Hyde Park Junior School Policy for the Teaching of Mathematics

Rationale.

The main purpose of our Mathematics teaching is to help children build mental math and computation strategies.

Our lessons are structured to promote of HPJS Mathematics Learning Behaviours.

The overarching behaviours are

Be flexible and Persevere.

We teach children to-

Stop to ensure children do not go to default to rote learnt formal written methods.

Notice patterns, connections, relationships, friendly numbers (i.e. multiples of 10, 100 etc.)

Jot (Estimate, Calculate, Check) Clever cloud etc.

Explain In full sentences using correct vocabulary

We **do not** teach procedures and strategies for pupils to memorise and reproduce.

We provide a platform for pupils to invent, construct, and make sense of important foundations in numbers.

Our pupils must have the ability to reason about quantitative information, possess number sense, and check for the reasonableness of the solution and answers.

We are focussed on teaching our pupils to be proficient Mathematicians, who can compute accurately, efficiently and flexibly.

We provide opportunities for them to grapple with number relationships, apply these relationships to computation strategies, and discuss and analyse their reasoning.

At Hyde Park Junior School, we teach The national curriculum for mathematics

The national curriculum for mathematics aims to ensure that all pupils:

- become **fluent** in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.
- **reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- can **solve problems** by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.

We are working to develop what might be described as 'Talk for Learning', helping children articulate and share their thinking in order to develop understanding and identify misconceptions. Through our work on 'Growth Mindset' we are helping our pupils see the value of 'having a go' and making mistakes to progress. We do not expect to see books full of ticks, as if this is all there is it means the children's learning needs have not been met; we want our pupils to seek challenge and embrace it.

The teacher organises the lesson flexibly to meet the needs of the pupils. (See Pupil support and differentiation.) At HPJS we do not expect to always see the whole class to be taught together. As learning progresses through an objective we expect to see that the teacher has identified those pupils who have quickly grasped concepts and these pupils are challenged through more demanding problems which deepen their knowledge of the same content.

We do not teach rules; we build conceptual understanding.

Lesson Structure

Pupils have daily Mathematics of approximately one hour.

The lesson and or parts of the lesson are planned to focus on our HPJS Mathematics Learning Behaviours.

A tool box of methods and strategies

Whilst we teach methods that pupil may add to their tool box, there is no hierarchy in calculation methods. By this we mean that jottings and mental methods continue to be used, as appropriate, after formal written methods have been taught. We teach children to choose the most appropriate method. As part of our teaching calculations are planned to encourage pupils to recognise which strategy is the most appropriate.

- No work- e.g. using knowledge of place value e.g. 2345-300
- Jottings/mental methods
- Formal written method.

Whilst the national curriculum sets objectives around the number of digits in a calculation, this is not how we teach. We carefully craft calculations and problems to help children develop their ability to notice and make appropriate choices.

Pupils are taught to use the most efficient method for the calculation, for example it would not be efficient to use a formal written method for 2000-1997.

Pupils are taught to explain their thinking using appropriate mathematical language.

Pupils are given the opportunity to demonstrate and model their methods and strategies. Discussion is not just oral it is always done with either concrete pictorial or abstract representation by the pupil explaining. A visualizer may be a useful tool for this.

Pupils are taught to look for pattern, connections and make generalisations.

All pupils are taught to use an empty number line (ENL) using the strategies set out in the Suffolk Empty Number Line Strategy (SENLS). Pupils will use the ENL methods as part of a calculation 'toolbox', choosing the most efficient method for the calculation.

Number Talks

Classroom Number Talks provide a collaborative forum for pupils to

- Use ENL and other strategies that have been taught in 'Tool Box' lessons
- Invent strategies;
- Generalize individual strategies into personal algorithms; and
- Build a conceptual bridge to the standard algorithm.

The introduction of number talks is a pivotal vehicle for developing efficient, flexible, and accurate computation that build upon the key foundational ideas of mathematics such as composition and decomposition of numbers, our system of tens, and the application of properties. Classroom conversations and discussion around purposefully crafted computation problems are at the very core of number talks. These are opportunities for the class to come together to share their mathematical thinking. The problems in a number talk are designed to elicit specific strategies that focus on number relationships and number theory. Pupils are presented with problems in either a whole or small-group setting and are expected to learn to mentally, or with jottings, solve them accurately, efficiently, and flexibly. By sharing and defending their solutions and strategies, pupils are provided with opportunities to collectively reasons about number while building connections to key conceptual ideas in mathematics. Our Number Talks take 5 to 15 minutes and happen at least 3x a week. They will happen daily when first introduced.

Key components of number talks

1. A safe risk free classroom environment and community.
2. Classroom discussions, where wrong answers are an opportunity to unearth misconceptions.

3. The teacher's role as facilitator.
4. The role of mental math with a focus on number relationships to develop efficient flexible strategies with accuracy.
5. Purposeful computation problems

During a number talk, the teacher writes a problem on the board and gives the pupils time to solve the problem mentally, or with jottings. Once pupils have found an answer, they are encouraged to continue finding efficient strategies while others are thinking. This quiet allows time for pupils to think, while the process continues to challenge those who already have an answer. When most of the pupils have a solution and strategy, the teacher calls for answers. All answers – correct and incorrect – are reordered on the board for the pupils to consider.

Pupils are then given the opportunity to share their strategies and justifications with their peers. This helps pupils to

1. Practise their noticing skills.
2. Clarify their own thinking.
3. Consider and test other strategies to see if they are mathematically logical.
4. Investigate and apply mathematical relationships.
5. Build a repertoire of efficient strategies.
6. Make decisions about choosing efficient strategies for specific problems.

Wrong answers are used to opportunities to unearth misconceptions. We see helping pupils realise that mistakes are opportunities for learning is an important cornerstone in building a learning community.

Teachers act as facilitators, Number Talks are a dialogue not a monologue. Teaching is rooted in asking, not telling. The focus is on 'How did you get your answer?' not 'What is your answer?'

Concrete Apparatus

Concrete apparatus is available to all pupils.

Concrete apparatus is stored so that it is easily accessible to all pupils in every lesson.

All new concepts are introduced with concrete apparatus.

There is a hierarchy in the level of abstraction that pupils need to use these different types of concrete apparatus.

> Numicon represents numbers to 10. As pupils develop their understanding tiles may be used to represent other numbers.
>
> Dienes or Base 10 apparatus represents ones, tens and hundreds.

For both Numicon and Dienes the apparatus reinforces one to one correspondence and allow children to make physical comparisons for exchanging.

When pupils are secure with place value and understand Base 10 they may use Place Value Counters.

Productivity and practice

Fluency comes from deep knowledge and practice.

Pupils work hard and are productive. At early stages, explicit learning of multiplication tables is important in the journey towards fluency and contributes to quick and efficient mental calculation. Practice leads to other number facts becoming second nature. The ability to recall facts from long term memory and manipulate them to work out o

All tasks are chosen and sequenced carefully, offering appropriate variation in order to reveal the underlying mathematical structure to pupils. Work provides this 'intelligent practice', which helps to develop deep and sustainable knowledge their facts is also important

Pupil support and differentiation

Taking a mastery approach, differentiation occurs in the support and intervention provided to different pupils, not in the topics taught, particularly at earlier stages.

There is no differentiation in the objectives taught, with the exception of those not working on year group objectives. Pupils who grasp concepts rapidly will be challenged through being offered rich and sophisticated problems they will not be accelerated through new content. Those who are not sufficiently fluent with earlier material will consolidate their understanding, including through additional practice, before moving on.

The differentiation is in

- A step back in order to step forward.
- the questioning, including promoting more sophisticated reasoning and generalisation.
- the scaffolding individual pupils receive in class as they work, for example the pre learning steps
- the problems offered- higher attaining pupils are challenged through more demanding problems which deepen their knowledge of the same content.

Pupils' difficulties and misconceptions are identified through immediate formative assessment and addressed with rapid intervention – commonly through individual or small group support later the same day.

As pupils progress through the school and our targeted teaching brings about Mastery, there will be very few "closing the gap" strategies, because there are very few gaps to close.

Assessment and Feedback

Assessment for learning is embedded into each lesson to identify pupils' strengths and misconceptions.

At Hyde Park Junior School, we make a distinction between

- a 'mistake' – something a student can do, and does normally do correctly, but has not on this occasion

and

- a 'misunderstanding', which occurs when a student has not mastered the required skill or has misunderstood.

We believe that careless mistakes should be marked differently to errors resulting from misunderstanding.

Actions resulting from Feedback

Feedback, either oral or written through marking resulting from assessment of the piece of work. Depending on the type of work and the needs of the child feedback may be oral in the form of conferencing, or written.

Following an assessment of the children's work the teacher will decide on the next steps for

- the individual
- a group of pupils with the same error or area for improvement
- the class

and adjust their planning accordingly.

Time is set aside to quality mark work with pupils and for pupil to respond to feedback, to correct and improve their work.

Summative assessment

Objectives are set for each two week block of work, these are steps toward s end of year objectives. These objectives are being entered on the school tracking system for teachers to record summative assessments. Teachers make a summative assessment against these objectives. Some of the evidence base for these assessments may come from day-to-day class work. Teachers may set specific tasks and tests to assess the degree of retention, independence and breadth of application shown. We identify and target those children not making expected progress and intervene accordingly. At the end of each academic year pupils are tested in the style of the end of key stage tests.

An environment for learning

A Growth Mindset Classroom

Pupils with a Growth Mindset:-

- Believe that talents can be developed and great abilities can be built over time.
- View mistakes as an opportunity to develop
- Are resilient
- Believe that effort creates success
- Think about how they learn

Maths Learning Wall

Each classroom has a Maths Learning Wall to support learning. They should include the following:

- Support for current learning.
- Support recent learning but still needed by the children.
- Examples of children's work
- Maths language/vocabulary

The content must be presented in a manner that is visible and accessible when children are at tables, but also in a more detailed form that children need to get up and get closer to access. It must be clear and uncluttered.

Display

Teachers may choose to display work relating to

- 'Maths Challenges'.
- Examples of reasoning/ problem solving or unusual /new thinking
- Maths applied in a cross-curricular way

Appropriate practical resources

To support Mathematical learning that are relevant to the area of learning, clearly labelled and easily accessible to the children. There needs to be the provision of opportunities to self select equipment.

Fluency

We focus on teaching two aspects of fluency

- Recall of basic number facts
- Procedural fluency, the ability to carry out calculations with accuracy using the most efficient method

Efficiency in the latter is dependent on the former.

Develop children's fluency with basic number facts

Fluent computational skills are dependent on accurate and rapid recall of basic number bonds to 20 and times-tables facts. At HPJS we spend a short time every day on these basic facts with the aim of leading to pupils quickly securing recall. It is important that recall is put in the context of pupils developing strong sense of number relationships, an important prerequisite for procedural fluency, for example, that the products in the 6× table are double the products in the 3× table.

At HPJS pupils are taught to see the relationship between-

the number bonds to 10, 20, 100 etc.

the multiplication tables, 5,10   2,4,8   3,6,12   x 11

At HPJS we teach group size x scaling (number of groups)= total

6x3=18   that is a group of 6 repeated 3 times, for example 3 boxes of ½ dozen eggs

Develop children's fluency in mental calculation

Efficiency in calculation requires having a variety of mental strategies. At HPJS all pupils are taught to use an empty number line (ENL) for addition and subtraction, using the strategies and labels described in the Suffolk Empty Number Line Strategy. See progression in calculation Policy.

Using the Empty Number Line to Solve Addition and Subtraction Problems

Pupils are free to choose what type of jumps they will use. The focus is on sharing different strategies in order to lead pupils to use the empty number line efficiently when adding or subtracting any pairs of numbers.

One of the interesting things about mental calculations is that we do not all think the same way. The empty number line allows pupils to see the variety of ways that the same question can be solved.

For example, to solve 157 + 36 one pupil may begin at 157, add 30, then 6 while another may start at 157 and break the 36 into 3 and 33. This turns the question into the problem of adding 33 to 160. Writing equations horizontally forces pupils to look at the numerals, whereas written vertically students tend to immediately turn to the procedural algorithm.

By the end of the year 3 pupils should be able to-

- Use extended Number bonds for splitting 1000
- Make valid choices as to appropriate methods to use for given numerical problems, and justify these choices

- Add or subtract mentally pairs of two-digit whole numbers (e.g. 47 + 58, 91 – 35)
- Use strategy labels when discussing their methods

The ENL highlights the importance of 10 as a convenient jump as well as reinforcing that it is helpful to make a 10 as this makes the calculation easier partitioning ones numbers to bridge through 10, called H10 (hitting the tens) For example:

9 + 6 = 9 + 1 + 5 = 10 + 5 = 15.

Develop fluency in the use of formal written methods (procedural algorithm.)

We teach a range of methods that pupil may add to their calculation tool box, there is no hierarchy in the use of calculation methods. There is a hierarchy in the order in which they are taught. See Progression in Calculation Policy. All equations are written horizontally, forcing pupils to look at the numerals, whereas written vertically pupils tend to immediately turn to the procedural algorithm.

Before pupils are taught formal written methods for addition and subtraction they must be able to confidently

- Use extended Number bonds for splitting 1000
- Make valid choices as to appropriate methods to use for given numerical problems, and justify these choices
- Add or subtract mentally pairs of two-digit whole numbers (e.g. 47 + 58, 91 – 35)
- Use strategy labels J10, H10, OJ, CO when discussing their methods
- Demonstrate using Base 10 adding or subtracting one and/or ten from any 3 digit number involving exchanging.

198+1=199	289+10=299	402-1=401	417-10=407	417-11= 406
199+1=200	299+10=309	401-1=400	407-10=397	406-11=395
200+1=201		400-1=399		

Before pupils are taught formal written methods for multiplication and division they must be able to confidently-

- Explain, identify and demonstrate grouping and sharing using concrete apparatus and pictorial representations.
- Either know their multiplication tables or be able to confidently use appropriate scaffolding materials.
- Be able to demonstrate their understanding of multiplying and dividing by 10 using concrete apparatus, showing exchanging to demonstrate how each column is 10x or /10 the previous

In teaching formal methods for we develop both procedural and conceptual fluency. We ensure that children understand the structure of the mathematics presented in the algorithms, with a particular emphasis on place value. This is done through the use of base ten apparatus initially. Place value counters are not used to initially demonstrate and explore as there is no direct exchange as each counter is the same circle with a number on it to represent its value. The Base 10 are constructed to represent their value and relate to each other.

Expanded methods of recording calculations are an important stage to help children develop fluency with formal methods of recording. It is important that children understand and are able to demonstrate with concrete apparatus the internal logic of formal methods of recording calculations. Expanded methods are a stepping stones to formal written methods.

Developing the children's understanding of the = symbol

At HPJS we ensure that children are taught to understand that

the symbol = is an assertion of equivalence.

At HPJS we vary the position of the = symbol and include empty box to deepen children's understanding of the = symbol.

This is because-

If we write: **3 + 4 = 6 + 1** then we are saying that what is on the left of the = symbol is necessarily equivalent to what is on the right of the symbol.

If calculations are always presented with the = at the end

3 + 4 = **5 × 7 =** **16 – 9 =**

Then children will interpret = as being simply an instruction to carry out a calculation.

If they only think of = as meaning "work out the answer to this calculation", rather than understand that the symbol = is an assertion of equivalence, they are likely to get confused by empty box questions such as:

3 + □ = 8

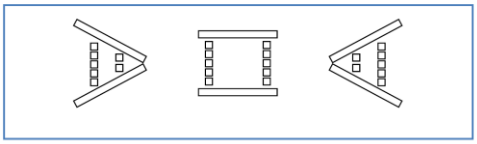
Later they are very likely to struggle with even simple algebraic equations, such as:

3*y* = 18

Teach inequality alongside teaching equality

To help young children develop their understanding of equality, they also need to develop understanding of inequality.

At HPJS we are experimenting with teaching inequality at the same time as equality. We introduce the < and > signs using rods and cubes to make a concrete and visual representations:



to show that 5 is greater than 2 (5 > 2), 5 is equal to 5 (5 = 5), and 2 is less than 5 (2 < 5).

We incorporate both equality and inequality into examples and exercises to help children develop their conceptual understanding. For example, in this empty box problem children have to decide whether the missing symbol is <, = or >:

5 + 7 □ 5 + 6

An activity like this also encourages children to develop their mathematical reasoning: "I know that 7 is greater than 6, so 5 plus 7 must be greater than 5 plus 6".

Asking children to decide if number sentences are true or false also helps develop mathematical reasoning. For example, in discussing this statement:

4 + 6 + 8 > 3 + 7 + 9

a child might reason that "4 plus 6 and 3 plus 7 are both 10. But 8 is less than 9. Therefore 4 + 6 + 8 must be less than 3 + 7 + 9, not more than 3 + 7 + 9".

In both these examples the numbers have been deliberately chosen to allow the children to establish the answer without actually needing to do the computation. This emphasises further the importance of mathematical reasoning.

Don't count, calculate

We use the strategies set out in the Suffolk Empty Number Line Strategy to support children in calculating, rather than relying on 'counting on'. We are aware that any child seen counting in ones on their fingers needs additional help and support.

For example, with a sum such as:

4 + 7 =

Rather than starting at 4 and counting on 7, children could use their knowledge and bridge to 10 to deduce that because 4 + 6 = 10, so 4 + 7 must equal 11.

Look for pattern and make connections

At HPJS we use a great many visual representations of the mathematics and alongside concrete resources. We plan lessons that encourage pupils to develop good habits from in terms of reasoning and looking for pattern and connections in the mathematics. The question "What's the same, what's different?" is used frequently to make comparisons. For example *"What's the same, what's different between the three times table and the six times table?"*

Use intelligent practice

At HPJS children do engage in regular practice of mathematics to develop both procedural and conceptual fluency. We avoid mechanical repetition; we create an appropriate path for practising the thinking process with increasing creativity. The arrangement of these tasks and exercises draw pupils' attention to patterns, structure and mathematical relationships, children are required to reason and make connections between calculations. This 'intelligent practice' allows the opportunity to deepen conceptual understanding. The connections made improve their fluency.

	2	4	8	20	40	80
3						
6						
12						
30						
60						
80						

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

Shanghai Textbook Grade 2 (aged 7/8)

Use empty box problems

Empty box problems are a powerful way to help children develop a strong sense of number through intelligent practice. They provide the opportunity for reasoning and finding easy ways to calculate. They enable children to practise procedures, whilst at the same time thinking about conceptual connections.

A sequence of examples such as

3 + □ = 8	30 + □ = 80	0.3 + □ = .8
3 + □ = 9	30+ □ = 90	0.3 + □ =.9
3 + □ = 10	30 + □ = 100	0.3+ □ =1
3 + □ = 11	30 + □ = 110	0.3+ □ =1.1

This sequence of examples does the same at a deeper level:

3 × □ + 2 = 20

3 × □ + 2 = 23

3 × □ + 2 = 26

3 × □ + 2 = 29

3 × □ + 2 = 35

Children should also be given examples where the empty box represents the operation, for example:

4 × 5 = 10 □ 10

6 □ 5 = 15 + 15

6 □ 5 = 20 □ 10

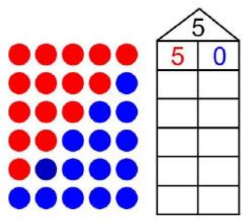
8 □ 5 = 20 □ 20

8 □ 5 = 60 □ 20

These examples also illustrate the careful use of variation to help children develop both procedural and conceptual fluency.

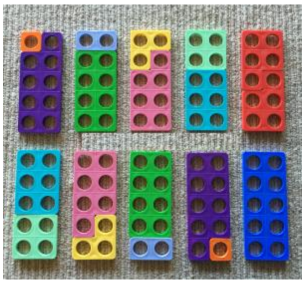
Expose mathematical structure and work systematically

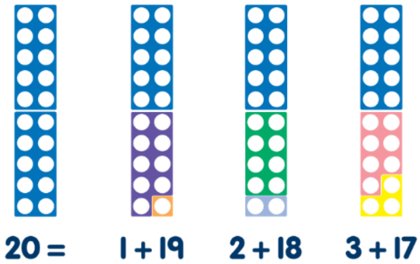
Developing instant recall alongside conceptual understanding of number bonds to 10 is important. This can be supported through the use of images such as the example illustrated below:



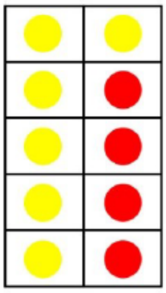
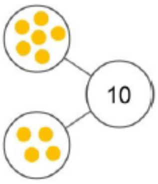
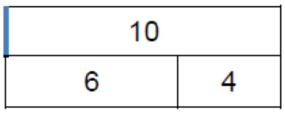
Shanghai Textbook Grade 1 (aged 6/7)

The image lends itself to seeing pattern and working systematically and children can connect one number fact to another and be certain when they have found all the bonds.





Using other structured models such as tens frames, part whole models or bar models can help children to reason about mathematical relationships.

 6 + 4 = 10 4 + 6 = 10 10 – 4 = 6 10 – 6 = 4	 6 + 4 = 10 4 + 6 = 10 10 – 4 = 6 10 – 6 = 4	 6 + 4 = 10 4 + 6 = 10 10 – 4 = 6 10 – 6 = 4
Tens Frame	Part Whole Model	Bar Model

Connections between these models should be made, so that children understand the same mathematics is represented in different ways.

Asking the question *"What's the same what's different?"* has the potential for children to draw out the connections.

Illustrating that the same structure can be applied to any numbers helps children to generalise mathematical ideas and build from the simple to more complex numbers, recognising that the structure stays the same; it is only the numbers that change.

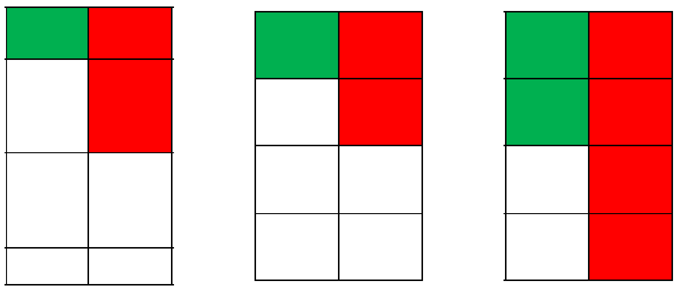
For example:

10	247	6.2
6 | 4	173 | 74	3.4 | 2.8
6 + 4 = 10	173 + 74 = 247	3.4 + 2.8 = 6.2
4 + 6 = 10	74 + 173 = 247	2.8 + 3.4 = 6.2
10 – 6 = 4	247 – 173 = 74	6.2 – 3.4 = 2.8
10 – 4 = 6	247 – 74 = 173	6.2 – 2.8 = 3.4

Move between the concrete and the abstract

Children's conceptual understanding and fluency is strengthened if they experience concrete, visual and abstract representations of a concept during a lesson. Moving between the concrete and the abstract helps children to connect abstract symbols with familiar contexts, thus providing the opportunity to make sense of, and develop fluency in the use of, abstract symbols.

For example, in a lesson about addition of fractions children could be asked to draw a picture to represent the calculation 1/4 + 1/8 = 3/8



Alternatively, or in a subsequent lesson, they could be asked to discuss which of three visual images correctly represents the calculation, and to explain their reasoning:

Contextualise the mathematics

A lesson about addition and subtraction could start with this contextual story:

"There are 11 people on a bus. At the next stop 4 people get on. At the next stop 6 people get off. How many are now on the bus?"

This helps children develop their understanding of the concepts of addition and subtraction. But during the lesson the teacher should keep returning to the story. For example, if the children are thinking about this calculation

14 – 8

then the teacher should ask the children:

"What does the 14 mean? What does the 8 mean?", expecting that children will answer:

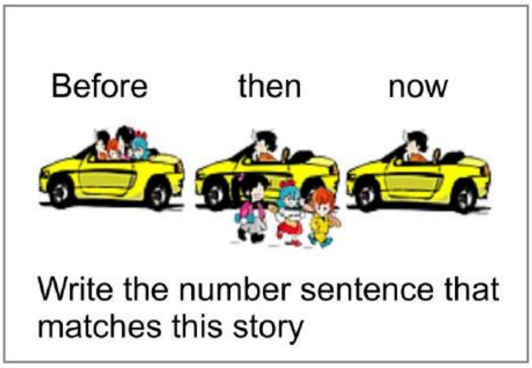
> "There were 14 people on the bus, and 8 is the number who got off."

Then asking the children to interpret the meaning of the terms in a sum such as 7 + 7 = 14 will give a good assessment of the depth of their conceptual understanding and their ability to link the concrete and abstract representations of mathematics

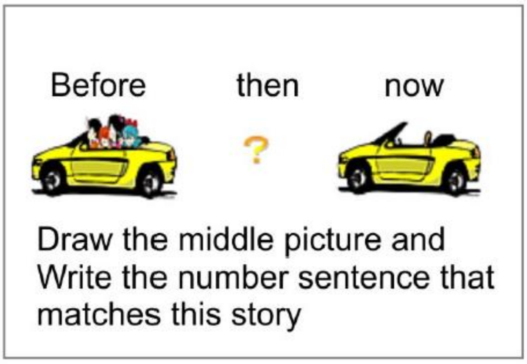
For example, the four slides below are taken from a lesson delivered by a Shanghai teacher.

Each activity varies. The children are asked to:

Slide 1: Start with the story (concrete) and write the number sentence (abstract).	**Slide 2**: Start with the story (concrete) and complete it. Then write the number sentence (abstract).



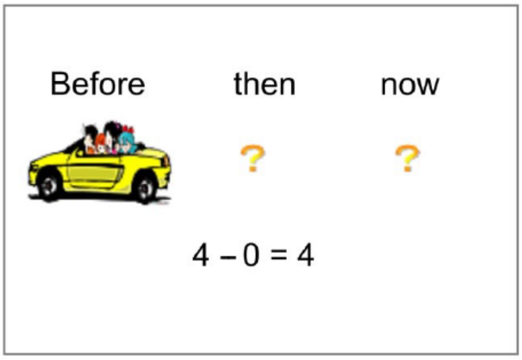
Slide 1



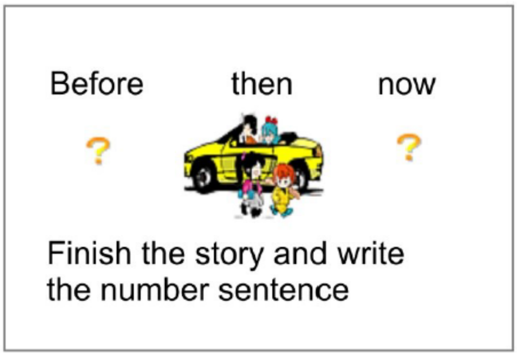
Slide 2

Slide 3: Start with the number sentence (abstract) and complete the story (concrete).

Slide 4: Start with part of the story, complete two elements of it (concrete with challenge) and then write the number sentence (abstract).



Slide 3



Slide 4

The children move between the concrete and the abstract and back to the concrete, with an increasing level of difficulty.

Use questioning to develop mathematical reasoning

Teachers' questions in mathematics lessons are often asked to find out whether children can give the right answer to a calculation or a problem. But in order to develop children's conceptual understanding and fluency there needs to be a strong and consistent focus on **questioning that encourages and develops their mathematical reasoning.**

This can be done simply by asking children to explain how they worked out a calculation or solved a problem, and to compare and contrast different methods that are described. At HPJS children are expected to explain and justify their mathematical reasoning. As calculations vary, different calculation strategies are more efficient. At HPJS we scaffold children's thinking to guide them to the most efficient methods, whilst at the same time valuing their own ideas. We engage in genuine discussion, not guess the answer that is in the teacher's head.

<u>**Rich questioning strategies include:**</u>

- **"What's the same, what's different?"** In this sequence of expressions, what stays the same each time and what's different?

23 + 10   23 + 20   23 + 30   23 + 40

Discussion of the variation in these examples can help children to identify the relationship between the calculations and hence to use the pattern to calculate the answers.

- **"Odd one out"**

" Which is the odd one out in this list of numbers:

24, 15, 16 and 22?

This encourages children to apply their existing conceptual understanding. Possible answers could be:
"15 is the odd one out because it's the only odd number in the list."
"16 is the odd one out because it's the only square number in the list."
"22 is the odd one out because it's the only number in the list with exactly four factors."
If children are asked to identify an 'odd one out' in this list of products:

24 × 3   36 × 4   13 × 5   32 × 2

they might suggest:
"36 × 4 is the only product whose answer is greater than 100."
"13 × 5 is the only product whose answer is an odd number."

- **"Here's the answer. What could the question have been?"**

Children are asked to suggest possible questions that have a given answer. For example, in a lesson about addition of fractions, children could be asked to suggest possible ways to complete this sum:

□ + □ = ¾

• **Identify the correct question**

Here children are required to select the correct question:

A 3.5m plank of wood weighs 4.2 kg

The calculation was: 3.5 ÷ 4.2

Was the question:

a. How heavy is 1m of wood?

b. How long is 1kg of wood?

• **True or False**

Children are given a series of equations are asked whether they are true or false:

4 × 6 = 23   4 × 6 = 6 × 4   12 ÷ 2 = 24 ÷ 4   12 × 2 = 24 × 4

Children are expected to reason about the relationships within the calculations rather than calculate

• **Greater than, less than or equal to >, < or=**

3.4 × 1.2 ○ 3.4   5.76 ○ 5.76 ÷ 0.4   4.69 × 0.1 ○ 4.69 ÷ 10

Further strategies to promote reasoning

The strategies embedded in the activities are easily adaptable and can be integrated into classroom routines.

Spot the mistake / Which is correct?

What comes next?

Do, then explain

Make up an example / Write more statements / Create a question / Another and another

Possible answers / Other possibilities

What do you notice?

Continue the pattern

Missing numbers / Missing symbols / Missing information/Connected calculations

Working backwards / Use the inverse / Undoing / Unpicking

Identifying hard and easy questions

What else do you know? / Use a fact

Convince me / Prove it / Generalising / Explain thinking

Make an estimate / Size of an answer

Always, sometimes, never

Making links / Application

Can you find?

What's the same, what's different?

Complete the pattern / Continue the pattern

Another and another

Ordering

Expect children to use correct mathematical terminology and to express their reasoning in complete sentences

The quality of children's mathematical reasoning and conceptual understanding is significantly enhanced if they are consistently expected to use correct mathematical terminology (e.g. saying 'digit' rather than 'number').
We expect pupils to explain their mathematical thinking in complete sentences.

I say, you say, you say, you say, we all say

is a technique that enables the teacher to provide a sentence stem for children to communicate their ideas with mathematical precision and clarity. These sentence structures often express key conceptual ideas or generalities and provide a framework to embed conceptual knowledge and build understanding.
For example:
If the rectangle is the whole, the shaded part is one third of the whole.
Having modelled the sentence, the teacher then asks individual children to repeat this, before asking the whole class to chorus chant the sentence. This provides children with a valuable sentence for talking about fractions. Repeated use helps to embed key conceptual knowledge. Another example is where children fill in the missing parts of a sentence; varying the parts but keeping the sentence stem the same.

For example:

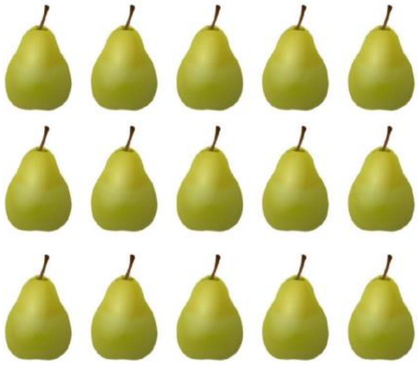
There are 12 stars. 1/3 of the stars is equal to 4 stars

Children use the same sentence stem to express other relationships. For example:

There are 12 **stars**. $\frac{1}{4}$ of the **stars** is equal to **3 stars**

There are 12 **stars**. $\frac{1}{2}$ of the **stars** is equal to **6 stars**

Similarly



There are 15 pears. 1/3 of the pears is equal to 5 pears.

There are 15 pears. 1/5 of the pears is equal to 3 pears

When talking about fractions **it is important to make reference to the whole and the part of the whole in the same sentence.** The above examples help children to get into the habit of doing so.
Another example is where a mathematical generalisation or "rule" emerges within a lesson. For example:

When adding 10 to a number, the ones digit stays the same

This is repeated in chorus using the same sentence, which helps to embed the concept.

Identify difficult points, possible misconceptions

Difficult points need to be identified and anticipated when lessons are being designed and these need to be an explicit part of the teaching, rather than the teacher just responding to children's difficulties if they happen to arise in the lesson. The teacher should be actively seeking to uncover possible difficulties because if one child has a difficulty it is likely that others will have a similar difficulty. Difficult points also give an opportunity to reinforce that we learn most by working on and through ideas with which we are not fully secure or confident. Discussion about difficult points can be stimulated by asking children to share thoughts about their own examples when these show errors arising from insufficient understanding. For example:

$$2/14 - 1/7 = 1/7$$

A visualiser is a valuable resource since it allows the teacher quickly to share a child's thinking with the whole class.