% of Year 3 students, 48% of Year 4 students, and 15% of students in Years 5 and 6 display Independent Column Thinker characteristics (Rogers, 2014). Essentially students with this misconception believe that each place value column has no relation to the others.

In each hundred and these must be 'released' in order to identify that there are 25 tens altogether. By including the word 'altogether' we are highlighting that our place value system is made up of composite units - that is, units within units.

Not surprisingly, students with this misconception find renaming numbers near impossible. At its core, renaming requires students to have a deep appreciation of the link between place value columns. To correctly answer the item shown in Figure 1, the student must recognise that '1 hundred' can be renamed as 10 tens. The response indicates Independent Column Thinking.

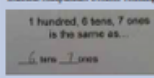


Figure 1. A response indicative of Independent Column Thinking.

the previously mentioned relationships as well as how each smaller unit relates to the composite unit 'hundred'. For example, 1456 is the same as (all the above relationships as well as):

- 3 thousands 4 hundreds 5 tens 6 ones
- 3 thousands 4 hundreds 56 ones
- 3 thousands 45 tens 6 ones
- 3 thousands 450 ones.

It can be said that each time a new composite unit is introduced, the number of relationships a student is required to understand doubles!

Another reason renaming poses major problems for students is because it requires access to multiplicative thinking. We know how difficult multiplicative thinking is for students. Research by Samson, Broad, Dale, Isaac, & Virginia (2016) found that only about 20% of students are multiplicative thinkers in Year 4 and even by Year 7 only about 60% of students think multiplicatively. If

3 | Do you have independent column thinkers in your class?

This article explores the independent column misconception. This is a common misconception where students don't appreciate the link between place value columns.

Zero Our Hero

Zero Our Hero is Ange's research-based app designed to support your teaching of whole number place value. It aligns with the Stages of place value development you can determine through the PVAT Form A assessment.



- ✓ Suitable for Year 2-6 students
- ✓ Over 480 items
- ✓ Addresses 6 aspects of Place Value
- ✓ Items sorted by 4 PVAT Stages
- ✓ Growth Mindset messages
- ✓ No sound on the app to limit distractions
- ✓ Available through the App Store on iPad or iPhone devices

PVAT MINI COURSE

Ange has developed an online mini-course to assist teachers and schools with administering and analysing all the three of the PVAT assessment tools: Form A (pre), Form B (post) and Stage 5 (Decimals).

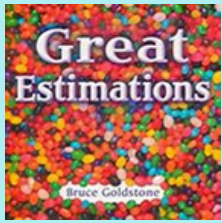
"Assessing Place Value in Years 3-6" is a 4.5 hour course that is research-based, practical and provides you with unlimited access to the 3 PVAT assessment tools, and the associated spreadsheets, score converters and templates. You can find out more here:

https://www.numeracyteachersacademy.com/PVAT_mini_course

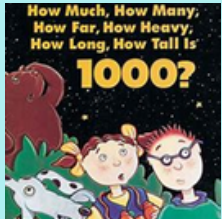


Picture Books-Place Value

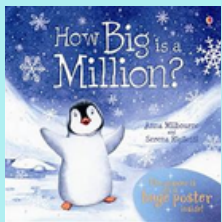
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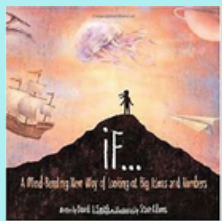
Great Estimations



How much, how far,
How heavy, how
long,
How tall is 1000?



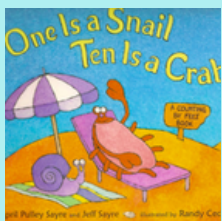
How big is
a million?



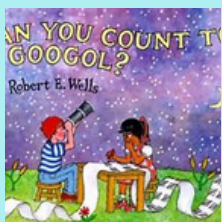
If... a mind bending
new way of looking at
big ideas and
numbers



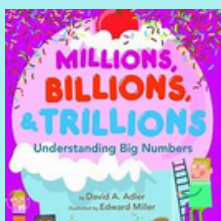
The history of
Zero



One is a Snail,
Ten is a Crab:
A Counting by Feet Book



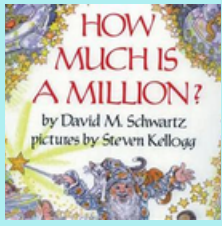
Can you count to
a Googol?



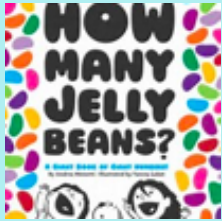
Millions, Billions &
Trillions

Picture Books-Place Value

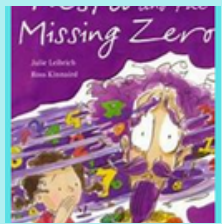
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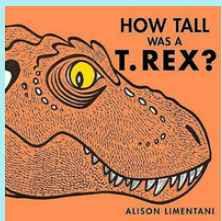
How much is a million?



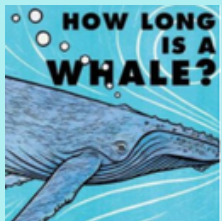
How many Jelly Beans



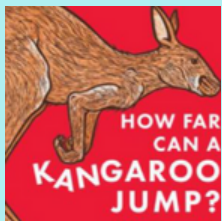
Nesta and the Missing Zero



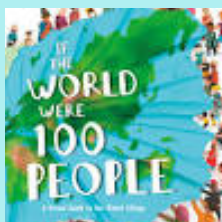
How tall was a T-Rex?



How long is a whale?



How far can a kangaroo jump?



If the world were 100 people



One lonely Fish



THANK YOU!

I hope you have found this session personally
and professionally valuable!

If you have any questions please reach out.

Ange

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