Culture of Mathematics at Davyhulme Primary School:

Habits of mind and explicit learning behaviours in reasoning and problem solving

At Davyhulme Primary School we believe that developing habits of thinking is crucial to children's long term mathematical success. We strive to ensure that all children develop these habits using mathematical learning behaviours and habits of mind to learn through reasoning and problem solving. We explicitly teach these habits and they are visible within all the Mathematics lessons to support the children to reason mathematically and grow as creative independent thinkers.

Davyhulme Primary School Mathematical Learning Behaviours

Logical reasoning requires **metacognition (thinking about thinking).** It influences behaviour and attitudes through greater engagement, requesting appropriate help (self-regulation) and seeking conceptual understanding.

- **Self-regulation – I check my own success.**
  'I will do… by myself.', 'I can easily…', 'I need help to learn…'
- **Collaboration - I follow the thinking of others.**
  'So you think… ', 'Why did you… ', 'I agree/disagree with…'
- **Curiosity: I can extend my thinking.**
  '…is similar to/different from… because… ', 'My example is…'
- **Resilience - I start by myself.**
  'I tried… ', 'My idea was…', 'I didn't know…'
- **Resourcefulness - I show my understanding in different ways.**
  'I could use pictures, explanations, examples, and explain mistakes'

Davyhulme Primary School Mathematical Habits of Mind

- Make logical leaps 'I know ___ so ____'
- Understand concepts
- Be creative
- Be flexible in approaches
- Be ordered
- Show understanding in different ways
- See relationships and generalise

Classroom Routines

- At Davyhulme Primary School we use a set of routines within interactive teaching which ensure mass participation within the lessons. Using these routines allows time for children to process their thinking, raising their internal narrative, and gives opportunity to free up their working memory. Normalising these routines means that the children know their importance:

- **Teachers acknowledge that there can be uncomfortable emotions when learning Mathematics. Through regular dialogue interweaved into the lessons, the children recognise that these emotions are normal and that they are passing.**
- **Teachers allow for 'pockets of silence' between a question being posed and an answer or discussion.**
- **Teachers use silence in modelling. Children focus upon thinking, not what the teacher is doing.**
- **Children know there is an expectation that everyone will join in using techniques such as 'taking other perspectives' ("So Karen, what does Dylan think?").**
- **Children know that 'I don't know' is not a check-out opportunity. Teachers use skilful questioning to support the children's thinking such as "When you said this did you mean…", "If you did know, what would you say?"**
- **When using whiteboards, children know to hold them to their chests, and they will be acknowledged one table at a time. The children remain focused upon the content of the lesson, not whether the teacher will see their answer.**
- **When engaging in pair work, children will have short independent thinking slots before discussing with their partner. This promotes different methods and thought processes, and lessens the risk of one partner becoming too dominant in the conversation.**
- **Teachers use 'doubt at the point of answer'. This gives the children a reason to explain their thinking and shows them that they it is their thought process that is valued, not whether the answer is right or wrong.**
- **Feedback is considered carefully – sometimes this needs to be specific to support children working through misconceptions, on other occasions it can be less specific to allow the children to see relationships. For example a teacher may say "Five of those answers are correct, two aren't. Can you find the two that aren't?"**
- **Teachers use representations to support visualisation. Children know it is the norm that they use equipment and they visualise changes in a sequence of questions.**

Reasoning techniques

At Davyhulme Primary School we use the techniques from I See Maths by Gareth Metcalfe. When building understanding, children are used to being given an *Explain the Mistakes* task; they know that they will be asked to explain links between questions when answering *Small Difference Questions* and they have become used to working systematically when given a *How Many Ways?* challenge. By establishing these norms, we can focus more of the children's attention to the maths content of the task, rather than having to explain how to approach each new technique.

Further information on the work of Gareth Metcalfe can be found at his website:

https://www.iseemaths.com/

Reasoning begins at the start of the children's journey in Early Years. We recognise that when tasks have significance and make sense in the real world, children operate at a higher level of thinking. We use 're-proposing' and extended mathematical play through continuous provision. As the children progress through Key Stage One and Two, they are exposed to a variety of tasks to grasp key ideas, break down calculations, and generate discussion and challenges for deeper learning. Context examples are used to connect maths concepts to real world scenarios.

Tasks to develop mathematical reasoning:	
Key Stage One:	Key Stage Two:
Read the picture	Read the picture
Spot the difference	Explain the mistakes
Different ways challenges	Which answer?
	Agree or disagree?
	Correct or incorrect
	Estimate
	Part complete examples
	Small difference questions
	Explain
	Rank by difficulty
	Extend and multi-skill
	How many ways?

Different reasoning techniques are used throughout the knowledge acquisition (novice stage) than when knowledge has been acquired (expert stage).

Word problems

Slow reveal problems

When students are presented with a mathematical word problem, their first response often is to try to compute an answer, even before they have tried to understand the problem. Expert problem solvers typically spend more time thinking about problems and trying to understand them than do novices, who tend to immediately execute a solution. Our teachers deconstruct the problems to avoid children's working memory becoming overloaded with information. It enables them to focus upon the deep mathematical structures, rather than trying to compute an answer immediately. Examples of 'slow reveal' problems may cover up some information, cover up the question, or cover up some numbers.

An example of a 'slow reveal' question:

Here is the cost of some items in a shop.

Banana 20p Drink 50p Bread 40p

.

Sequence of questions

We recognise that problem solving questions should not be like an island on their own. At Davyhulme Primary school we teach using progressively harder questions in a sequence. These are not be totally different questions, but build up so that the children make connections and all the children can engage. Depth of understanding comes from systematic thinking, not by making questions harder on their own. Changes are made in small steps, so that the process is accessible. These are known as task families.

An example of a sequence of questions:

1. Ben has 8 sweets. Tom had 2 sweets.
How many sweets do they have altogether?

2. Kate has 8 sweets. Joy has 2 sweets.
How many more sweets does Kate have than Joy?

3. Holly had 8 sweets. Amy had 2 sweets. Holly ate 4 sweets.
Who has the most sweets now?

4. Holly had 8 grapes. Amy had 2 grapes. Holly gave Amy 4 grapes.
Who has the most grapes now?