Dyscalculia

Dyscalculia is a specific difficulty which can sit anywhere on the intelligence scale. It is caused by a difference in a small part of the brain – it is a small part of the brain which is less dense than numerate people. It causes a person to have difficulties in acquiring arithmetical skills such as simple number concepts and having a lack of an intuitive grasp of numerosity, e.g. understanding the 'threeness of three'.

Definitions have been written and examples are below:

- "Dyscalculia is a condition that affects the ability to acquire arithmetical skills. Dyscalculia 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." (DfES 2001).
- "A congenital condition: its effects on the learning of numerical skills can be very profound." (Butterworth).
- "Dysfunction in the reception, comprehension or production of quantitative and spatial information." (Sharma).

The following 'checklists' will give a clue that something is wrong and the pupil is experiencing difficulties which will get in the way of them learning arithmetical skills. This 'checklist' should not be used as a diagnostic tool.

A Checklist for Identifying Dyscalculic Learning Difficulties (taken from the BDA 2012 document):

Language and Memory:

1. Doesn't seem to comprehend the precise meaning of terms used in mathematics.
2. Has difficulty reading mathematical terms.
3. Doesn't remember what the abbreviations for terms mean.
4. Has difficulty comprehending questions or holding the ideas long enough to make sense of the request.

Numbers:

1. Has difficulty linking words and numbers.
2. Doesn't understand the concept of number, i.e. "threeness" and therefore may answer randomly with any number to a question.
3. Has difficulty with sequences.
4. Has difficulty with time e.g. telling the time, concepts of time passing such as yesterday, today, tomorrow.
5. Reverses numbers.
6. Has difficulty transferring from the concrete to abstract ideas.

Work:

1. Work is very messy and the columns do not line up.
2. Methods are not stable and mistakes cannot be explained.
3. May be ok with the tangible but cannot deal with concepts.
4. Lacks confidence and avoids estimating and checking or other systematic ways of validating working methods.
5. Has problem with place value.
6. Has orientation problems e.g. left and right or vertical and horizontal.

Confidence:

1. Does not appear confident even with work which should be quite easy.
2. Finds ways to avoid being in class, being exposed to arithmetical work.
3. Displays stress or withdraws during mathematical lessons.
4. Gets tired very easily when doing mathematical work.
5. Worries about performance, time taken or being slow.

What are the signs of dyscalculia?

(Taken from http://www.dyslexia.uk.net/specific-learning-difficulties/dyscalculia/the-signs-of-dyscalculia/)

Pre-School

- Has trouble learning to count.
- Struggles to connect a number to an object, such as knowing that "3" applies to groups of things like 3 cakes, 3 cars, or 3 friends.
- Struggles to recognise patterns, like smallest to largest or tallest to shortest.

Primary School

- Has difficulty learning and recalling basic number facts such as number bonds, e.g. 6+4=10.
- Still uses fingers to count instead of using more advanced strategies (like mental maths).
- Poor understanding of the signs +, -, x and ÷ or may confuse these mathematical symbols.
- Struggles to recognise that 3+5 is the same as 5+3 or may not be able to solve 3+26-26 without calculating.
- Has trouble with place value, often putting numbers in the wrong column.
- May not understand maths language or be able to devise a plan to solve a maths problem.
- Finds it difficult to understand maths phrases like *greater than* or *less than.*
- Has trouble keeping score in sports or games.
- Has difficulty working out the total cost of items and can run out of money.
- May avoid situations that require understanding numbers, like playing games that involve maths.

Secondary School

- Struggles to understand information on charts and graphs.
- Has trouble finding different approaches to the same maths problem, such as adding the length and width of a rectangle and doubling the answer to solve for the perimeter (rather than adding all the sides).
- Struggles to learn and understand reasoning methods and multi-step calculation procedures.
- Has trouble measuring items like ingredients in a simple recipe or liquids in a bottle.
- Lacks confidence in activities that require understanding speed, distance and directions, and may get lost easily.
- Has trouble applying maths concepts to money, such as calculating the exact change.

Resources to help with identification:

- 'Dyscalculia Assessment' – Babtie and Emerson (ISBN 9781408193716). This book has an observational assessment as well as lots of strategies to support.
- 'The Trouble with Maths' – Steve Chinn (ISBN 9781138187467).
- 'More Trouble with Maths' – Steve Chinn (ISBN 9781138187504). This book has many observational tests and assessments which can be used to identify maths difficulties.
- 'Dyscalculia Screener and Guidance' – GL Assessment. This is a digital assessment.

Some Areas of Difficulty – this is not an exhaustive list but rather food for thought…

If you have a child who you feel may be showing signs of dyscalculia (or any difficulty with maths), the following areas of difficulty should be considered by the teacher.

Number:

Dyscalculic pupils/learners do not have a 'feel' for number. At the most basic level, they do not know the 'threeness of three'. Specific areas can be found in the checklists above.

Possible strategies:

- A list cannot possibly be made here but pupils may benefit from tasks which revisit concepts regularly. It may be best, for specific intervention, to have short activities, possibly in the style of games (anxiety can be reduced), that the pupils work on at least once every day.
- Photocopiable games can be found in the books mentioned in the final section.

Language and Vocabulary:

There are many things to take into consideration when thinking about the language of maths. Language is used to communicate – as teachers, we need to communicate learning to those in our care. The language we use must be clear, succinct and without inconsistencies so that we avoid confusion. However, the language of maths is full of inconsistencies and confusions – maths does appear to have its own language.

Many of the words we use in maths having multiple meanings:

- take away – subtraction or take away food?
- product – the answer to a multiplication question or something we make or can buy?
- minus – subtraction or colder than zero?

Confusions can also be made with vocabulary:

- -teen and –ty. They sound very similar when they are said and if a learner does not have secure place value knowledge, mistakes will be made.
- hundreds and hundredths also sound very similar but mean very different things.
- 'weight' may be said but this means something completely different to 'wait'.
- a table in maths holds data but in school, we sit at tables.

There are many different words which can be used for the same concept or used differently across concepts:

- + - add, more, more than, greater than, plus.
- - - take away, subtract, minus, less than, difference, fewer.
- second – is a unit of time and also ordinal number.

When these words are used in word problems, confusion can arise:

- 'John has two pounds more than Dan. John has ten pounds. How many pounds does Dan have?' If the dyscalculic learner has learnt that 'more' means add, they will think that they need to calculate 10+2=12. But in this problem, the learner will need to subtract because there has to be some level of understanding about what the question actually means, or physically 'looks like'.

A dyscalculic learner can become very overwhelmed by this differing use of vocabulary and will cause many confusions, misconceptions and also anxiety.

Possible strategies:

- Pupils could make their own vocabulary board.
- Be aware of the language you use when working with the pupils.
- When working on word puzzles, pupils could draw a picture of the 'story' so that they are able to visualise what is being asked.

Working Memory:

The working memory is used when information in the short term memory needs to be used in some way. It is used when working things out 'in your head'.

Dyscalculic learners may have difficulties with mental arithmetic. It may be that they are unable to hold the information in their head and then work out what they have to do with it in order to solve the question. Holding this information in their heads can be challenging.

They may also suffer with maths anxiety which will impact on working memory (along with short term memory).

When completing written problems, a lot of information may need to be written onto paper in order for the steps to be recorded and not forgotten. When doing this, there are more opportunities for things to go wrong (such as number/place value reversals, incorrect symbol for calculation etc.) and the arithmetic to be incorrect. Confusion may also arise if the learner loses track of their working out.

Possible strategies:

- Songs. This can be a multi-sensory experience.
- Using key facts to derive facts – teach them the 'easy' facts: 1x, 2x, 5x and 10x. These can then be used to work out everything else.
- Thinking book. The pupil should take ownership of this and include information that they wish to remember. It could include diagrams of how to complete different mathematical strategies.

Time:

Time is a very abstract concept which is full of inconsistencies.

The language used in time can cause confusion:

- hands and face – they are not like our hands and faces.
- seconds – this has many different meanings in the English language, e.g. the second hand, which is actually the third and fastest moving hand on a clock….
- hours and minutes – a dyscalculic learner doesn't have a 'feel' for what these are like in real life. We also use terminology such as 'wait a minute' when we don't actually mean waiting a minute.
- understanding the concept of past and to along with quarters and half past. The question of 'what is o'clock' also presents itself.
- the language we use when reading a digital clock is different to that of an analogue clock, e.g. we may say half past 6 when looking at an analogue clock but then six thirty when reading a digit clock. For some learners, this will be like translating time from a different language.
- this can also be confusing when we see 7.10 on digit clock but say ten past 7.
- when we talk about 'a day', the question of the day with just daylight, the day as a whole (24 hours), the 'working/school day' becomes an issue.
- children and learners also need to understand the term 'clockwise' – if they do not know what clockwise means, then driving around a roundabout can become tricky.
- when we say 'quarter to', a dyscalculic learner may not understand that 'to' is 'to' rather than 'two'.

The maths of time is also very abstract:

- we are taught most maths using a straight number line which is either vertical or horizontal. In time, this number line is circular.
- the numbers on the circular number line can also mean two things – the 5 can be 5 o'clock or 25 past (or if a second hand, which is actually the third hand, is being used it will be 25 seconds).
- base 12 is used (60 seconds in one hour, 12 hours in half a day, 24 hours in whole day) rather than base 10 which is used for everything else such as money.
- we also count up to 12, sometimes 24, and always 60 then start again.
- there is no zero at the beginning of a clock 'number line'.
- when telling the time, we count on from one hour and then when we reach half past, we count to the next hour.

With all of these inconsistencies and confusions, it is a wonder that anybody has learnt to tell the time!

Possible strategies to help with underlying skills:

- Follow a number line in a circular fashion and understand what clockwise means.
- Count in fives.
- Understanding of fractions – quarter and half.
- Getting a 'feel' for time. Make a visual timetable, with the children, of their day.
- Avoid using language such as 'wait a minute'.

What can go wrong? (Taken from Steve Chinn's book The Trouble with Maths)

- Short Term memory.
- Working memory.
- Long term memory.
- Direction.

- Visual.
- Speed of working.
- No attempts.
- Recording.
- Poor recall of basic facts.
- Poor reading skills.
- Sequencing.
- Transfer of skills.
- Order.
- Not checking an answer.
- Organisation.
- Transposals.
- Generalisations and recognising patterns.

This list is included so that teachers are aware of how pupils can be affected by their dyscalculia (and general mathematical difficulties); consideration can then be given as to how these things can be addressed.

Professor Sharma's Six Levels of Mathematical Knowing

In this context, the term 'level' relates to the order that information is presented and then processed and learned. It is important to make use of these levels of knowing for any piece of mathematical work. Think about where the children are and what they need as support – for any piece of learning.

Professor Sharma's six levels of mathematical knowing are:

- Intuitive
- Concrete
- Pictorial
- Abstract
- Application
- Communication

Intuitive:

At this level, any new material introduced is an extension of something the learner already knows.

Concrete:

At this stage, a new piece of information is presented using a concrete model. This is the beginning of using concrete materials to support the learning of the new information and developing an image for learners to refer to.

Pictorial:

The model is then shown as a picture on paper.

Abstract:

The model is turned into the related symbols.

Application:

The learner is able to apply the new information/learnt concept to a situation, such as a word problem.

Communication:

The learner is able to communicate the new, learnt concept to others.

An example of teaching/supporting the learning of the bonds of 10 using Professor Sharma's approach:

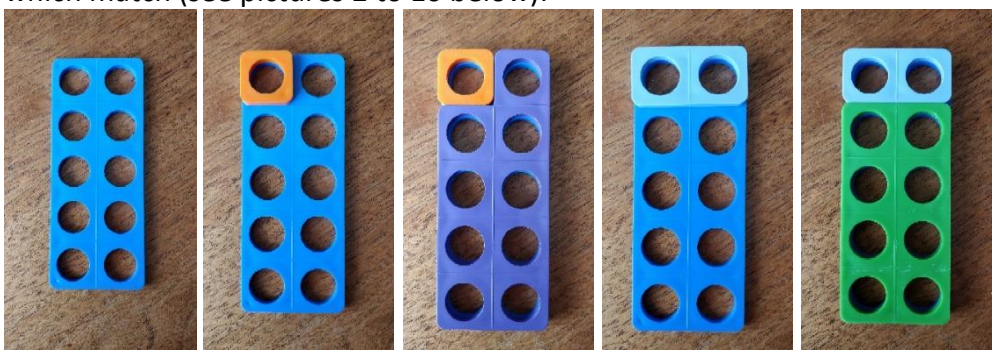
Intuitive:

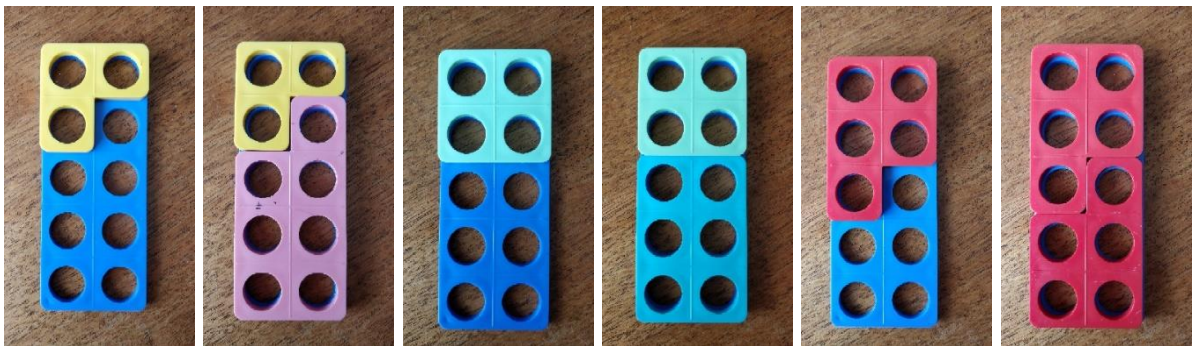
Ask the pupil how many fingers they have on both hands. Hopefully, without counting, they will be able to say 10.

Concrete:

The use of concrete materials at this stage is key to helping the learner develop an effective visual model in their heads which can be called upon at a later date. Numicon could be used as a 'ten-piece'; this can be laid

on a table (see picture 1) and then the learners can experiment by placing more pieces on the top to see which match (see pictures 2 to 10 below):

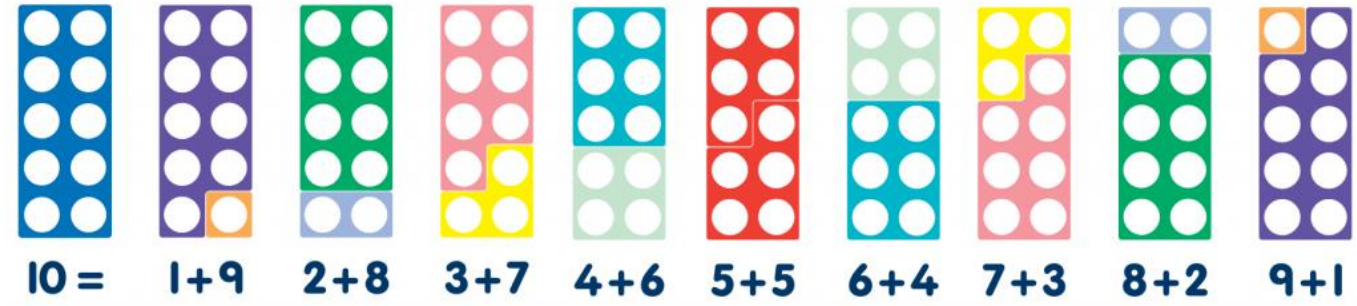




This model can also be used to support subtraction as well as addition because the 'ten-piece' is underneath, an understanding of 'taking away' can be physically seen. This will then help to demonstrate inverse operations and how addition and subtraction are linked.

Pictorial:

The pictorial stage of this could then encompass the use of pictorial images of the Numicon pieces (see picture below). This would then reinforce the concrete level above thus extending the visual model created. These can also be placed into a number line as individual pieces.



Abstract:

The abstract section of this learning would be to see a question such as 4+6 or 8+2 but without any visual models (concrete or pictorial) and the learner would need to solve it. The answers would be recorded using the written digit.

Application:

Next, give the learner a word puzzle such as, "I had 4 apples and bought another 6. How many apples do I have now?"

Communication:

The learner could try to explain number bonds to 10 to a child in another class, possibly a younger student under the guise of teaching them to do something new. The original learner may want to make use of the concrete and pictorial stages to help them.

Tips

- Take Professor Sharma's Levels of Mathematical Knowing into consideration. Do not move through the steps too quickly. Make use of other steps to aid understanding.
- Concrete manipulatives are key AT ALL LEVELS (including Secondary).
- Observe the pupil working. Take note of how they approach tasks. Where is it going wrong for them? This is where they need the support.
- Intervention should be little and often, revisiting constantly.
- Reduce maths anxiety.
- Give the pupils plenty of opportunities to communicate their learning.
- Break tasks down into manageable chunks to reduce the load on working memory.
- Keep learning multi-sensory.
- For exam questions, teach the children to look at the amount of marks given. This will give a clue as to how much information is required in the answer.

Useful websites:

- http://www.dyslexia.uk.net/specific-learning-difficulties/dyscalculia/the-signs-of-dyscalculia/
- http://www.stevechinn.co.uk/articles.html
- http://www.ronitbird.com/ - lots of free resources.

Useful books and resources:

- The Dyscalculia Toolkit – Ronit Bird (ISBN 978-1473974265).
- Overcoming Difficulties with Number – Ronit Bird (ISBN 978-1848607118).
- The Dyscalculia Resource Book – Ronit Bird (ISBN 978-1473975002) – photocopiable games.
- Dyslexia, Dyscalculia and Mathematics – Anne Henderson (ISBN 978-0415683111).
- Dyscalculia Assessment – Babtie and Emerson (ISBN 9781408193716). This book has an observational assessment as well as lots of strategies to support.
- The Trouble with Maths – Steve Chinn (ISBN 9781138187467).
- More Trouble with Maths – Steve Chinn (ISBN 9781138187504). This book has many observational tests and assessments which can be used to identify maths difficulties.
- Dyscalculia Guidance – Brian Butterworth and Dorian Yeo (ISBN 978-0708711521.
- Dynamo Maths - https://dynamomaths.co.uk/ - this is a paid for resource.