



The daily mathematics lesson

Guidance to support pupils with dyslexia and dyscalculia

Teachers and
Teaching Assistants
in Primary Schools

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Dyslexia and dyscalculia

Dyslexia

Dyslexia is a condition that affects the ability to process language. Dyslexic learners often have difficulties in the acquisition of literacy skills and, in some cases, problems may manifest themselves in mathematics. It is not surprising that those who have difficulties in deciphering written words should also have difficulty in learning the sets of facts, notation and symbols that are used in mathematics. This pattern of abilities and weaknesses is known as 'specific learning difficulties'.

Problems often occur with the language of mathematics, sequencing, orientation and memory, rather than with the mathematics itself. Dyslexic learners find it difficult to produce mental or written answers quickly, and the need to 'learn by heart' for pupils who have poor memory systems may well result in failure and lack of self-belief. Some dyslexic learners will enjoy the flexibility of approach and methods while, for others, choice creates uncertainty, confusion and anxiety.



Dyscalculia

Dyscalculia is a condition that affects the ability to acquire arithmetical skills. Dyscalculic learners may have difficulty 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.

Very little is known about the prevalence of dyscalculia, its causes, or treatment. Purely dyscalculic learners who have difficulties only with number will have cognitive and language abilities in the normal range, and may excel in non-mathematical subjects. It is more likely that difficulties with numeracy accompany the language difficulties of dyslexia.

How do pupils with dyslexia and dyscalculia learn mathematics differently?

Numbers and the number system

Dyslexic learners:

- *often have difficulty counting objects.*

This affects basic 'number sense'. They need clear instructions on how to count in an organised, meaningful way. They should count objects frequently, move objects as they count, count rhythmically to synchronise counting words with counting objects, and pause to 'take in' the quantity counted.

- *may have difficulty processing and memorising sequences.*

Dyslexic learners may be slow to learn a spoken counting sequence. Counting backwards is particularly difficult. They need additional practice in counting orally and need to continue oral counting into higher value sequences. Support can be provided by presenting sequences such as 0.7, 0.8, __, __, as 0.7, 0.8, __, __, 1.1, 1.2. The use and recognition of pattern is important and can be used to circumvent some of the problems with memory. Dyslexic learners need support counting through transitions, e.g. 198, 199, 200, 201 or 998, 999, 1000, 1001, and practice structuring from one count to another, e.g. from counting in tens to counting in ones.

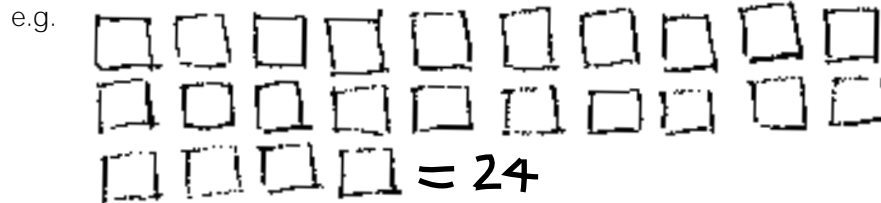
- *may find the underlying structure of the number system difficult to grasp.*

Dyslexic learners find completed 100-grids difficult to process and understand, failing to visualise or grasp the significance of the number patterns. Working with 'practical' versions of a 100-grid can facilitate understanding, e.g. working with a 100-bead frame, or counting estimated quantities into a 100-frame formation before moving on to 1–100 grids. Some pupils benefit from grids that have 1 to 10 across the bottom row so that the numbers get bigger as one moves up the grid.

91	92	93	94	95	96	97	98	99	100
81	82	83	84	85	86	87	88	89	90
71	72	73	74	75	76	77	78	79	80
61	62	63	64	65	66	67	68	69	70
51	52	53	54	55	56	57	58	59	60
41	42	43	44	45	46	47	48	49	50
31	32	33	34	35	36	37	38	39	40
21	22	23	24	25	26	27	28	29	30
11	12	13	14	15	16	17	18	19	20
1	2	3	4	5	6	7	8	9	10

- *find the interval-based structure of a number line difficult to understand.*

Many dyslexic learners make better progress if they work with practical versions of 'number tracks' first, e.g. a 100-bead string. Estimated quantities may be counted into tens-structured tracks,



Quantities structured in this way are easily 'rounded'.

Follow-up work on number lines should highlight number structures. For example, on a line to 100, the decades should be clearly demarcated. Pupils with learning difficulties also benefit from work on 'emptier' lines and 'emptier' materials, such as counting stacks. Such materials support the rounding of numbers.

- *need extra support in counting forwards and backwards.*

Use a clearly labelled number line, or counters placed in recognisable clusters, as on dominoes. Teen numbers are an example of the inconsistencies of our number system. For example, *thirteen* should be *ten three*, but it is said and written as *three* and *ten*. By contrast, the word *twenty-three* is in the same order as the digits, even if *twenty* is an irregular word (compared to *two hundred*). Careful teaching can minimise these difficulties as well as introduce the more regular pattern of larger numbers – *sixty-six*, *seventy-six*, etc.

Dyslexic learners may find the transfer of a learned sequence, say *90, 80, 70 ...*, to a modified sequence *92, 82, 72 ...*, challenging. Base ten blocks or coins may help illustrate which digit changes and which remains constant.

- *often have difficulties understanding place value.*

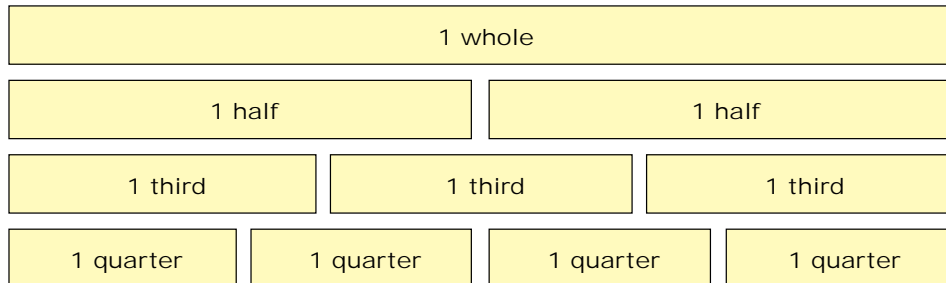
Language uses names to give values when counting (*ten, hundred*) while numerals use the principle of place value – the relative places held by each digit in the number (*10, 100*). Pupils who have not mastered the name value system may say that nine hundred and ninety-nine is bigger than one thousand.

Language demands are greater in writing numbers in words. Numbers that feature zeros, such as 5006, will need careful teaching, using practical materials and focusing pupils on the 'top value' word: *five thousand and six* has four digits because the top word is 'thousand'. A place value chart might be useful.

Dyslexic learners need to handle materials, as pictorial representations of base ten materials do not offer sufficient support for early learning experiences. Place value cards can also demonstrate the structure of numbers at a more symbolic/abstract level.

- *may find fractions confusing.*

Learners may be confused by the fact that $\frac{1}{20}$ is smaller than $\frac{1}{2}$ when previously they have learned that 20 is bigger than 2. There are also different ways of representing the same fraction; $\frac{1}{2}$ is equivalent to $\frac{2}{4}$ and $\frac{5}{10}$. The use of fraction walls may support understanding by providing a visual representation of the relationships.



The vocabulary of decimals combined with directional demands can confuse learners, when whole numbers sequence left from the decimal point as units, tens, hundreds, thousands, and decimal numbers sequence right from the decimal point as tenths, hundredths and thousandths.

Calculations

Dyslexic learners:

- *have difficulty combining and partitioning numbers.*

Some dyslexic learners often rely on finger counting and counting in ones. They may lack the flexibility to use many fact-derived strategies effectively. Initially, pupils should work with concrete materials, and the component parts of all numbers to 10 should be 'overlearned' in oral and written activities. They benefit from being shown number patterns which are extensions of earlier knowledge, e.g. $3 + 2 = 5$, $43 + 2 = 45$.

- *find it difficult to learn number facts 'by heart' but can usually work within a manageable target and can learn to use strategies.*

Number bonds to 10 are fundamental and the key to so many more facts that they should form the focus of quick recall. Patterns need to be taught using multi-sensory approaches. Use memory hooks to help relate new facts to learned facts. Visual imagery, e.g. showing the links between $5 + 5$ and $5 + 6$ with coins or counters, will also support non-dyslexic pupils in the class.

Facts that may be accessed through rapid mental recall are stored as verbal associations in exact sequences of words, such as '8 plus 5 equals 13' or '7 times 8 is 56'. Dyslexic learners find it difficult to remember such verbal associations. Facts that have been successfully stored as verbal associations may be accessed very slowly. Learners should be encouraged to maximise the use of key number facts, e.g. '10 x' facts can be used to deduce '9 x' facts, as in $9 \times 7 = (10 \times 7) - 7$. Short sequences of step counting from '5 x' can lead towards a 'partial products' approach in which, for example, 7×8 is seen as $(7 \times 5) + (7 \times 3)$.

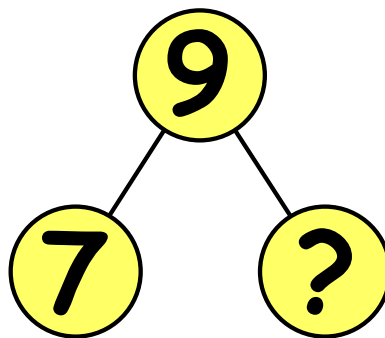


- *fail to remember the variety of fact-derived strategies or mental calculation methods.*

The sequence of steps in a calculation is difficult to remember for dyslexic pupils because of a poor working memory. Weak number concepts and a lack of flexibility hinder multi-path reasoning and learners may become confused or feel overburdened. Some see too many methods to learn and remember. It is important to concentrate on strategies that can be generalised, such as partitioning, rather than 'one off' methods, as these skills can then be more widely used across a range of calculations.

- *may experience counting difficulties that will lead to subtraction errors.*

Teaching 'counting up' is helpful, e.g. $9 - 7 = \square$; $7 + \square = 9$. Many dyslexic pupils gain valuable learning support from the triad method of recording number facts.



Dyslexic learners also benefit from learning to bridge-up-through-ten to work out calculations such as $13 - 8$.

- *find that mental arithmetic may overstretch short-term and working memory.*

Through careful differentiated questioning, support can be built in to overcome this difficulty. For example, when adding 9 as + '10 - 1', the question could be asked in a structured way using the two steps. A key question may act as a prompt, e.g. 'Have you remembered to adjust the answer?'. Encourage learners to use jottings to support mental calculations.

- *have problems recording calculations on paper.*

Learners who have performed well in mental mathematics may fail to cope with written methods of calculations. This is due to the increased load on short-term memory of having to remember a more formal written procedure, plus difficulties in writing the calculation. Mental calculations often favour working with the most significant digit first. It may be useful for some to continue this approach with written calculations.

ADDITION	768	SUBTRACTION	716
	+166		-428
add 100	868	subtract 400	316
add 60	928	subtract 20	296
add 6	934	subtract 8	288

Working with base ten materials should support the introduction of written calculations, as these can illustrate the written method. Area, using squared paper, is a good model for multiplication.

- *may have problems using calculators.*

Calculators may help to overcome difficulties and help learners access more mathematics. But a calculator will only facilitate work in some stages of the question and thus not act as a total problem-solver. Also, once a dyslexic learner has selected the appropriate calculation, they may then have difficulty between the stages of reading it on a page and transferring it to a calculator keyboard.



Solving problems

Dyslexic learners:

- *often have significant reading difficulties.*

Reading unusual words, including mathematical vocabulary, is often problematic. Better progress is often made if a significant proportion of the work can be represented as simple images or put in a real context. Mathematical vocabulary should be pre-taught. Encourage learners to refer to difficult names and places by initial letters. These difficulties need to be overcome before dyslexic learners can attempt to decide between choices of mathematical operations to solve a problem.

- *may need more clues to recognise, develop and predict patterns to help them solve problems.*

Word problems are likely to be a source of difficulty. Teach the use of a 'problem-solving frame':

- read the problem;
- identify the key information and write it down or draw pictures;
- decide which calculation is necessary;
- use an appropriate calculation method: mental, written or calculator;
- interpret the answer in the context of the problem.

Pupils may learn how questions are constructed if they invent their own word problems. The use of materials or images to interpret word problems can increase success.

- *may have difficulties in understanding and retaining the meaning of abstract mathematical vocabulary.*

Words such as *difference*, *multiply* and *divide* are often confusing. Abstract terminology should only be used once the relevant conceptual understandings are already in place. In building understanding it is best if appropriate informal or colloquial 'translations' are used alongside the formal vocabulary.

- *may have difficulty deciding which operations to use to solve a word problem, even though they are gifted, intuitive problem-solvers.*

Some learners require further conceptual work to consolidate their understanding of difference, multiplication, or division. Using concrete materials, at all ages, may help. Drawing diagrams may provide useful support in understanding a problem.

- *may visualise and solve certain word problems without reverting to formal operations.*

This is common in problems involving difference and division. Both problem forms may be visualised as 'missing number' questions, but learners may require help in setting up the appropriate number sentence. Asking learners how a calculator would represent the relevant calculation can be helpful.

Dyslexic learners should not be discouraged from using their own special strategies. Some problems are less dependent on number facts and dyslexic learners may have more opportunities to succeed, even though language and sequencing may present difficulties.

- *may be unsettled by the insecurity of estimation.*
Estimation requires risk-taking and insecure learners avoid risk. Visual models may help pupils see 'closeness'.

Measures, shape and space

Dyslexic learners:

- *find the sequencing of time difficult.*
Sequences of days of the week or months of the year are not easy to learn, and the introduction of simple clock time may also be a problem.

The language of time is potentially confusing, with deceptively simple changes such as saying *7.10* as *ten past seven* (reverse order) creating problems. Using a clock face with pupils moving the hands and specifically relating the language to the image may help. The introduction of digital representations may be supported, in the first instance, by a set of personal sequencing cards.
- *may confuse left and right, hindering work on position, direction and movement.*
Left and right are difficult to anchor to a fixed image. Learners need to spend time involved in physical activities using direction cards and possibly learning a simple mnemonic to help remember left and right: e.g. 'write with my right hand and the one that is left is my left'.

Clockwise and anti-clockwise may present similar problems, although they can be anchored to a visual image. ICT equipment, including the use of programmable toys, may help.
- *may have problems with the range of vocabulary related to measures, shape and space.*
Similar-sounding words such as *triangle* and *rectangle*, *cube* and *cuboid*, may cause confusion both in understanding and learning the properties of these shapes.

Spelling may also pose a difficulty. 3-D and 2-D shapes and drawings need to be used to ensure over-learning takes place. Difficulties with spatial imagery can cause confusion when children are presented with 2-D representations of 3-D shapes.

- *may have difficulties reading graphs.*

The points on a grid and the x- and y-axes can be confused. A simple mnemonic – ‘along the corridor and up the stairs’ – may help. The introduction of negative co-ordinates often causes disproportionate difficulty because of the change of direction.

- *may find drawing shapes challenging.*

Support such as joining dots or modelling in plasticine adds a multi-sensory approach.

Handling data

Dyslexic learners:

- *may have difficulties reading graphs and charts.*

Reading scales and two-way tables, e.g. mileage, timetables etc, can be difficult. Clearly-labelled diagrams may be interpreted more easily if different colours are used to represent the data recorded.

- *may have problems understanding the different types of averages.*

The teaching and use of the terms *mode*, *median* and *mean* is difficult as they all begin with the same letter. When teaching, it might be useful to use separate coloured index cards with the words and their meanings written on.

e.g. mode – most frequent
median – middle
mean – average
range – 'biggest minus smallest'



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