Mathematics Mastery

What is Mathematics Mastery?

A guide for parents and carers 2017-18

Today's Aims:

- Understand the 'mastery' approach and the changes it brings for teaching and learning in maths

- Explore the 'Mathematics Mastery' programme that we began this year to help deliver a structured, mastery approach

Maths Curriculum

- Orleans follows the Mathematics Mastery programme in Years R, 1 and from next year 2
- This will move up through the school with the children
- In years 3 to 6 the National Curriculum is followed but using a mastery approach

So what is mastery?

What is the Asian 'maths mastery' approach?

- Thousands of UK primary schools have begun to adopt a new way of teaching maths that’s popular in South Asia.

- What is the Asian "maths mastery" method all about?

What is the Asian 'maths mastery' approach?

Pupils in South Asian schools are renowned for their academic ability. In 2015, Shanghai, Hong Kong, Singapore, Japan and South Korea topped the rankings for English and maths test results, while the UK languished in 23rd place. But now, primary schools in England are adopting their method of teaching maths with the hope of improving pupils' performance.

So far, 840 schools have been chosen to try out the new teaching programme starting in September2016, and over the next four years, it'll be rolled out to a total of 8,000 schools – half of all primary schools in England.

It follows a pioneering exchange programme, where English teachers spent time in Shanghai schools learning their methods of teaching maths. 'Teachers involved in the Shanghai exchange have returned to England beaming at how engaging the approach is for children,' says a Department for Education (DfE) spokesperson.

What is 'maths mastery?'

The Asian mastery approach to maths focuses on **whole-class teaching**, developing a **deep understanding** of maths.

It's a common misconception that South Asian children are simply taught by rote; while there's an element of drilling, the method is also highly interactive. 'All pupils are encouraged by the belief that by working hard at maths, they can succeed,' says the DfE's spokesperson.

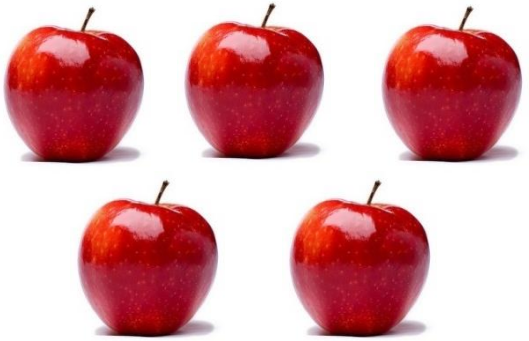
A typical maths mastery lesson is led by the teacher, with all of the pupils in the class working together on the same tasks at the same time.

Children use objects and pictures to physically represent mathematical concepts (the concrete > pictorial > abstract approach), alongside numbers and symbols – for example, using Lego bricks to add and subtract numbers. This helps them visualise abstract ideas, and as they become more proficient, they will gradually stop relying on physical props.

Multiple representations

Concrete

The DOING



Demonstrating depth

Pictorial

The SEEING

Abstract

The SYMBOLIC

5

/‘faɪv/

five

What is ‘maths mastery?’

The pace of the lessons is brisk, with teachers constantly asking questions, inviting pupils to demonstrate solutions on the board, and quizzing them about their thinking. There’s a mixture of short tasks, explanation, demonstration and discussion – and a lot of practice to help reinforce children’s learning.

Children are also expected to learn key maths facts like times tables and addition facts by heart to free up working memory and give them the mental space to focus on new concepts.

Maths mastery can be taught at any Key Stage, and schools will be able to decide to what extent they use it alongside current teaching methods. However, the DfE is hoping that schools will commit to a radical change to the way they teach maths, which could lead to a ‘renaissance’ in maths teaching.

How does maths mastery benefit children?

The maths mastery approach is intended to raise children's performance in maths. As well as South Asian countries topping the worldwide education rankings in maths, pupils in these countries are 10 per cent less likely to be 'functionally innumerate' – that is, unable to perform basic maths functions – at 15 than children in English schools. By introducing maths mastery in primary schools, the DfE is hoping to close this gap.

Teachers who took part in the Shanghai exchange are enthusiastic about the new approach. 'The teachers involved are overwhelmingly positive, and the momentum for this programme has come as much from teachers as from government,' the DfE says.

Initial research shows that the approach could lead to a radical shift in how maths is taught in primary schools, with a significant impact on pupils' achievement.

Will less able children be left behind?

If your child struggles with maths, you might well be concerned that they won't keep up with whole-class teaching. However, the DfE says that the method is suitable for children of most abilities.

'Every step of a lesson is deliberate, purposeful and precise,' the spokesperson says. **'If children are struggling with a concept, more time is spent supporting and building their understanding.'**

Those who are stronger are also catered for and are able to deepen their understanding of the principles by being given challenging questions, as well as demonstrating to the rest of the class.'

Which schools will be involved?

Initially, 700 teachers will be trained to support schools in introducing maths mastery. Schools will be able to get involved through their local maths hub: 35 school-led centres of excellence in maths teaching. The first 840 schools to take up the approach have already been chosen, but it'll be rolled out to other schools across the next four years.

What differences will you notice?

The main difference should be that you see your child's maths skills improving more dramatically.

'Parents will see their children becoming more competent mathematicians and using correct mathematical language,' says the DfE's spokesperson.

What is "Mathematics Mastery?"

Curricular principles

- **Fewer topics in greater depth**

  Opportunities are provided throughout Mathematics Mastery for pupils to use reasoning skills to make connections between prior knowledge and newly presented material. These connections will help foster a deeper understanding of the maths concepts.

- **Mastery for all pupils**

  Differentiation through depth, cumulative learning, AfL

- **Number sense and place value come first**

  Traditional algorithms meaningfully taught

- **Problem solving is central**

  Comprehension, calculation and problem solving developed simultaneously.

What is "Mathematics Mastery?"

Core belief

Mathematics Mastery schools want to ensure that their aspirations for every child's mathematics success become reality

- Success in mathematics for every child **is possible**
- Mathematical ability is not innate, and is **increased through effort**

Mindset: fixed vs growth

Mathematics Mastery

Mindset: fixed vs growth

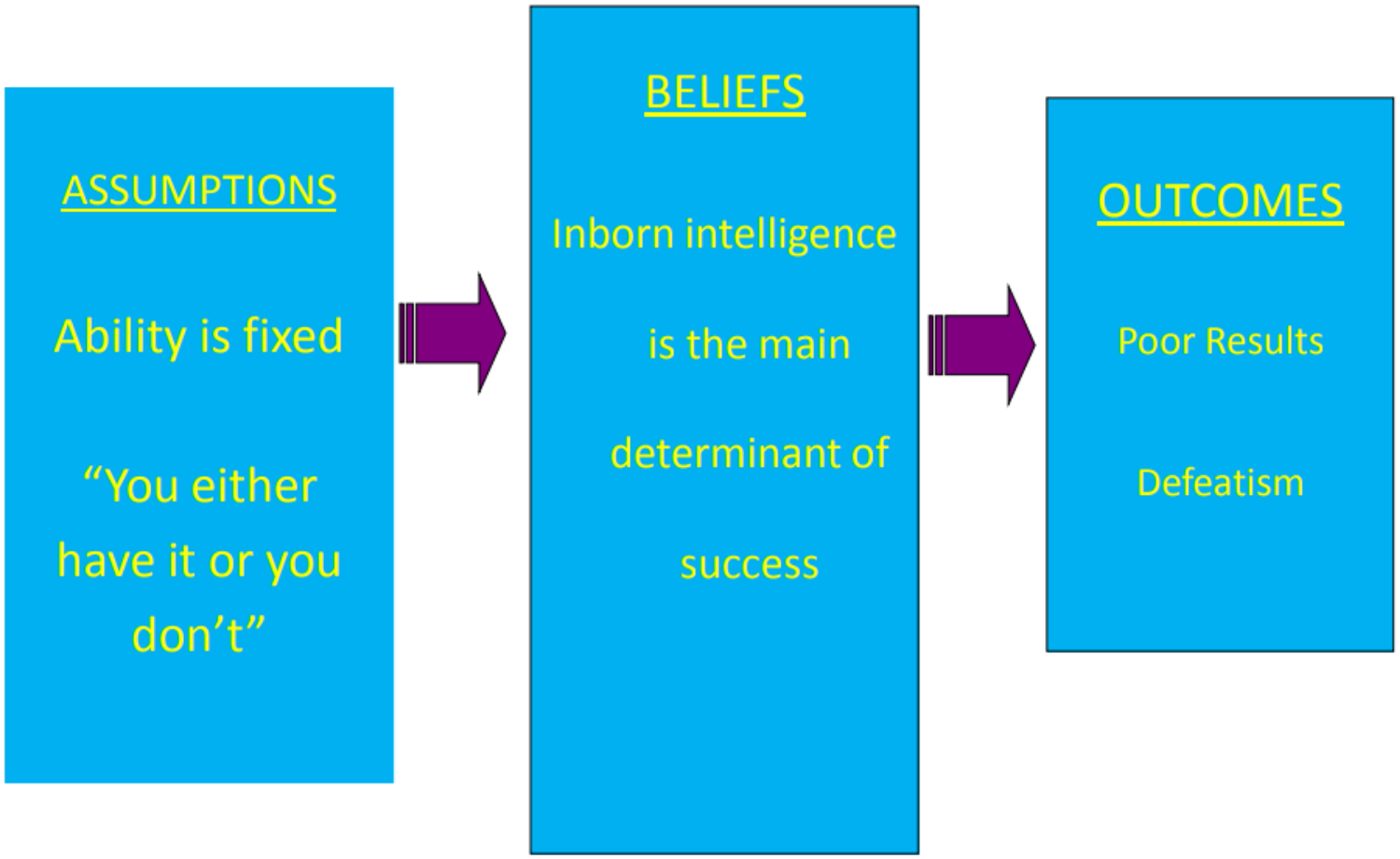
Two Beliefs about Intellectual Ability

- Innate Ability
- Effort-Based Ability

“I can’t do maths.”

Mathematics Mastery

Belief in innate ability



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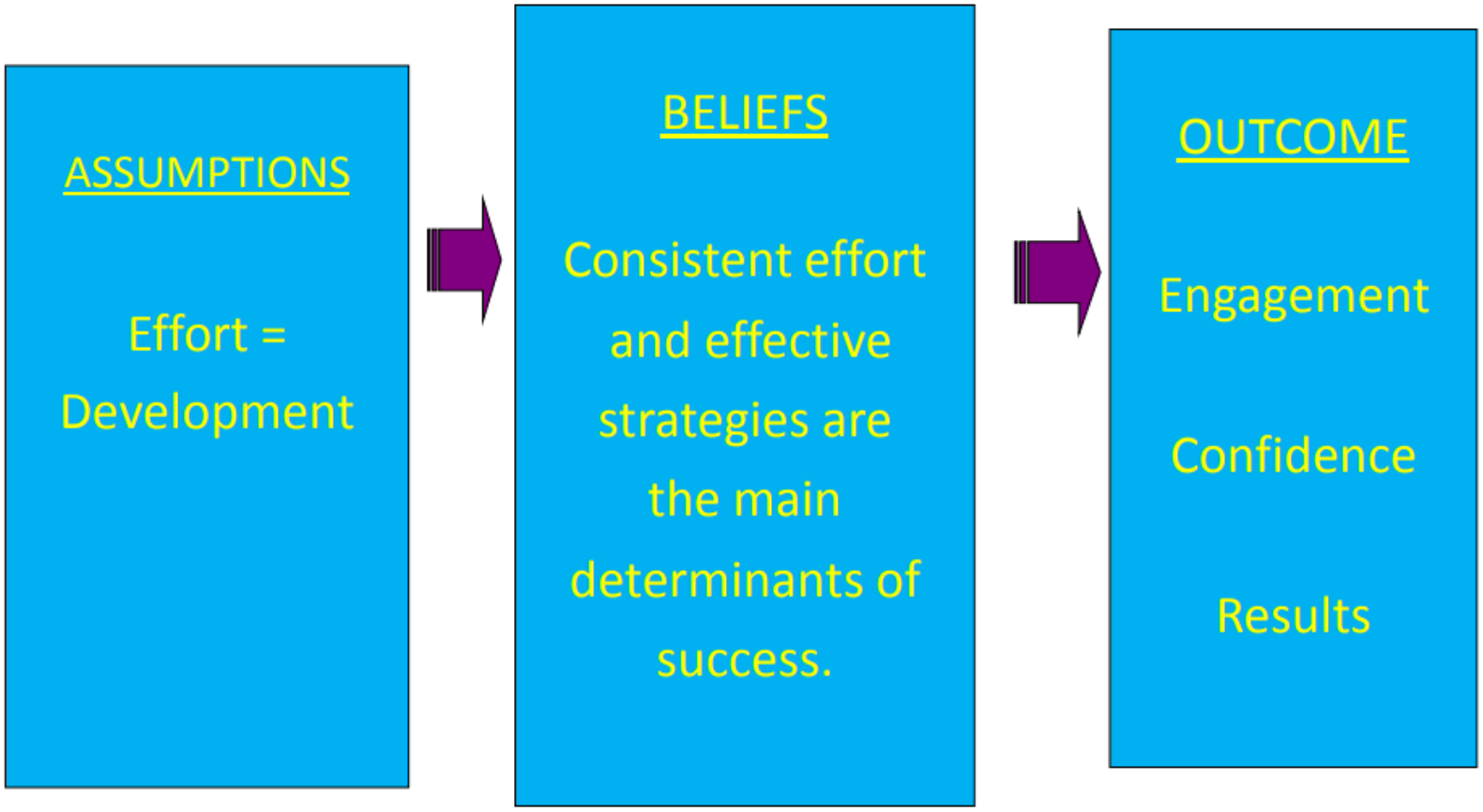
Belief in innate ability



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Effort-based ability – growth mindset

Intelligence can grow

Effort leads to success

When the going gets tough … I get smarter

I only need to believe in myself

Success is the making of targets

When the going gets tough … dig in and persist

Innate ability

Intelligence is fixed

Ability leads to success

When the going gets tough … I get found out

I need to be viewed as able

Success is doing better than others

When the going gets tough … give up, it's hopeless

Mathematics Mastery

What does the National Curriculum say?

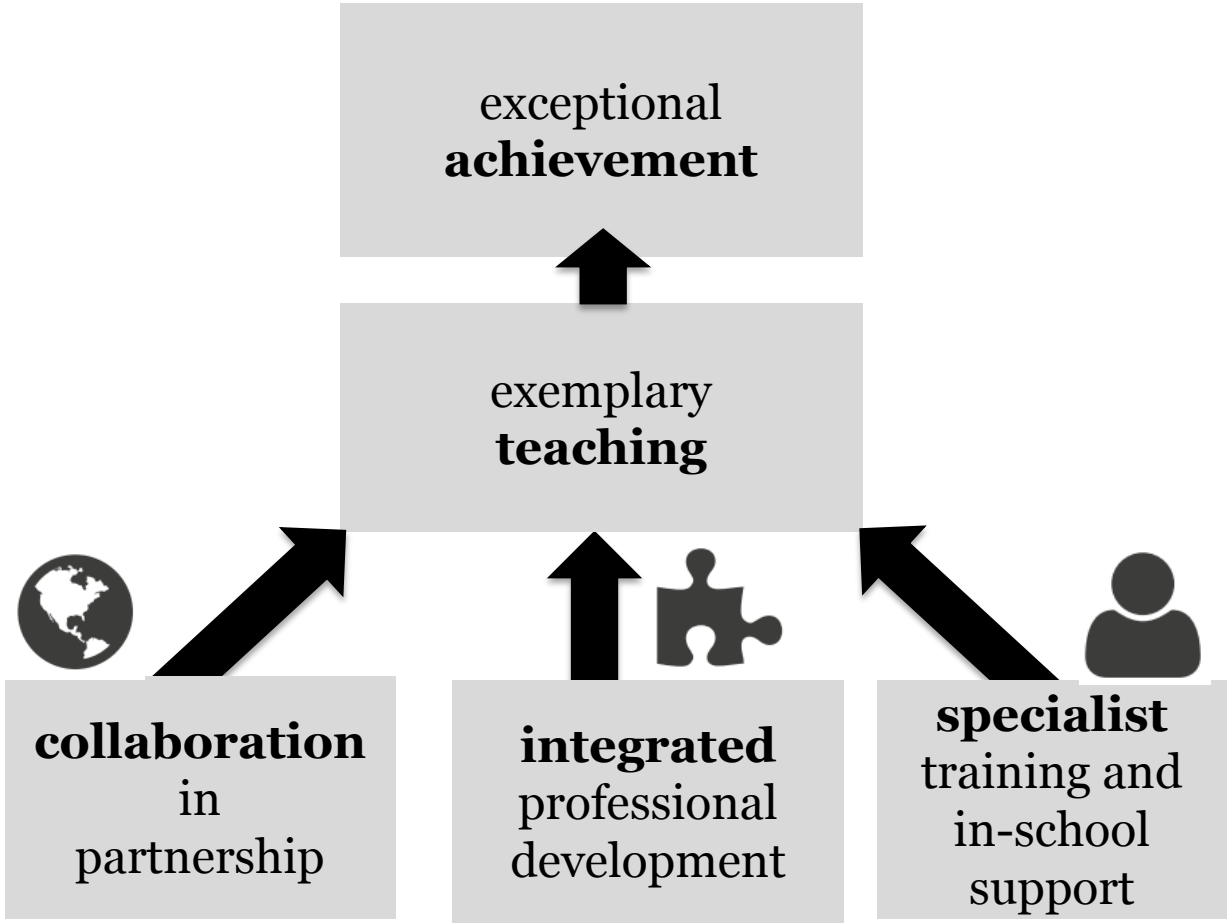
- "Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content."
- "Those who are not sufficiently fluent should consolidate their understanding, including through additional practice, before moving on."

What is mastery?

"In mathematics, you know you've mastered something when you can apply it to a totally new problem in an unfamiliar situation."

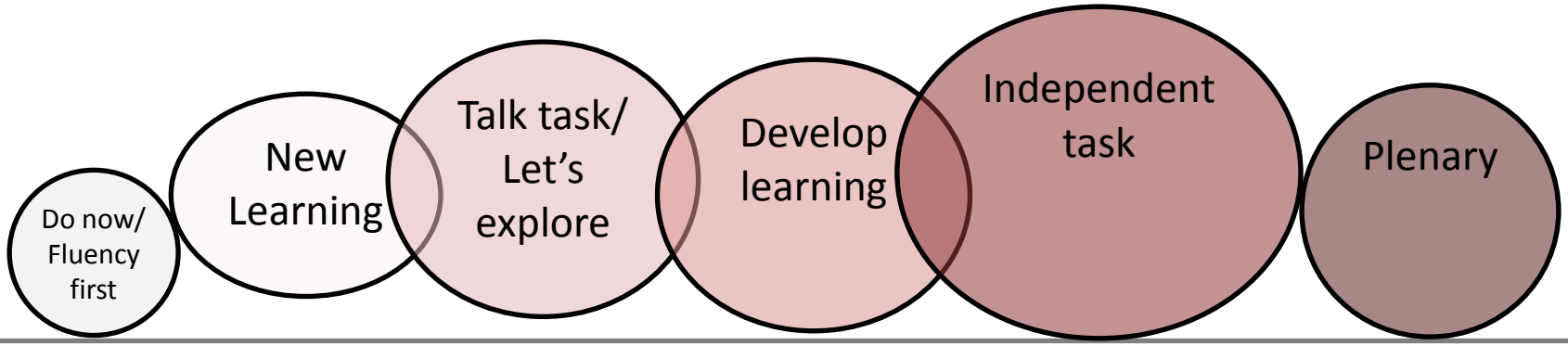
Dr. Helen Drury, Director of Mathematics Mastery

Our partnership approach to transforming achievement



What does Mathematics Mastery lesson look like?

- Mathematics Mastery lessons follow a 6-part structure. This keeps the lesson pacy, gives flow and allows more opportunities to teach creatively, give feedback and assess learning.
- Pupils have access to plenty of concrete materials such as bead strings and place value counters so that they have time to fully explore mathematics.



Lesson Structure – Six parts

The Mathematics Mastery six-part lesson includes:

Do Now	This is a quick task to introduce the maths lesson. All pupils should be able to access the activity without any teacher input and we recommend this segment lasts no longer than five minutes.
New Learning	This segment introduces the main mathematical concepts for the day's lesson.
Talk Task	This segment focuses on practising the new learning by talking about the maths using key vocabulary.
Develop Learning	This segment builds on the New Learning content and helps pupils deepen their understanding of the concepts.
Independent Task	This segment enables pupils to practise their learning independently.
Plenary	The closing segment enables you to recap on the lesson, checking understanding and celebrating success.

Unit 1: Numbers and number bonds to 10

Lesson 1: Counting from zero to ten

Key learning: To count sets of objects within ten

Lesson overview

Count sets of objects.

Represent the number of objects on a ten frame.

Use the term 'same'.

Find sets that have the same number of objects.

Key vocabulary

there is, there are, count, count up to, how many?

number, zero, one, two, three, four, five, six, seven, eight, nine, ten

equal, is equal to, the same number as, as many

Sentence structures

There are __ bears.

There is _ glass.

The number of ___ is equal to the number of ___ .

Resources

objects to count

cubes

Resource 1 (ten frame)

Task sheet 1a (1)

Task sheet 1a (2)

Task sheet 1b

By the end of this lesson ALL pupils must be able to:

count a set of objects (within 10) accurately.

Do now

Practising transitions

For the first term, use the 'do now' part of the lesson to practise transitions.

Transition: Plan as appropriate.

New learning

Counting objects up to 10

Put a selection of bears on the carpet and ask, "How many bears are there?"

Count the numbers of bears together and model pointing to each object while counting.

Model the sentence structure by saying, "There are _ bears."

Repeat this with several examples within 10 to model the use of language using concrete objects on the carpet. Make sure that all pupils participate in counting and saying the full sentence.

Invite pupils to point to each object as they count and say in a full sentence how many there are.

Show a ten frame and model counting out the same number of cubes as bears. "There are 7 bears. One, two, three, four, five six, seven." Place cubes one by one on the ten frame as you count.

Repeat the ten frame activity for other sets of objects.

Model the talk task.

Possible misconceptions

Pupils may miss objects if not using one-to-one correspondence when counting.

Transition: Plan as appropriate.

Unit 1: Numbers and number bonds to 10

Lesson 1: Counting from zero to ten

Key learning: To count sets of objects within ten

Talk task

Representing the number of objects on a ten frame

Show Task Sheet 1a and a ten frame.

Model pointing to an object and counting aloud. Model placing the same number of cubes on a ten frame. Invite two pupils to model the activity.

Pupil A will point to each object and count aloud.
Pupil B will place the same amount of cubes on a ten frame.
They will then swap roles for the next example.
The pupils will take it in turns to work with the ten frame, and to count and say the sentence.

How many rabbits are there?

One, two, three. There are three rabbits.

How many flowers are there?

One, two, three, four. There are four flowers.

Transition: Plan as appropriate.

Develop learning

Counting sets of objects and using the term 'same'

Present pupils with two sets of four objects on the carpet.

Ask pupils, "How many objects are in each set?"

Including pupil participation, point to each object, count together and label.

Invite a pupil to count out the same number of cubes for each set of objects using a different colour for each set. Build each set of cubes into a tower. Put the two towers next to each other to introduce the term 'same'. Model the sentence and ask pupils to repeat.

"The number of ___ is the same as the number of ___."

Repeat with more examples from the images on the IWB. Ensure that all pupils are counting. Have pupils build the towers of cubes and place the towers together to show the number of objects is the same. Pupils must repeat the full sentence, "The number of ___ is the same as the number of ___."

Model the independent task.

How many apples are there? How many sandwiches are there?

Can you find two sets with the same number of objects?

How do you know that the number of butterflies is the same as the number of bees?

There is one apple. There is one sandwich.

The number of butterflies is the same as the number of bees.

I made a tower of three cubes for the butterflies and a tower of three cubes for the bees. When I put the towers together, I could see that there was the same number of cubes.

Transition: Plan as appropriate.

Unit 1: Numbers and number bonds to 10

Lesson 1: Counting from zero to ten

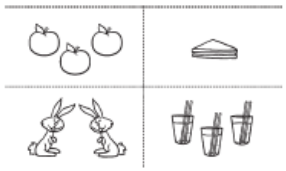
Key learning: To count sets of objects within ten

Independent task

Finding sets that have the same number of objects

Pupils will count the objects in each set, placing cubes on top of each image. Pupils will then build the cubes into a tower for each set. Pupils can predict which sets will have an equal number. They will check by placing the towers side by side. If they are correct, they will stick sets with an equal number of objects next to each other in pairs.

This activity will be completed in pairs and pupils will practise saying sentences about the pairs, for example, "The number of bees is the same as the number of butterflies."



Transition: Plan as appropriate.

Plenary

Celebrating success and addressing misconceptions

The plenary should celebrate pupils' success, address any misconceptions or prepare pupils for another lesson.

Teachers should plan the plenary based on the lesson to address any misconceptions.

Reinforce that success comes from working hard and trying your best.

Possible adaptations

Count objects in the classroom or on the table and find sets of objects that have the same number (e.g. pencils, pens).

Take away some of the paired cards and replace them with blank cards. Can the pupils create their own cards with the right amount of objects?

Suggested consolidation task

Roll a 1 to 9 spotted die and count out the same number of objects.

Play a game of snap or pairs with the cards.

Transitions related to this lesson

Count from any number within ten forwards and backwards.

Counting rhymes.

Clap a number.

Mathematics Mastery

Mastery questions you may have…

- How will my child be challenged?
- How will my child be supported if they are struggling?
- What does ‘deepening’ look like in the classroom? What sorts of tasks/activities will my child be doing?
- How is their thinking being challenged?

Differentiation – a different picture

The New Curriculum sets higher expectations for pupil achievement and *the expectation is that the majority of pupils will move through the programmes of study at broadly the same pace.*

To achieve fluency, reasoning and problem solving.

Mastery is about keeping children together and not moving on at an over rapid pace

The premise of mastery teaching is that children are kept together on one focused learning objective.

"So teaching mu… …se you don't differenti…

"So dif… …tion doesn't exist anymore?"

It does exist – but it is very different

Challenge through depth

Year 3 – Place value of 3 digit numbers – how it may have looked previously

Red	Orange	Green
1) 34	1) 234	1) 2534
2) 85	2) 854	2) 8544
3) 92	3) 492	3) 4922
4) 63	4) 643	4) 6455
5) 43	5) 342	5) 3455
Ext:	Ext:	Ext:
345	7548	75485

674 is made of 6 hundreds, 7 tens and 4 ones.

674 is also made of 67 tens and 4 ones.

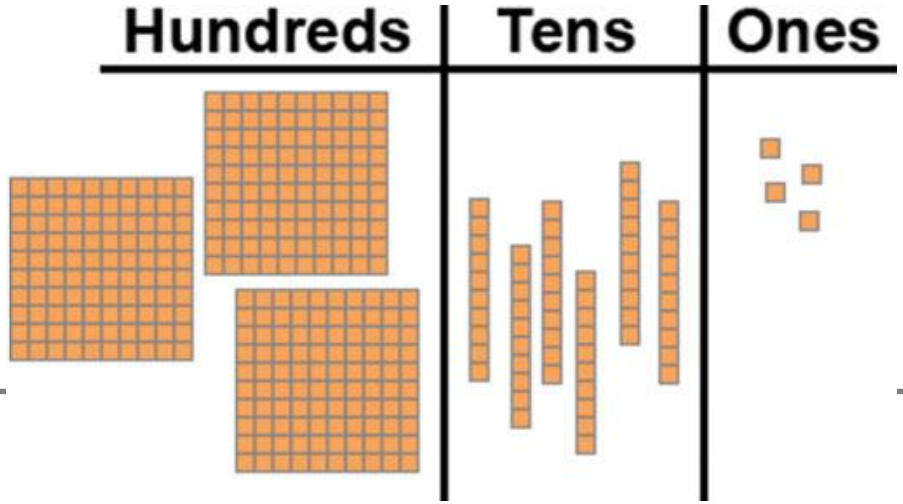
674 is also made of 6 hundreds and 74 ones.

Find different ways of expressing:

- 630
- 704
- 867

And now…

1) 23<u>4</u>
2) 8<u>5</u>4
3) 4<u>9</u>2
4) 6<u>4</u>3
5) <u>3</u>42



How it may have looked previously

Multiply by 10,100 and 1000

Red

4 x 10

5 x 100

Orange

32 x 100

45 x 10

Green

4.3 x 10

100 x 5.65

Multiply by 10,100 and 1000

Multiply by 10,100 and 1000 – this year

"The digits stay the same but the place value changes."

Task 1: Answer

1) 4.5 x 100

2) 10 x 87

Task 2: fill in the blanks

1) □.8□ x 1000 = 3850

2) 100 x 2.□ = □50

Task 3 (what's gone wrong? Please explain)

1) 1.47 x 1000 = 147

2) 3.4 x 10 = 340

Mastery challenge

0.25 x 1000 = ____ x 25

Can you explain how you solved this?

Can you write your own similar problem?

Mathematics Mastery

Challenge through depth

1. Work out

   $(999 - 99 + 9) \div 9$

   Can you do it another way?

   http://www.ukmt.org.uk

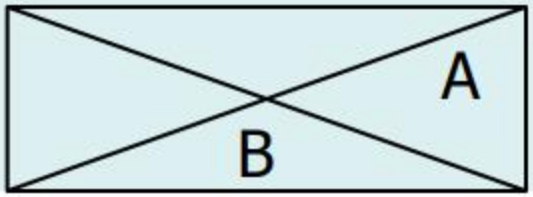
   (junior challenge 2014)

2. P, Q, R, S and T represent single digits in this subtraction.

$$\begin{array}{r} 7\ Q\ 2\ S\ T \\ -\ P\ 3\ R\ 9\ 6 \\ \hline 2\ 2\ 2\ 2\ 2 \end{array}$$

   What is the value of P + Q + R + S + T ?

3. What is the ratio of the areas of triangles A and B?



Practice makes perfect?

Compare these two multiplication exercises.
Which supports the development of fluency better? Why?

8 x 5 =	8 x 3 =	9 x 4 =	9 x 4 =	7 x 9 =	1 x 4 =
2 x 8 =	5 x 2 =	3 x 9 =	6 x 3 =	6 x 8 =	8 x 5 =
1 x 1 =	3 x 8 =	2 x 5 =	9 x 2 =	7 x 7 =	4 x 6 =

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

The NC: a mastery curriculum

- An expectation that all pupils can and will achieve.
- The large majority of pupils progress through the curriculum content at the same pace. Differentiation emphasises deep knowledge and individual support/intervention.
- Teaching is underpinned by methodical curriculum design, with units of work that focus in depth on key topics. Lessons and resources are crafted carefully to foster deep conceptual and procedural knowledge.
- Practice and consolidation play a central role. Well-designed variation builds fluency and understanding of underlying mathematical concepts in tandem.
- Teachers use precise questioning to check conceptual and procedural knowledge. They assess in lessons to identify who requires intervention so that all pupils keep up.

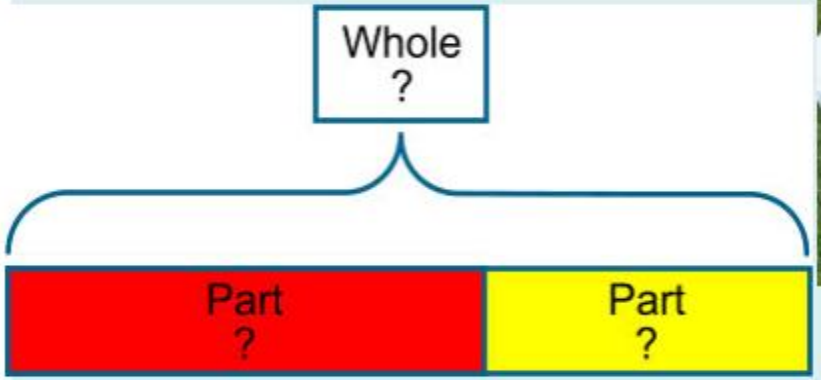
Developing fluency…

…securing depth of understanding.

Models, images and practical apparatus

All of these play an important part in supporting pupils' conceptual understanding and reasoning skills.

Can you name these?

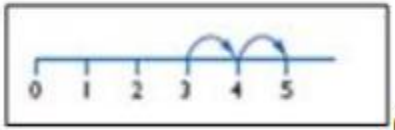


Flexibility with different representations is an important element of fluency.

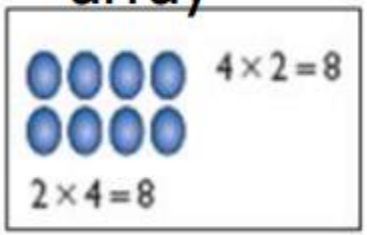
Resources to help build concepts

Numicon

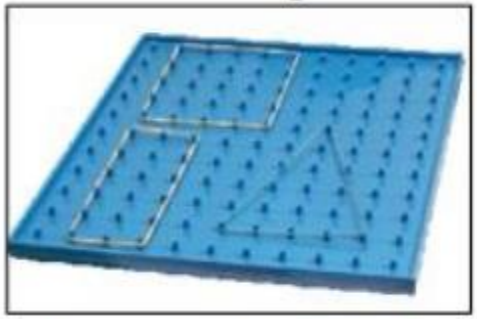
number line



array

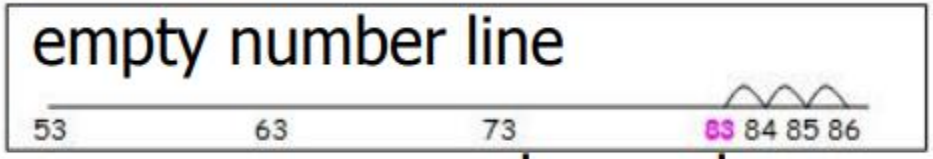


geoboard

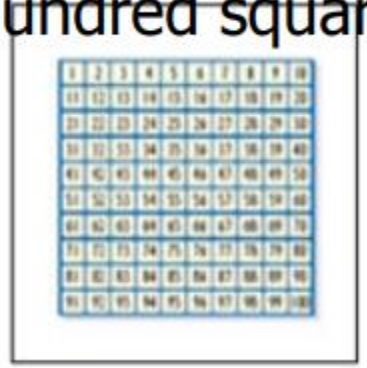


counting stick or metre rule

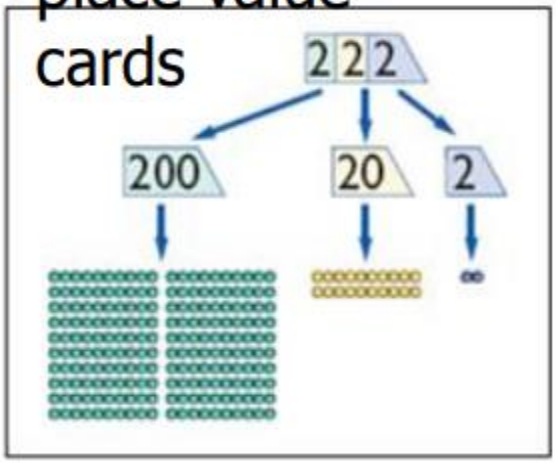
empty number line

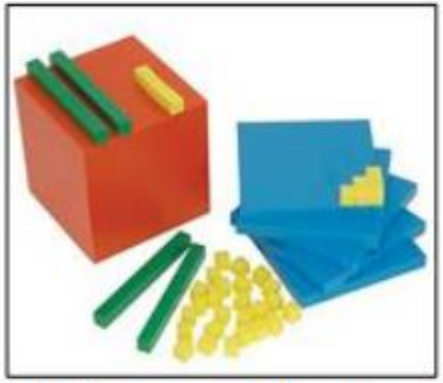


hundred square



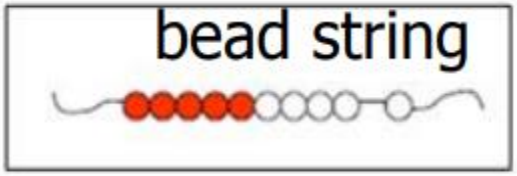
place value cards





Dienes blocks
base-ten blocks

bead string



Developing fluency…

…securing understanding and proficiency.

Video of part of a lesson

Column subtraction

www.ncetm.org.uk/resources/40532

When watching the video, think about:

- the progression in the mathematics the pupils are learning
- how the teacher and pupils use practical equipment and/or images
- features of the teaching that support and deepen pupils' conceptual development through the design of the activity, the teacher's explanations and/or questioning

Developing good problem solving…

…including challenging the more able.

Problems and puzzles

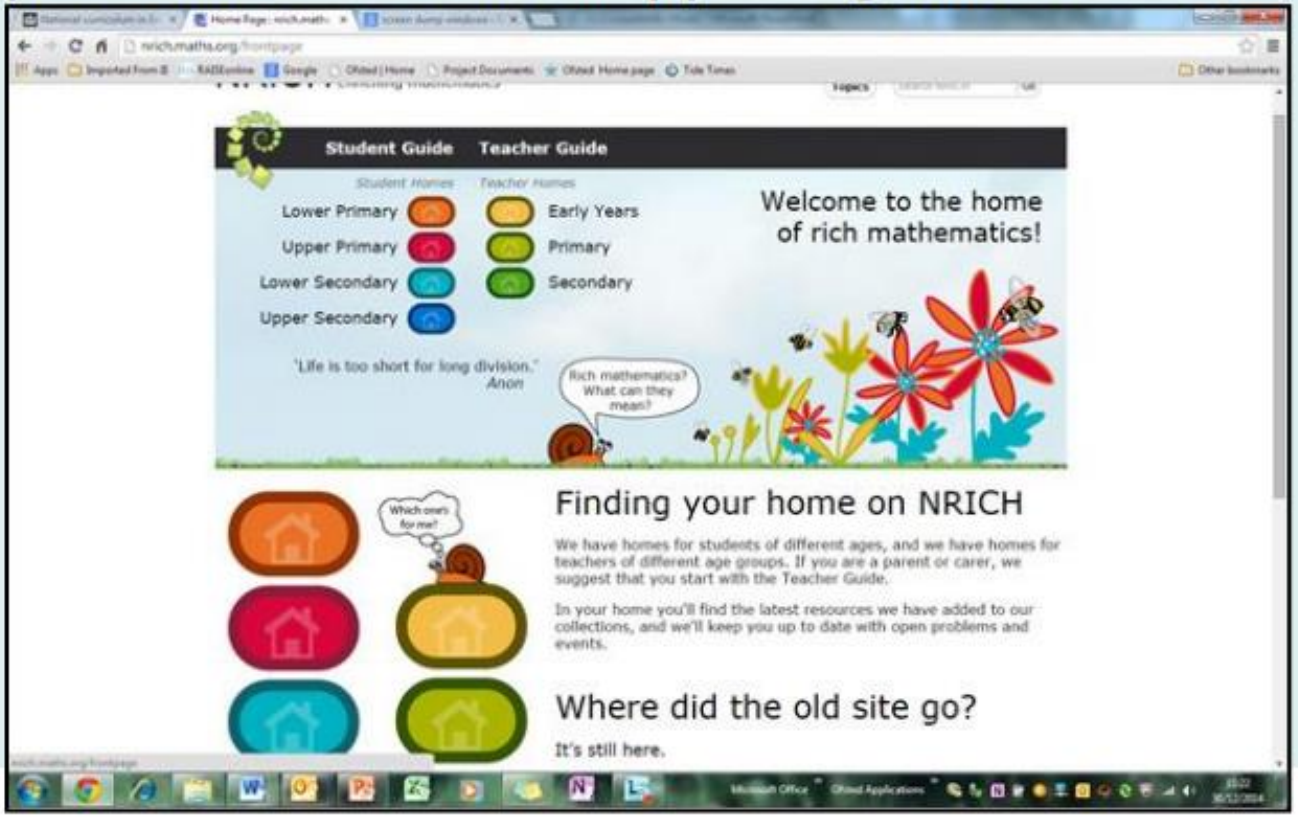
- Providing a range of puzzles and other problems helps pupils to reason strategically to:
  - find possible ways into solving a problem
  - sequence an unfolding solution to a problem
  - use recording to help their thinking about the next step.
- It is particularly important that teachers and teaching assistants stress such reasoning, rather than just checking whether the final answer is correct.
- All pupils need to learn how to solve problems from the earliest age – the EYFS early learning goals also include problem solving.

Common weaknesses in teaching problem solving

- Pupils are expected to acquire problem-solving skills without them being made explicit. Lesson objectives and planning tend to focus on content rather than specific problem-solving skills.
- Teachers/TAs are too quick to prompt pupils, focusing on getting 'the answer' – pupils need to build their confidence and skills in solving problems, so that they can apply them naturally in other situations.
- When problems are set, teachers do not use them well enough to discuss with pupils alternative approaches and why one is more elegant than another.
- Problems for high attainers involve harder numbers rather than more demanding reasoning and problem-solving skills.

Problem solving: nrich.maths.org

- The nrich website is a good source for problems.
- It includes printable resources, notes for teachers and solutions written by pupils.
- Each problem has been mapped against the new NC.



The problem, 'Forwards add backwards' is shown on the next slide.

Spend a couple of minutes on it.

- Which pupils in a class might it be suitable for? Why?

Answers and explanation at nrich.maths.org/11111

'Forwards add backwards'

The number 726 can be formed by adding a 3-digit number with its reversal: 462+264=726, for example.

- Can you find the other two ways of making 726 in this way?
- Can you find the three ways to do this for 707 and 766?

Which ten numbers between 700 and 800 can be formed from a number plus its reversal?

- What common property do they have?
  Can you explain why?

How many numbers between 300 and 400 can be formed from a number plus its reversal?

How about between 800 and 900?

Improving problems …

… what is the area of this rectangle?

Adapt this question to encourage pupils to think harder about how to solve it, and to develop better their problem-solving skills and conceptual understanding of area of a rectangle.

Building variety in problem solving

Straightforward problems can be adapted to create more opportunities for reasoning and for learning about different problem-solving strategies, by:

- removing intermediate steps
- reversing the problem
- making the problem more open
- asking for all possible solutions
- asking why, so that pupils explain
- asking directly about a mathematical relationship.

Developing reasoning …

… research by Terezinha Nunes (2009) identified the ability to reason mathematically as the most important factor in a pupil's success in mathematics.

Development of Maths Capabilities and Confidence in Primary School
http://dera.ioe.ac.uk/11154/1/DCSF-RR118.pdf

Partitioning

Notes and Guidance

This small step builds on basic partitioning. Children will explore how numbers can be broken apart in more than one way.

This step is particularly important later on, when children begin to exchange. Understanding that 5000 + 300 + 20 + 9 is equal to 4000 + 1300 + 10 + 19 is crucial, and this small step enables children to explore this explicitly.

Mathematical Talk

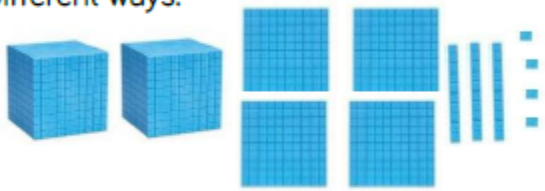
What number is being shown?

If we have 10 hundreds can we exchange them for something?

If you know ten 100s are equal to 1000 and ten 10s are equal to 100, how can you use this to make different exchanges?

Varied Fluency

1 Move the Base 10 around and make exchanges to represent th number in different ways.

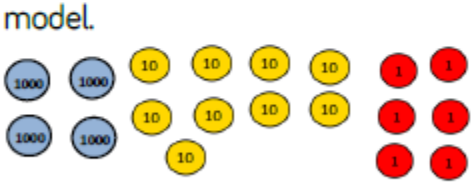


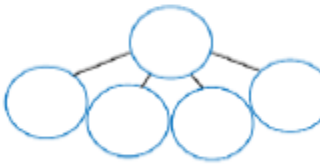
2000 + 400 + ☐ + 4

1000 + ☐ + ☐ + 14

1000 + 1300 + ☐ + ☐

2 Represent the number in two different ways in a part whole model.





3 Lily describes a number. She says,

"My number has 4 thousands and 301 ones"

What is Lily's number?

Can you describe it in a different way?

Partitioning

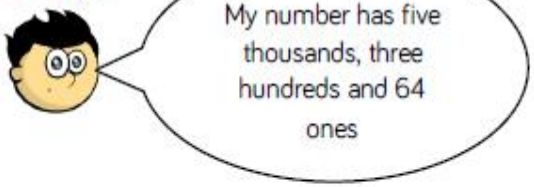
Reasoning and Problem Solving

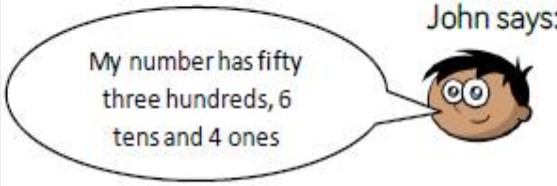
Which is the odd one out?

3,500	3,500 ones
2 thousands and 15 hundreds	35 tens

35 tens is the odd one out because it does not make 3500, it make 350

Jeff says:





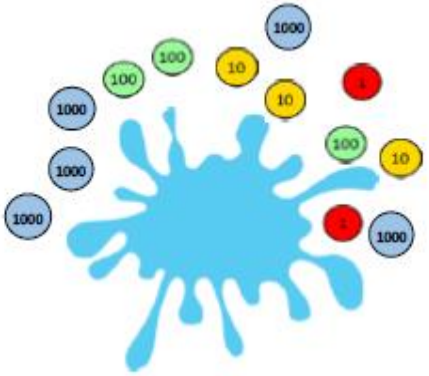
Who has the largest number?
Explain.

They both have the same number because 53 hundreds is equal to 5 thousand and 3 hundred. Jeff and John both have 5364

Some place value counters are hidden.
The total is six thousand, four hundred and thirty two.

Which place value counters could be hidden?

Think of at least three solutions.



Could be one 1,000 counter and one 100 counter.
Could be ten 100 counters and ten 10 counters.
Could be eleven 100 counters.

dd more than 4-digits

otes and Guidance

ildren will build upon previous learning of column addition. ey will now look at numbers with more than four digits and e their place value knowledge to line the numbers up curately.
ildren will learn that when there are more than ten ousands in the thousands column these can be exchanged for n thousands.

lathematical Talk

ll you have to exchange? How do you know which columns ll be affected?

es it matter that the two numbers don't have the same nount of digits?

hich number goes on top in the calculation? Does it affect the swer?

Varied Fluency

1

Solve:
4,434
+3,325

Th	H	T	O
●●	●●	●	●●
●	●	●	●●●

Th	H	T	O
●	●	●	●●●

____ + ____ = ____ ____ + ____ = ____

Can you give the other 3 fact family questions that relat this question? (Inverse operation link)

2

Answer:

32 461	48 276
+ 4 352	+ 5 613

Can you think of a sensible story to represent this question?

3

Using the column method, answer:

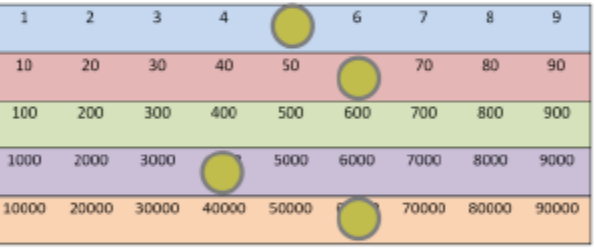
54,311 + 425 + 3,501
35,622 + 24,316 + 7,43
3,942 + 14,356 + 88

dd more than 4-digits

easoning and Problem Solving

am is discovering numbers on a attegno board.

e makes this number:



am moves one counter three spaces on horizontal line to create a new number.

hen he adds this to his original number e gets 131,130

hich counter did he move?

He moved the counter from 4,000 to 7,000

64,065 + 67,065 = 131,130

Work out the missing numbers.

$$\square 4 \square 3 \square$$
$$+ \; 2 \square 5 \square 2$$
$$\overline{\qquad\qquad}$$
$$78529$$
$$\overline{\qquad\qquad}$$

54,937 + 23,59
78,529