Dyscalculia

What is it?

Dyscalculia is often called a ‘maths’ difficulty, but it actually only affects those aspects of mathematics to do with number. A dyscalculic learner may have no problems with shape and space but be unable to recall or use a basic addition number bond. It would therefore be better to think of dyscalculia as a specific difficulty with number and arithmetic.

The Department for Education and Science first recognised developmental dyscalculia in 2001. It was defined as:

‘a condition that affects the ability to acquire arithmetical skills. Dyscalculia learners may have difficulty in understanding simple number concepts, lack an intuitive grasp of numbers, and have problems learning number facts and procedures. Even if they produce a correct answer, or use a correct method, they may do so mechanically and without confidence’
(DfES 0512/2001, p.2)

Research into dyscalculia is still at an early stage, but it is estimated that it affects roughly 4-6% of the population. This equates to at least one child in any average class. The above definition may leave you feeling that the majority of your class are dyscalculic on some days ! The first question to address is how are dyscalculia learners different from learners experiencing everyday difficulties with new concepts or procedures in maths ? A dyscalculic learner stands out as having:

- no feel for numbers at all
- no ability to estimate even small quantities, and
- no idea whether their answer to an arithmetic problem is reasonable or not

Dyscalculia learners often have memory weaknesses, both long-term and short-term. This results in the learner being:

- unable to remember facts and procedures accurately or consistently
- unable to derive associated facts, such as times tables
- able to recall number facts one day but not the next
- likely to lose track of what they are doing when attempting a procedure that requires two or three steps
- unable to count, even basic forwards counting, although counting backwards is most often the problem

The indicators for dyscalculia:

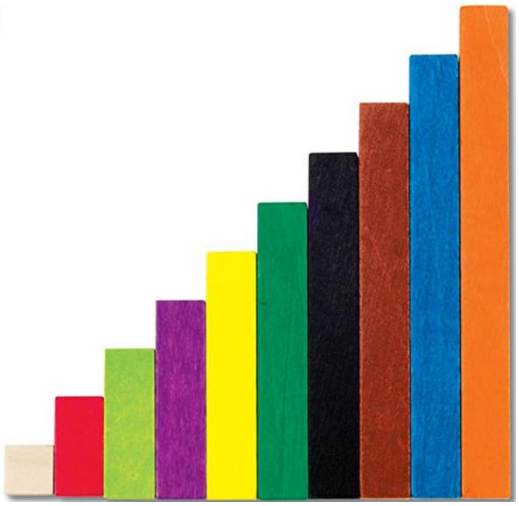
This list is not exhaustive but includes the most common indicators. Learners may show some, but not all, of these characteristics and behaviours:

- an inability to subitise (see without counting) even very small quantities
- an inability to estimate whether a numerical answer is reasonable
- weaknesses in both short-term and long-term memory
- an inability to count backwards reliably
- a weakness in visual and spatial orientation
- directional (left/right) confusion
- slow processing speed when engaged in maths activities
- trouble with sequencing
- a tendency not to notice patterns
- a problem with all aspects of money
- a marked delay in learning to read a clock to tell the time
- an inability to manage time in daily life

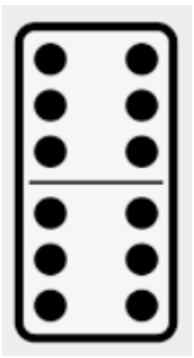
What kind of teaching do dyscalculic learners need?

All numeracy teaching should aim to help learners build up a sound mathematical understanding of numbers and their relationships. With dyscalculic learners, a focus on numeracy and arithmetic is important starting- crucially- with a variety of versatile concrete materials that provide practical experience and clear visual models. Once a learner can manipulate the concrete materials and images with some understanding, it may be possible to move forward into a more abstract or symbolic method.

A versatile and powerful tool to support learners struggling to build a coherent mental model of the number system is Cuisenaire rods. The rods should be supplemented with discrete counting objects, such as counters, for arranging and re-arranging into dot patterns for those who are not yet ready to use the rods. When learners are more secure with the rods, the use of Dienes blocks, or other base-10 equipment is helpful. One of the great strengths of Cuisenaire is that numbers are not presented as a collection of ones, so the learner's focus is directed away from counting and towards number relationships.



It is important that teachers beware of the 'counting trap', dyscalculic learners cannot necessarily memorise the word strings associated with counting. They need to develop an ability to pattern spot and one of the best ways to do this is to use dice, dominoes, and dot patterns with counters. This can improve recognition of spot patterns, rather than expect the learner to recall and chant for counting.



Double six is twelve modelled with dot patterns on dominoes and dice

Rote counting for a dyscalculic may mean that they must always ‘count all’ when trying to calculate, rather than progress to ‘counting on’, for example. Using recognition of dot patterns and practising visualisation may help with this.

It is worth noting that problems with numeracy often go hand-in-hand with significant memory and processing weaknesses. This is why simple repetition will never be a way forward for dyscalculic learners. It is likely to be much more helpful to focus on only a few key facts, those that are most important or have the widest application. The teaching strategy would be to allow the learner to explore and internalise the key facts through multi-representations and dual coding using verbal and visual prompts. Then teach them explicitly how to derive other key facts by logical reasoning in small steps.

For dyscalculics, visualisation is a strategy that needs to be explicitly taught as a route towards mental calculations. One approach is to follow any work with concrete resources with a short session where the learner closes their eyes and recalls what they have seen, they then represent this in picture or diagrammatic form. For example, if we are building number bonds to 10 using different coloured inter-locking cubes to create a ’10 tower’, then we might ask the learner to recollect this mentally and then draw on squared paper.

HIAS resources to support diagnosis of difficulties and small steps planning.

The HIAS maths team offers a range of resources to support teachers with provision for learners with dyscalculia. This includes a series of toolkits for primary and secondary learners to support planning in small incremental steps. In the Year 1 example below, small steps towards end of year 1 expectations are identified to enable the teacher to break down objectives and focus on a few key ideas at any one time.

Year 1 National Curriculum Notes and Guidance (non-statutory): Number and Place value	**Year 1: Big Ideas in Number and Place Value (NCETM mastery booklet)**
Pupils practise counting (1, 2, 3…), ordering (for example, first, second, third…), and to indicate a quantity (for example, 3 apples, 2 centimetres), including solving simple concrete problems, until they are fluent. Pupils begin to recognise place value in numbers beyond 20 by reading, writing, counting and comparing numbers up to 100, supported by objects and pictorial representations. They practise counting as reciting numbers and counting as enumerating objects, and counting in twos, fives and tens from different multiples to develop their recognition of patterns in the number system (for example, odd and even numbers), including varied and frequent practice through increasingly complex questions. They recognise and create repeating patterns with objects and with shapes.	• The position a digit is placed in a number determines its value. • The language used to name numbers does not always expose the place value, for example the word 'twelve' does not make it transparent that the value of this number is ten and two. It is important that children develop secure understanding of the value of each digit. • Place value is based on unitising: treating a group of things as one 'unit'. In mathematics, units can be any size, for example units of 1, 2, 5 and 10 are used in money. • In place value units of 1, 10 and 100 are used.

National Curriculum strands		Concepts, knowledge and skills		Year 1 National Curriculum expectations
Counting	• Oral counting forwards • Oral counting backwards • Number sequences (inc odd/even) • Estimating and counting a set of objects	Can say the number sequence from 1-10 (1-20; 1-30; 1-100)	Can say the number sequence backwards from 10-1 (20-1; 30-1; 100-1)	count to and across 100, forwards and backwards, beginning with 0 or 1, or from any given number
		Within the range 1- 10 (1-20; 30-1;1-100) can count forwards from a given number to another given number	Within the range 10- 1 (20-1; 30-1; 100-1) can count backwards from a given number to another given number	
		Can say the number after a given number in the range 1-10 (1-20; 1-30; 1-100) without dropping back to 1	Can say the number before a given number in the range 1-10 (1-20; 1-30; 1-100) without counting up through all numbers first	count, read and write numbers to 100 in numerals; count in multiples of twos, fives and tens
		Recognises patterns in the number sequences from 1-20 (1-30; 1-100) and uses this to say them/ self-correct	Can find 10 more than any given number U +10 = ? (teen numbers); (10-20;)	
		Points to or moves objects when counting	Can find 1 less than any number up to 10	given a number, identify one more and one less
		Can count accurately up to 3/ 4 (10; 20; 30) objects	Can find 1 less than any number up to 20	
		Can count for a short sequence in multiples of 2(5)	Uses step counting to count larger groups of objects (2s, 10s)	
Comparing Numbers	• Symbol order • Number line model • Cardinality • ordinality	Can use a structured (empty) number line to compare position of two numbers 0-10; (0-20; 0-30)	Can say whether two numbers are close together or far apart (through oral counting or number line model) 0-10 (0-20; 0-30)	use the language of: equal to, more than, less than (fewer), most, least
		Can use language of 'more/ less' to describe two sets of objects with links to > < signs	Can order numbers 1-10 (1-20; 1-30)	
		Can use structured resources eg numicon to compare numbers 1-10 (1-20, 1-30+)	Can use a structured (empty) number line to compare position of two numbers related to multiples of 10	
		Can identify first, second, third and last in a line of objects	Can use language of ordinality up to tenth (twentieth)	

In these secondary examples, the foundations for secondary have been identified from the primary curriculum and small steps towards end of year attainment are exemplified.

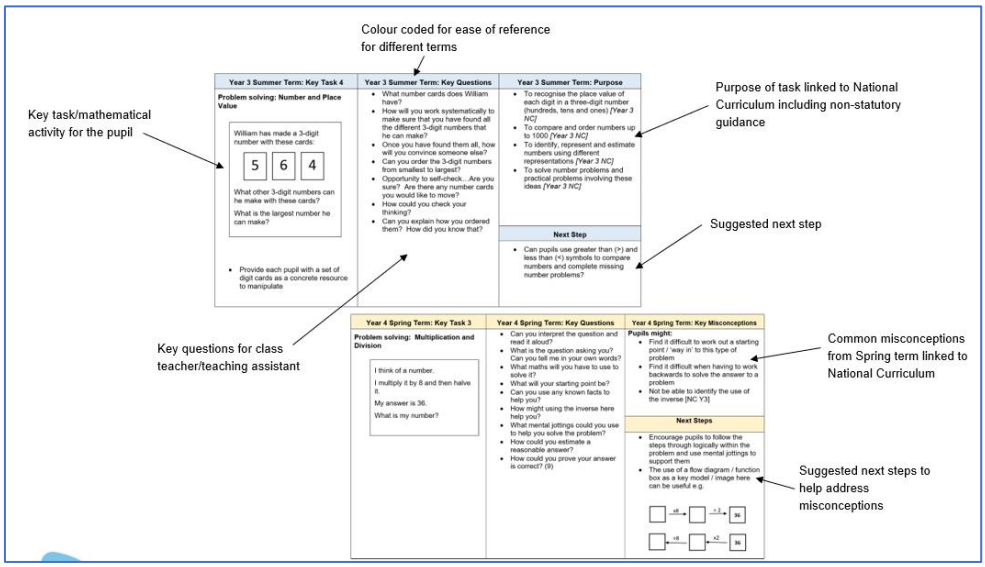
Properties of numbers	Can systematically identify factor pairs for multiples of 6 (7, 8, 12)	Can systematically identify factor pairs for multiples of 2 and 6 and identify which factors are common to both numbers (multiples of 5 and 10, 3 and 4)	identify common factors, common multiples and prime numbers establish whether a number up to 100 is prime and recall prime numbers up to 19 (yr 5) know and use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers(yr 5) recognise and use square numbers and cube numbers, and the notation for squared (^{2}) and cubed (^{3}) (yr 5) solve problems involving
	Use arrays to show prime numbers (1 to 10, 20)	Can use a system, find factor pairs of numbers up to 20 (30, 50) and identify which ones are prime	
	Know that multiples of a number X, are the numbers in that times table	Know that 1 is not a prime number and that 2 is the only even prime number	
	Can show which numbers will NOT be prime using, for example: arrays; multiplication square; times tables knowledge	Can find multiples of 2 (3, 4, 5) up to 50	
		Can recognise that multiples of 2(4,8,6) will be even	
	Can systematically find multiples of 10 (11, 6, 7, 9) up to 100	Can systematically find all multiples of 2 and 6 (3 and 4, 4 and 6, 3 and 10) up to 50. Identify the multiples that are common to both times tables	
	Use arrays to show square numbers (1 to 5, 10)	Use interlocking cubes to show cube numbers (1 cubed to 4 cubed)	

Negative numbers	Can identify and read negative numbers on a number line	Understands negative numbers in context; Eg. Temperatures, floors in a building / car park	interpret negative numbers in context, count forwards and backwards with positive and negative whole numbers, including through zero (yr 5) use negative numbers in context, and calculate intervals across zero
	Can order temperatures, including negative ones (to -10, -20)		

In addition to this, the HIAS maths team has produced a series of diagnostic packs to support teachers with identifying barriers to progress in key areas of mathematics for all learners from Y1 to Y11.

This resource has been designed to support teachers in using diagnostic assessment to inform teaching that addresses significant gaps in pupil learning. The example is taken from the Y3 to Y4 booklet. The booklets contain a series of mathematical questions and activities covering a range of mathematical domains, which enable teachers to progressively explore pupils' knowledge, conceptual understanding, and skills from the end of the summer term in one year group to the

sprint term in the next year group. The resources encourages the use of tightly focussed practical activities that address one idea at a time to ensure accurate diagnosis of a mathematical difficulty and provision for each individual learner.



The key message for what works best for dyscalculic learners is to:

- **break down** every bit of teaching and learning into very small incremental steps, and to not make any assumptions about what is already known or internalised
- **minimise** the number of facts that you expect to be committed to memory, focussing on games and activities rather than abstract worksheets. It is important not rush into abstract or written work too soon.

As with all learners, sound numerical understanding can only develop if it rests on secure foundations at every stage.

References:

Bird, R (2017) 'The Dyscalculia Toolkit' Sage publishing *ISBN 978-1-4739 - 7426 -5*
HIAS Maths Planning Tool for pupils with SEND
HIAS Maths Diagnostic Questions packs.