

Professional Development
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National Centre
for Excellence in the
Teaching of Mathematics



A Mastery Approach in a Primary Setting

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What is 'Mastery' in terms of maths?

Mastery is what we aim for pupils to achieve - not what teachers do....It is a goal

Competence....

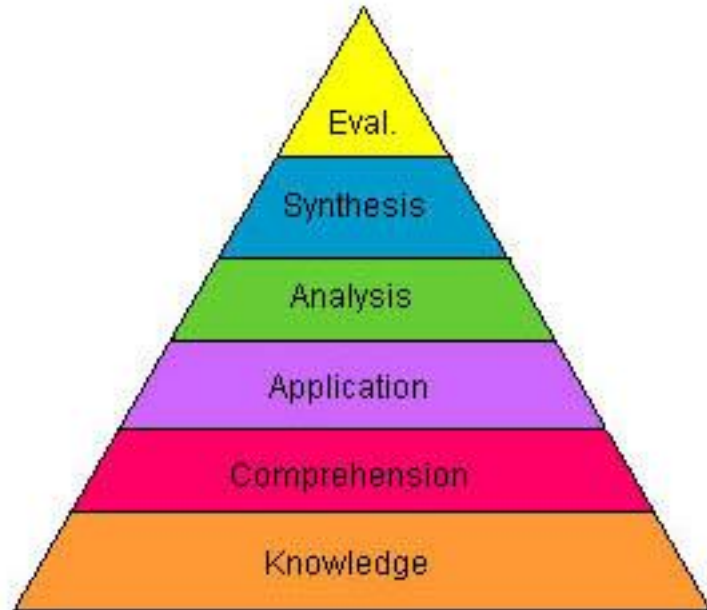
- ▶ Deep and sustainable learning
- ▶ Ability to reason about a concept (and make connections)
- ▶ Ability to build on something that has already been mastered
- ▶ Conceptual and procedural fluency

I know that....

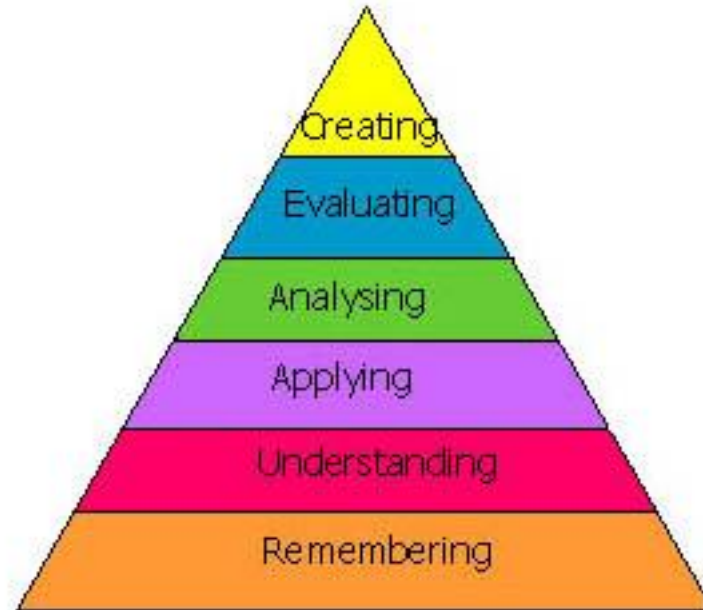
I know why...

I know how....

Mastery - is it new?



Old Version



New Version

I know
how....

Procedural
Fluency

I know
why..

Conceptual
Understanding

Mastery

Lessons from Shanghai - resolute belief that fluency comes through a balance
- conceptual understanding and procedural fluency.
TOGETHER make MASTERY

Mastery in action... *OECD figures - by age 15 students from east and south-east Asia are up to 3 years ahead of our own children*

Key Principles

- ▶ Teachers' expectations that all children are capable of achieving high standards
- ▶ **Majority** of children progress through curriculum at same pace
- ▶ Lessons are designed to **foster deep conceptual and procedural knowledge**
- ▶ **Variation** builds fluency and understanding of concepts - regularly practiced and consolidated
- ▶ **Use of questions** to ensure conceptual and procedural knowledge - coupled with **constant assessment and immediate (maybe same day) intervention.**

Keep Up - NOT Catch up

- ▶ Lack of differentiation in classes (think of teacher workload)
- ▶ Mastery focusses on depth of understanding rather than accelerated learning
- ▶ Conceptual understanding rather than rote learning
- ▶ All children move together and stay together
- ▶ Shanghai and Singapore do not see a constant change in mathematics teaching with only cyclic improvements being made from time to time

SMALL GROUP INTERVENTION ON THE SAME DAY.....

Thoughts from: NCETM's Director, Charlie Stripp

- ▶ For the children identified as 'mathematically weak':
 - ▶ Less-demanding tasks, and this helps to fix them in a negative 'I'm no good at maths' mindset that will blight their mathematical futures.
 - ▶ Their access to the knowledge and understanding they need to make progress is restricted, so they get further and further behind
 - ▶ With low challenge, children can get used to not thinking hard about ideas and persevering to achieve success.
- ▶ For the children identified as 'mathematically able':
 - ▶ Extension work, unless very skilfully managed, can encourage the idea that success in maths is like a race, with a constant need to rush ahead,
 - ▶ Being identified as 'able' can limit pupils' future progress by making them unwilling to tackle maths they find demanding because they don't want to challenge their perception of themselves as being 'clever' and therefore finding maths easy.

Mixed ability grouping...1997 DfEE suggested
'setting' pupils by ability

Effective Classroom Organisation in Primary Schools: Mathematics (Updated)

- ▶ Figures did not show that schools setting by ability had greater maths gain overall.
- ▶ No evidence to suggest beneficial effect of setting on average standards.
- ▶ Slower learning children benefit from learning in mixed ability classes and average and higher ability children do not suffer.

*Source: Whitburn, J., Institute of Economic and Social Research, UK
Oxford Review of Education, Vol. 27, No. 3, 2001, pp.411-428*

Importance of Vocabulary...

ACCURATE MATHS TALK

ADDEND + ADDEND = SUM

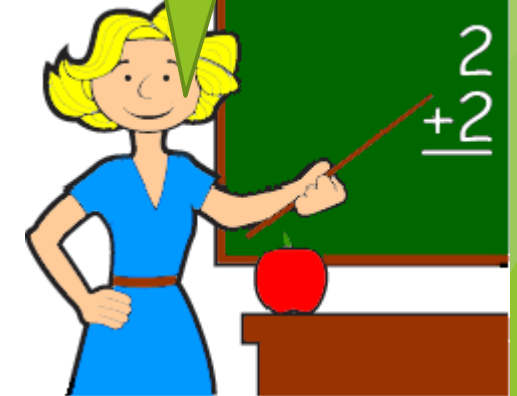
MINUEND – SUBTRAHEND = DIFFERENCE

FACTOR X FACTOR = PRODUCT

DIVIDEND ÷ DIVISOR = QUOTIENT

In China, children use the correct terminology to help them explain, reason, predict and spot patterns in mathematics.

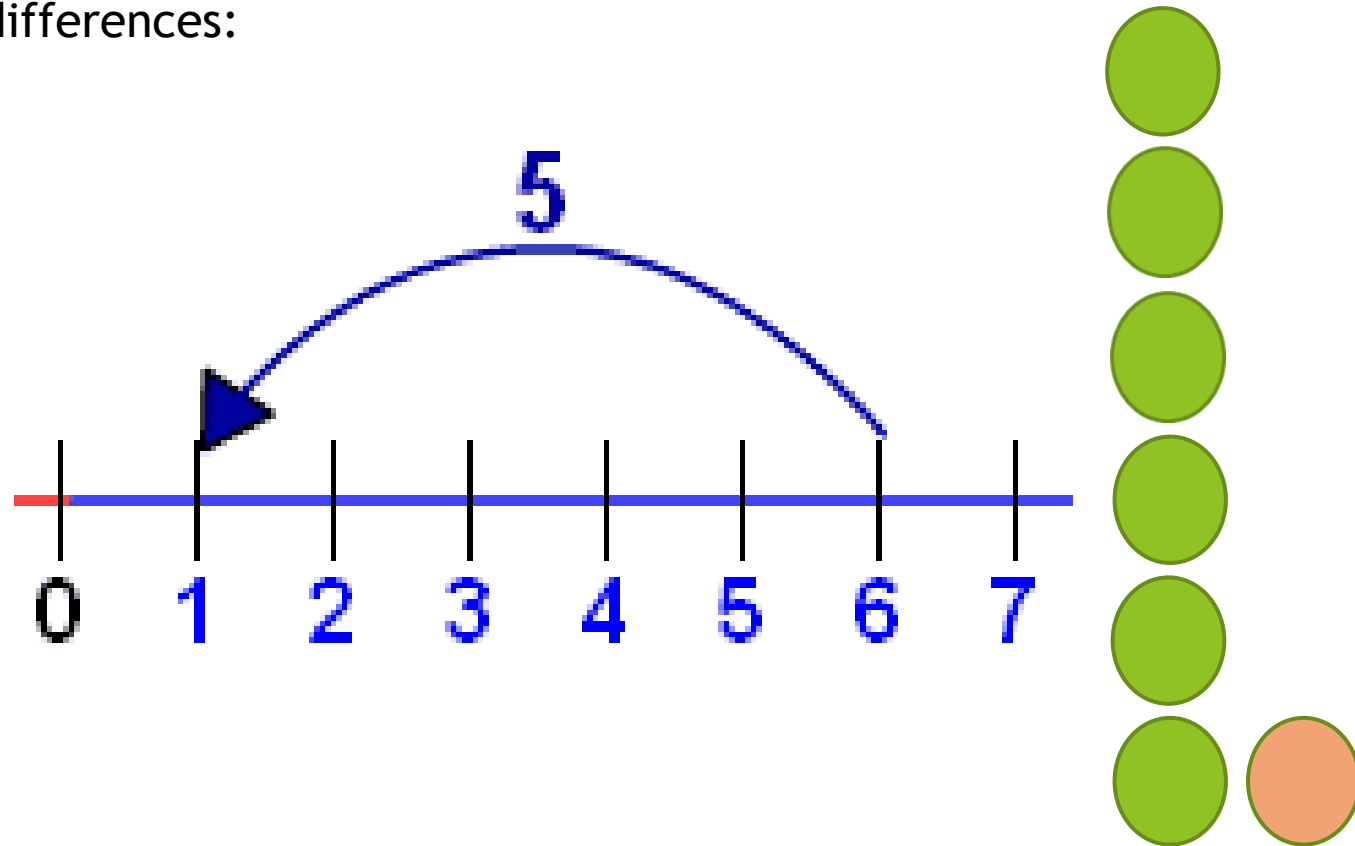
Don't forget children, I want you to answer in full sentences and using the correct vocabulary...



Constant difference...changing minuend and subtrahend...but difference same (intelligent practice)

Can you calculate the differences:

- 6-1
- 7-2
- 8-3
- 9-4



How would you calculate these (intelligent practice):

$$502-397$$

$$2.57-1.98$$


A bit of maths to practice our new vocabulary and use intelligent practice

$$\square + 17 = 15 + 24$$

$$99 - \square = 90 - 59$$

Little warm up....

- ▶ 25×32 on your whiteboards...
 - ▶ (paper for today!)
- ▶ We will come back to this..



▶ A jack of all trades, a
master of none...

The National Curriculum: expectations

The expectation is that the majority of pupils will move through the programmes of study at ***broadly the same pace***.

However, decisions about when to progress should always be based on the ***security of pupils' understanding*** and their readiness to progress to the next stage.

Pupils who grasp concepts rapidly should be ***challenged through being offered rich and sophisticated problems*** before any acceleration through new content.

Those who are not sufficiently fluent with earlier material should ***consolidate their understanding, including through additional practice***, before moving on.

This expectation has implications for lesson planning and teaching

What are 'rich and sophisticated' problems?

Rich tasks can enable students to:

- ▶ *Step into activities even when the route to a solution is initially unclear*
- ▶ *Get started and explore because the tasks are accessible to pupils of wide ranging abilities*
- ▶ *Work at a range of levels - challenge who grasp concepts rapidly*
- ▶ *Extend knowledge or apply knowledge in new contexts*
- ▶ *Work successfully when using different methods*
- ▶ *Broaden their problem-solving skills*
- ▶ *Deepen and broaden mathematical content knowledge*
- ▶ *See and make sense of underlying principles or make connections between different areas of mathematics*

What about if we add consecutive numbers?

- ▶ 1 1
- ▶ 1+2 3
- ▶ 1+2+3 6
- ▶ 1+2+3+4 10
- ▶ 1+2+3+4+5 15

Adding consecutive numbers 1 to 10:

$$1 + 10 = 11$$

$$2 + 9 = 11$$

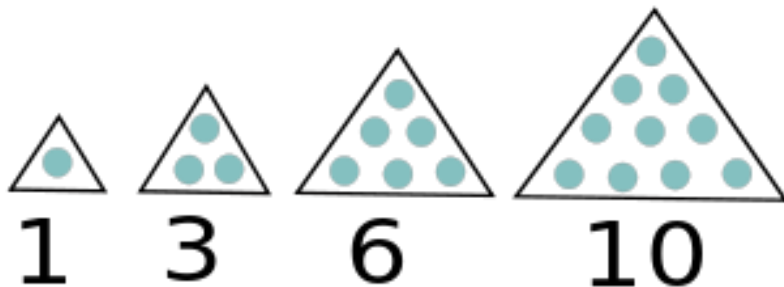
$$3 + 8 = 11$$

$$4 + 7 = 11$$

$$5 + 6 = 11$$

Answer $5 \times 11 = 55$

- ▶ What will my next total of consecutive numbers be?



Mrs Gillespie's candles....

Can you make your own number problem - maybe using consecutive odd numbers..

The candle problem

Mrs Gillespie is 73 today. She has had a birthday cake and candles every year since she was born.



How many candles has she blown out in her lifetime?

Do you remember this one.....

▶ 25 x 32

on your whiteboards...

▶ (paper for today!)



Let's play a little game..

bingo (grid - handout)

1 x 48	5 x 20	4 x 18	2 x 20	6 x 8
8 x 5	4 x 12	2 x 36	4 x 25	1 x 100
10 x 10	3 x 24	2 x 24	2 x 50	4 x 10
3 x 16	6 x 12	1 x 40	1 x 72	8 x 9

Developing fluency...which set of calculations is best?

$8 \times 5 =$	$8 \times 3 =$	$9 \times 4 =$	$9 \times 4 =$	$7 \times 9 =$	$1 \times 4 =$
$2 \times 8 =$	$5 \times 2 =$	$3 \times 9 =$	$6 \times 3 =$	$6 \times 8 =$	$8 \times 5 =$
$1 \times 1 =$	$3 \times 8 =$	$2 \times 5 =$	$9 \times 2 =$	$7 \times 7 =$	$4 \times 6 =$

$2 \times 3 =$	$6 \times 7 =$	$9 \times 8 =$
$2 \times 30 =$	$6 \times 70 =$	$9 \times 80 =$
$2 \times 300 =$	$6 \times 700 =$	$9 \times 800 =$
$20 \times 3 =$	$60 \times 7 =$	$90 \times 8 =$
$200 \times 3 =$	$600 \times 7 =$	$900 \times 8 =$

Procedural Variation *(what children should be able to do in relation to a particular concept)*

1. Varying a problem (from last slide)

EG $2 \times 3 =$ $2 \times 30 =$ $2 \times 300 =$ $20 \times 3 =$ $200 \times 3 =$

2. Multiple methods of solving a problem

EG $9 + 5 =$

A number line diagram for the addition problem 9 + 5. The number 9 is written above the line, and the number 5 is written above the line. A bracket connects 9 to 10, and another bracket connects 10 to 14. The number 10 is written below the line, and the number 14 is written below the line. A small number 1 is written below the line between 9 and 10, and a small number 4 is written below the line between 10 and 14.

$9 + 5 =$

A number line diagram for the addition problem 9 + 5. The number 9 is written above the line, and the number 5 is written above the line. A bracket connects 9 to 4, and another bracket connects 4 to 10. The number 4 is written below the line, and the number 10 is written below the line. A small number 5 is written below the line between 4 and 10.

3. Multiple applications of a method

EG

	+6
523	
623	
723	

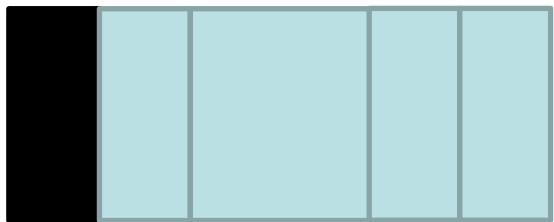
What is the same, what is different?



Conceptual Variation

Teachers predict likely misconceptions and teach explicitly to raise, address and resolve them

EG Identify which of these is $\frac{1}{5}$.



Mastery	Mastery with Greater Depth
<p>It is correct that $273 \times 32 = 8736$. Use this fact to work out:</p> <ul style="list-style-type: none"> ■ 27.3×3.2 ■ 2.73×32000 ■ $873.6 \div 0.32$ ■ $87.36 \div 27.3$ ■ $8736 \div 16$ ■ $4368 \div 1.6$ 	<p>Which calculation is the odd one out?</p> <ul style="list-style-type: none"> ■ 753×1.8 ■ $(75.3 \times 3) \times 6$ ■ $753 + 753 \div 5 \times 4$ ■ 7.53×1800 ■ $753 \times 2 - 753 \times 0.2$ ■ $750 \times 1.8 + 3 \times 1.8$ <p>Explain your reasoning.</p> <p style="font-size: 2em; text-align: center;">Let's look at this one....</p>
<p>Work out:</p> <ul style="list-style-type: none"> ■ $8.4 \times 3 + 8.4 \times 7$ ■ $6.7 \times 5 - 0.67 \times 50$ ■ $93 \times 0.2 + 0.8 \times 93$ ■ $7.2 \times 4 + 3.6 \times 8$ 	<p>In each pair of calculations, which one would you prefer to work out?</p> <ul style="list-style-type: none"> ■ (a) $35 \times 0.3 + 35 \times 0.7$ or (b) $3.5 \times 0.3 + 35 \times 7$ ■ (c) $6.4 \times 1.27 - 64 \times 0.1$ or (d) $6.4 \times 1.27 - 64 \times 0.027$ ■ (e) $52.4 \div 0.7 + 524 \div 7$ or (f) $52.4 \div 0.7 - 524 \div 7$ ■ (g) $31.2 \div 3 - 2.4 \div 6$ or (h) $31.2 \div 3 - 1.2 \div 0.3$ <p>Explain your choices.</p>
<p>All the pupils in a school were asked to choose between an adventure park and the seaside for a school trip.</p> <p>They voted, and the result was a ratio of 5:3 in favour of the adventure park.</p> <p>125 children voted in favour of going to the adventure park.</p> <p>How many children voted in favour of going to the seaside?</p>	<p>All the pupils in a school were asked to choose between an art gallery and a science museum for a school trip.</p> <p>The result was a ratio of 12:7 in favour of the science museum.</p> <p>Five pupils were off school and didn't vote.</p> <p>Every pupil went on the trip to the science museum the following week.</p> <p>After the trip there is a news headline on the school website that says 'All 700 pupils in the school went to the science museum.'</p> <p>Do you think that this news headline is correct? Explain your reasoning.</p>

NCETM ASSESSMENT BOOKLETS – Year 6

Mastery with Greater Depth

Which calculation is the odd one out?

- 1 753×1.8
- 2 $(75.3 \times 3) \times 6$
- 3 $753 + 753 \div 5 \times 4$
- 4 7.53×1800
- 5 $753 \times 2 - 753 \times 0.2$
- 6 $750 \times 1.8 + 3 \times 1.8$

Explain your reasoning.

My multiplication is based on deep conceptual and procedural fluency.....



Mastery with Greater Depth

Which calculation is the odd one out?

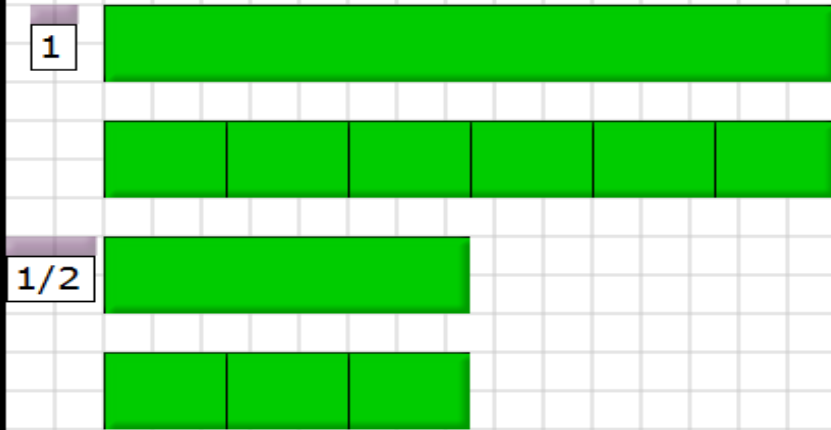
- 1 753×1.8
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- 4 7.53×1800
- 5 $753 \times 2 - 753 \times 0.2$
- 6 $750 \times 1.8 + 3 \times 1.8$

Explain your reasoning.

If you did have to calculate, which calculation would you choose?



Conceptual variation - problem $\frac{1}{2} \div 3$



Do you remember
being taught to flip
it and multiply?
Think of the
conceptual
understanding (or
not...)

Workspace controls:

- Color selection: Green, Blue
- Line style: Solid Line, Dotted Line
- Resize Blocks and Braces: 300
- Make Equal Parts: 1
- Orientation: Horizontal, Vertical
- Label: Label
- Reset: Reset
- Problems: Problems, Full Screen, Grid, Keyboard
- Undo: Undo, Erase

Use
of
Text
books



Only three people
in one boat



How many 3s?

One three
(one lot of three)



Only three people
in one boat



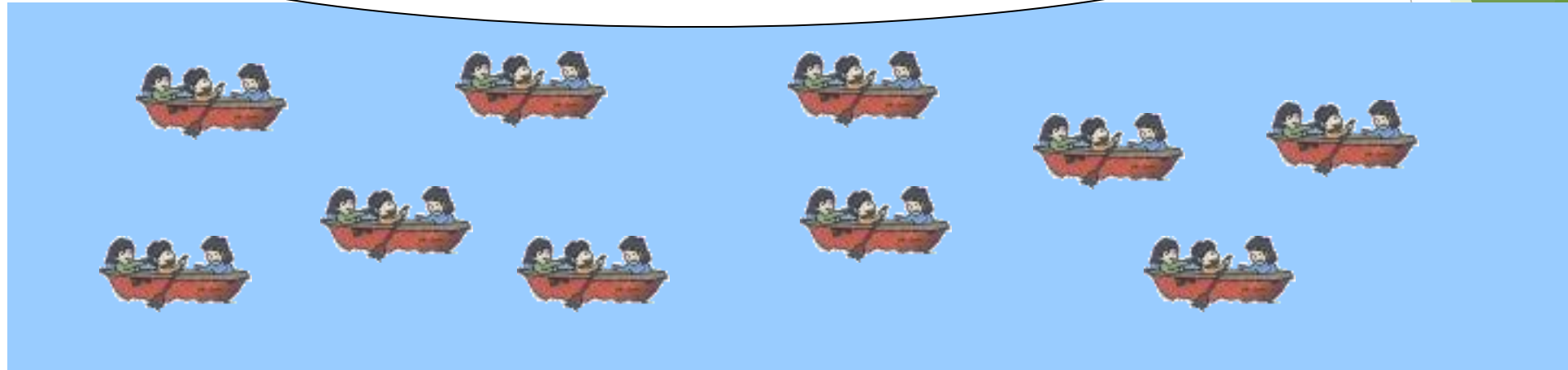
How many 3s?

Two threes
 $3 + 3$





This sentence of ten threes would be very long



How many 3s? **ten threes**

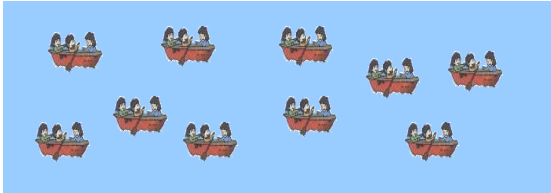
How many children altogether?

$$3+3+3+3+3+3+3+3+3+3=30$$

When we are doing successive addition it will be easier if we use multiplication



How do I write ten threes as a multiplication sentence?



The addition sentence: $3+3+3+3+3+3+3+3+3+3=30$

Multiplication sentence

$$10 \times 3 = 30$$

10 times 3 makes 30

Bring in the correct vocabulary

10

3

30

The number of boats

The number of people in each boat

The number of people altogether

Factors

Product

Osted

Bruno Reddy's summary:

Ofsted doesn't have a preferred lesson style, marking approach, differentiation approach, pupil grouping arrangement, textbook, lesson activity, assessment system or curriculum. So long as you can evidence how your school's choices on all of these impacts your students' learning, there is no need to "do it for Ofsted".

► <http://mrreddy.com/blog/2015/06/ofstedmaths-roundup/>