Cognus

No Limits on Learning

Educational Psychology Service

Supporting Maths Difficulties

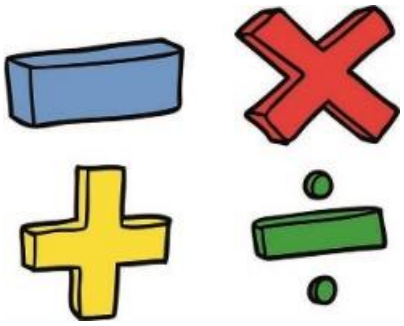
Guidance Document for Schools

Developed by

Cognus Educational Psychology Service

Welcome to the first edition of Sutton's maths guidance document created in July 2023. This guidance has been developed by Cognus Educational Psychology Service in conjunction with schools to provide information and advice to schools in Sutton for supporting children and young people who may be presenting with maths difficulties.

Contents



Importance of maths

Having a strong foundation in mathematics enables pupils to achieve good GCSE results when they reach that stage but is also a factor in opening doors towards quality job opportunities, apprenticeships, and higher education. However, the significance of maths goes beyond these academic and career pursuits; it plays a fundamental role in our daily lives. Basic mathematical skills are essential for everyday activities, including shopping, comprehending special offers and discounts, managing time and schedules, dealing with salaries and taxes, handling bills, mobile phone contracts understanding interest rates and many more.

It is estimated that 23% of UK adults are functionally innumerate (Geary, 2011). Poor numeracy skills are associated with poor individual outcomes in terms of work, pay, housing and health. Poor outcomes also appear to be linked to other forms of disadvantages. In 2018, just 66% of disadvantaged children achieved at least the expected level of development for number at the end of the Early Years Foundation Stage compared to 82% of their peers.

Supporting Maths Difficulties

This document has been created by Cognus Educational Psychology Service to provide guidance to schools around supporting pupils who are presenting with maths difficulties. It aims to introduce approaches to assessing difficulties as well as to provide information about factors which may underlie difficulties with maths. Approaches to intervention are also covered for supporting maths difficulties as well as maths anxiety at home and in school. We hope you find this guidance useful but would welcome any feedback that you may have which we can use to update and improve this document for future editions.

If you require further advice or training for your school, please contact your attached educational psychologist.

Part A: Identifying maths difficulties

Key take-away messages

- **It is important to identity maths difficulty early so that timely intervention can be put in place.**
- **One-off assessments are rarely effective – schools should strive for assessment over-time using a range of tools.**

Identification and assessment

It is crucial that we start early and make sure that all young people regardless of their background have access to great maths teaching. Therefore, it is important to identify any potential maths difficulty early, using assessment to ensure that targeted intervention can be put in place in a timely manner.

A 'one-off' assessment is rarely effective, instead best practice involves ongoing assessment of the young person's maths skills, evaluating their response to intervention, and reviewing progress. This usually follows the assess, plan, do, review model.

Figure 1: Review cycles

A variety of methods from different sources should be used to gather information about the young person's strengths and barriers to developing their maths knowledge. This may include:

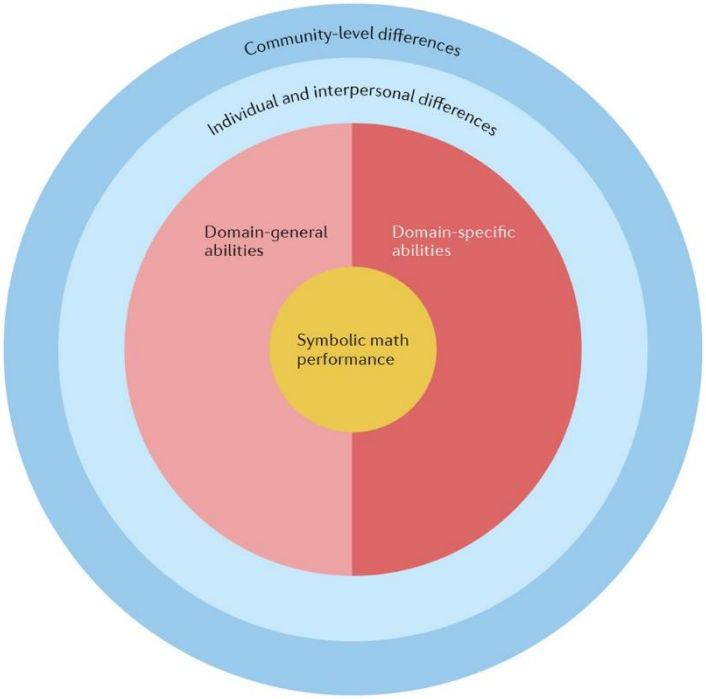
- ✓ Classroom observations.
- ✓ Pupil progress data.
- ✓ Scrutinising workbooks.
- ✓ Screening tools:
  - Pre-key stage 1 and 2 standards – see link.
  - GL assessment screener tool – see link.
  - GL progress tests – see link.
- ✓ Pupil self-evaluation.
- ✓ Pre- and post- measures of an intervention.
- ✓ Discussions with parents/carers, teachers and/or teaching assistants.
- ✓ Diagnostic Assessment e.g. Wave 3 Numeracy Materials, Sandwell Assessments, and MaLT (Mathematical assessment for Learning and Teaching).
- ✓ Screeners for maths anxiety (see link)

If concerns remain after multiple cycles of assess, plan, do and review, then it may be helpful to consult with your attached educational psychologist for further assessment.

Part B : Difficulties that impact on maths

Key take-away messages

- **The environment plays an important role in maths development, both at home and in school.**
- **Maths difficulty can be as a result of a difficulty in domain-general abilities such as executive functioning, non-verbal reasoning, and working memory.**
- **Maths anxiety can play an important role in maths performance.**



Children and young people have a set of individual abilities which are nested in their larger family and school environment, which are further nested in broader communities and culture. The interplay of these factors has a direct impact on symbolic maths performance.

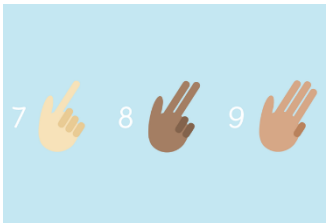
Symbolic maths performance can be broadly explained by the person's ability to learn maths.

We all have a set of abilities – general cognitive skills and skills specific to maths which impact on symbolic math performance as well as interpersonal differences such as motivation and interest.

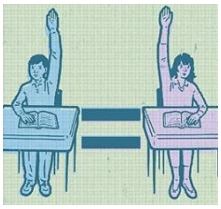
Figure 2: Factors impacting on maths development.

Environmental factors – Community

Studies have examined the differences at a community level in maths development such as languages, cultural attitudes, and beliefs. For example, children exposed to a language with exact number words (e.g. one, two, three) rather than inexact (e.g. a few, a lot) demonstrate stronger performance in maths tasks (Hrastinski & Wilbur, 2016). This is particularly impacted by children who have a hearing impairment as they often lack access to exact number words from birth and therefore perform lower in skills like counting, arithmetic and fractions.



In addition, individuals from communities with stronger gender stereotypes and gender equity tend to have larger gender gaps in symbolic maths performance (Stoet & Geary, 2018).



Environmental factors - Home

Research has highlighted the impact of factors at home on maths development (Berkowitz et al., 2015). In particular, students from families with lower socio-economic status (SES) are more likely to present with a difficulty in maths (Banerjee 2016). A recent study indicated that over half of those eligible for free school meals had not achieved the expected level in maths by age 16. Further research has shown that those of higher SES tend to outperform those from lower SES homes. Given the impact of poor performance in maths on long-term outcomes, it is important that consideration is given to support families to promote maths development.

Alongside SES, Silver and Libertus (2022) identified the following factors within the home that can become a determinant of maths academic success:

- ✓ Exposure to maths-focused language at home (especially counting and labelling sets).
- ✓ Familial attitudes and beliefs about the importance of maths.
- ✓ Engagement with maths activities frequently at a young age.
- ✓ Caregivers' confidence (and reduced anxiety) around maths.
- ✓ Caregivers' education level.

See link to page 16 for ideas and guidance on supporting maths at home.

Environmental factors – School

There has been extensive research on the relationship between instructional principles and mathematical achievement within the classroom and it is clear that teacher competence and quality of teaching methods has a direct impact on the progress of maths for students.

In addition to this, research has shown that teachers' expectations of students' progress impacts on their academic achievement (Denessen et al., 2020). Where teachers have high estimations of students' understanding, the student is more likely to do well and have lower levels of maths anxiety (and vice versa).

Furthermore, some children may have missed significant learning within the classroom due to missed schooling, unidentified hearing or eyesight difficulties in the early years, or attentional difficulties (to name a few). This may mean that some children have gaps within their early foundational maths skills. With a fast-paced curriculum, this could mean that children have gaps that have not been appropriately addressed and therefore subsequently find it difficult to manage the demands of the maths curriculum when increasingly complex concepts are introduced.

See link to page 12-14 for high quality teaching methods within the classroom.

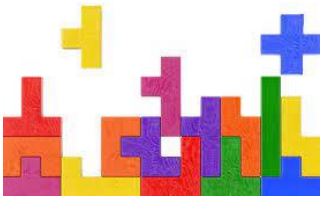
Individual factors – Cognition

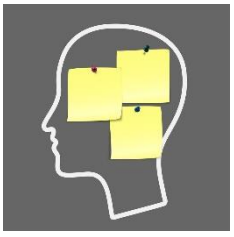
This is the area in which most research has been carried out to date. Cognitive abilities that relate to the development of mathematical skills can be divided into two categories: domain-general and domain-specific abilities relating exclusively to maths (Passolunghi & Lanfranchi, 2012).

Domain general abilities are cognitive skills related to maths but also to performance in other tasks. Performance on many domain-general cognitive tasks is associated with math performance starting in the early childhood years and continuing into adulthood. It is important to note that the exact causality of these links remain unknown, and the evidence tends to be correlational in nature.

These include:

Visual spatial awareness: Difficulties in visual-spatial ability can affect skills in geometry and measurement; setting out written problems and mentally representing number (e.g. on a number line or in a calculation). Spatial skills and number sense are known to share some neural networks in the brain.





Long-term memory: Difficulties with long term memory could result in problems with retrieving mathematical knowledge and facts, impacting on their maths performance overtime.

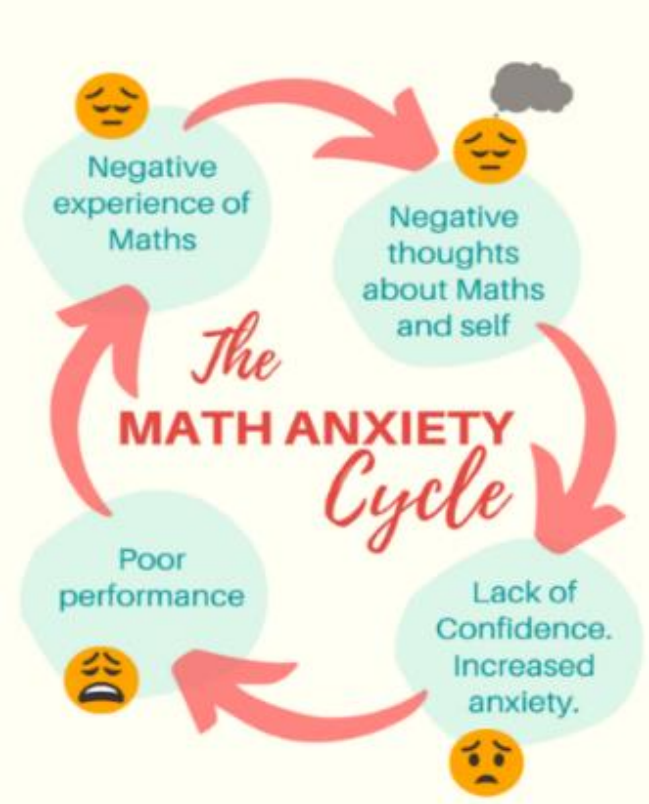
Language: Difficulties in language may affect the following of instructions, understanding of verbally presented information, and comprehending and answering of verbally presented maths problems.

Executive functioning (the inter-related cognitive processes involved in goal-directed thought and action that help you to execute a task) may have an impact on a pupil's capacity to sustain attention, initiate tasks, consider alternative solutions, and plan their task. In particular, working memory and executive functioning seem very important because they coordinate which items of interest receive attention, when, and in what order they are processed. Such functions are essential in complex calculations which require the continuous selection and co-ordination of several processing steps and items in memory – important skills for the development of maths. Overall, stronger executive function is typically associated with better math performance (Fuchs et al., 2005).

Individual factors – Emotions

Emotional factors are also known to impact on maths ability. Maths anxiety is defined as an adverse emotional reaction to maths or to the prospect of doing maths in both academic situations and ordinary life.

This usually happens when a person has ongoing negative experiences associated with maths which are stored in their memory so that when they encounter maths again, they instantly go into a 'fight' or 'flight' mode. This may be triggered by an event such as being asked to say a times-table or completing a maths problem.



Ashcroft and Moore (2009) estimated that 17% of the population have high levels of maths anxiety, indicating this may be more prevalent in the classroom than dyscalculia. Extreme maths anxiety is estimated at between 2-6% in UK secondary schools (Chinn, 2009). Interestingly, children as young as six can develop maths anxiety and it is more common in females. Research suggests that parental maths anxiety has a strong impact on child maths anxiety (Maloney et al., 2015). The challenge is that once a person develops a negative mindset about maths, it can be difficult to shift. Please see the link for further information.

Indicators of potential maths anxiety when faced with a maths task or thinking about maths:

- Feeling panicked or stressed.
- Difficulty concentrating on the task.
- Increased heart rate.
- Sweating and nausea.
- Negative self-talk about maths.
- Avoiding situations which involve maths.

Whilst maths anxiety is not a direct indicator of maths achievement, the associated stress can often impact performance. Students can become too overwhelmed and therefore do not have the mental capacity to complete maths tasks (further exacerbating their maths anxiety). Some often avoid maths tasks due to their levels of anxiety which means less opportunity and exposure to maths to learn, improve, and experience success. Therefore, secondary maintenance factors can increase their maths anxiety and lead to reduced maths performance.

See link to page 17 for ideas and guidance on supporting maths anxiety.

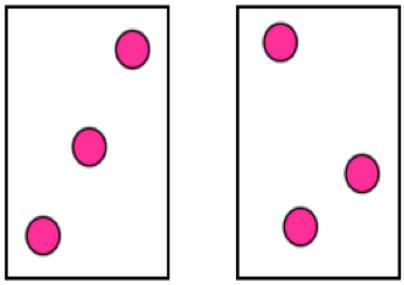
Part C: Specific maths difficulties

Key take-away messages

- **Researchers have established that we are born with a 'start up kit' for number hard wired in the brain.**
- **Dyscalculia is generally recognised as a term for 'mathematics learning disability' – a specific, severe, and enduring difficulty with maths.**

The Maths Brain and Early Development

Are babies born with an innate sense of number?



Piaget argued that while counting may start as early as two years, number sense does not develop until four or five years or later. He noted that younger children tend to fail the 'number conservation test' (emphasising size versus quantity). However more recent research has suggested that very young children can show implicit understanding of quantity. For example, in one study children aged 2years+ chose the line with more sweets on it even when the other line appeared longer.

Experiments tracking eye gaze have also suggested that babies can clearly distinguish between one, two and three objects. Therefore, the current consensus amongst researchers is that there is a 'start up kit' for number hard-wired in the brain from a very early age.

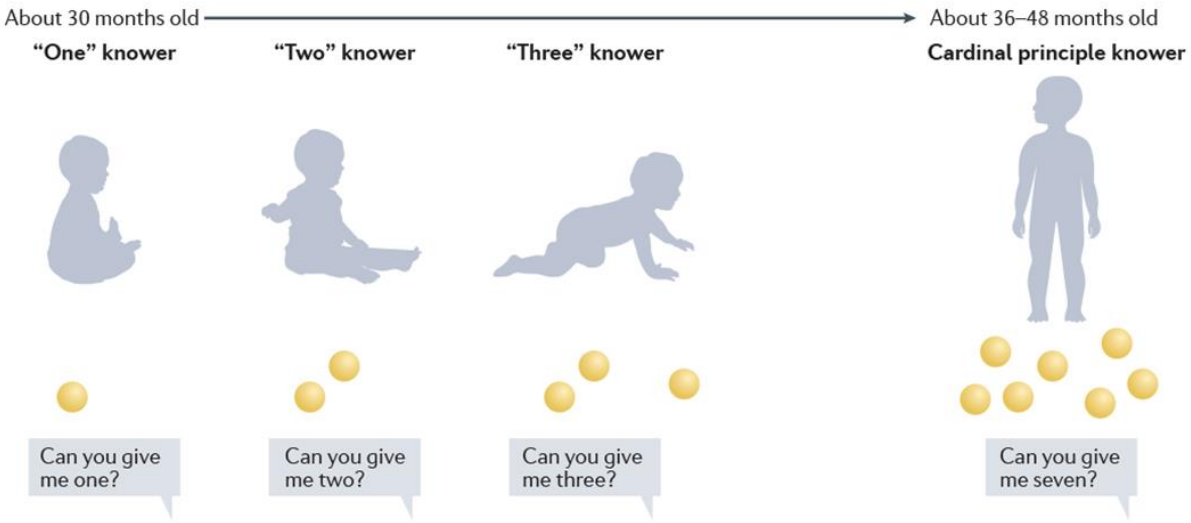


Figure 3: Average timeline of number word acquisition for English speaking children

How does the mathematical brain work?

Brain imaging studies have led to the conclusion that different parts of the brain are specialised for different aspects of maths.

- The left hemisphere is important for language and linked to times tables knowledge. It also plays a key role in carrying out specific calculations.
- The right brain is activated when approximating or estimating answers. This is important for understanding quantity and linked to basic 'number sense'.
- The parietal lobe (inferior right hemisphere) is associated with carrying out maths-based activities such as comparing, adding, and subtracting. This area is also associated with seeing and remembering where objects are, magnitude, quantity, time, and space.

Specific maths difficulty: Dyscalculia

Dyscalculia is the term typically used when learners have been identified as having a persistent learning difficulty specifically impacting their maths ability. It has been argued that this should be seen as a distinct, brain-based difficulty relating to number sense (Butterworth, 2018).

Learners with a dyscalculic profile show difficulty with:

Number sense (intuitive understanding)	Ordering and spotting patterns	Subitising (knowing how many items in a set)	Symbolic and non-symbolic magnitude

Dyscalculia relates to severe maths difficulties which are not explained by age, level of education, teaching or experience. It can occur singly but may co-occur with other specific learning difficulties, developmental difficulties, or maths anxiety. While it is argued that between 5-8% have an enduring maths difficulty, researchers have emphasised the need for more research in this area, noting there is little compared with other areas of learning difficulty such as dyslexia. It is also important to note that amongst those with severe maths difficulty, individuals may still vary in terms of their exact profile of strengths and weaknesses (Chin, S. 2014).

Dyscalculia is listed in the SEND Code of Practice (January 2015: 6.30 and 6.31) as an example of a Specific Learning Difficulty which may require special educational provision but is not a recognizable medical condition. Definitions can be found via the following:

- https://www.dyscalculia.org/dyscalculia/what-s-dyscalculia
- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/926052/specific-learning-difficulties-spld-cst-report.pdf
- https://www.bdadyslexia.org.uk/dyscalculia

Specific maths difficulty – Early signs

Deficits in number sense and subitising are evident by year 1 and typically persist in the same children throughout primary, even where high quality teaching and intervention is in place. It is important to note that difficulties with number sense will be a barrier to acquiring basic arithmetic skills during the Early Years and Key Stage One, providing an early indication of possible longer-term difficulties (Desoete, 2015). Early difficulties with cardinal number (understanding that number reflects quantity) correlates strongly with maths difficulties during adolescence.

Difficulties associated with dyscalculia:

- ✓ Number sense or numerosity (intuitive sense of number)
- ✓ Subitising (ability to recognise quickly and without counting, small sets of items)
- ✓ Quantity discrimination (selecting the larger of two numbers)
- ✓ Estimation (approximate number system)
- ✓ Number and symbol recognition which relates to understanding the written code (encoding and decoding)
- ✓ One to one correspondence (each item is counted once)
- ✓ Cardinality (that the final word in a count indicates the number of items in a set, a sense of quantity)
- ✓ Ordinality (understanding that numbers are in a regular space and stable order).

Specific maths difficulty - Later signs

These signs may be evident in children from KS2 – KS3 depending on severity.

- ✓ *Counting:* learning the sequence of counting words, but may have difficulty navigating back and forth, especially in twos and threes.
- ✓ *Calculations:* learning and recalling number facts difficult. They often lack confidence even when they produce the correct answer. They also fail to use rules and procedures to build on known facts. For example, they may know that 5+3=8, but not realise that, therefore, 3+5=8 or that 5+4=9.
- ✓ *Numbers with zeros:* difficulty grasping that the words ten, hundred and thousand have the same relationship to each other as the numerals 10, 100 and 1000.
- ✓ *Measures*: difficulty with operations such as handling money or telling the time. They may also have problems with concepts such as speed (miles per hour) or temperature.
- ✓ *Direction/ orientation:* difficulty understanding spatial orientation (including left and right) causing difficulties in following directions or with map reading.

Assessment for specific maths difficulties/dyscalculia

It is acknowledged that the subject and labelling of dyscalculia can be a contentious issue. It is imperative that a label of dyscalculia is not used as a 'key' to access resources. Routes to provision of resources and support are made based on pragmatic decision-making and ensuring equality of access for all, regardless of diagnoses. Therefore, regardless of whether or not a child or young person has been identified as having dyscalculia, if maths difficulties are present, they should have access to the appropriate support.

Assessment for maths difficulties should be initially carried out at school following the guidance on page 4. For understanding of more complex or severe maths difficulties, specialist advice may be sought from an Educational Psychologist or professional with qualifications in assessment of Specific Learning Difficulties. When considering dyscalculia, the following working definition is often used:

> *'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.'*
>
> *(The National Numeracy Strategy: DfES, 2001).*

There is no single 'dyscalculia assessment' or cut-off point that is indicative of dyscalculia, and a variety of tools can be used to ascertain whether a pupil's learning needs could be described as dyscalculia. It is important to always consider how the child/young person has responded to well-founded interventions that have been implemented. For some pupils, the label may serve a powerful psychological function and be experienced as an affirming explanation, providing reassurance to the pupil and the adults around them. For others, the identification of dyscalculia may be detrimental as it leads to the pupil and the adults around them developing a 'fixed' view of their maths ability. These factors should form the basis of whether or not a label of dyscalculia is given.

The following 4 principles apply to dyscalculia and other SpLDs and differentiate them from other mathematics difficulties – see link.

1. Difficulties must be unexpected in relation to age, level of education, level of experience and level of other attainments.
2. Difficulties should be specific and persistent.
3. Difficulties must not be solely caused by other factors such as:
    - Inappropriate teaching or gaps in mathematics education.
    - Social and personal factors which adversely affect attitude/motivation with regard to learning mathematics.
    - Maths anxiety.
    - Incomplete mastery of the language of instruction (e.g. EAL/ESL).
    - General learning difficulties.
4. Difficulties should not arise from another neurological, physical, or mental health condition(s).

Part D: Strategies and interventions

Key take-away messages

- **High quality teaching and learning is imperative for maths development for all.**
- **Ongoing professional development supports staff to feel equipped to deliver best practice.**
- **There are a range of evidence-based interventions to support maths development for those with increased difficulty; this should supplement high quality teaching.**
- **It is important to ensure good home-school liaison to encourage maths practice at home.**
- **Support for maths anxiety is just as important.**

It is important that potential maths difficulties are identified as soon as possible, as early identification and intervention for numeracy difficulties have been shown to be more effective early in a child's education than interventions for older children. Schools should aim to follow the graduated response when planning the provision for students; this is the notion that the young person receives the least support first, and if problems persist as part of the review cycles, the student begins to receive more targeted and specialist support.

Figure 4: Graduated response

Quality first teaching recommendations

It is important that all pupils are supported by **high quality teaching and learning strategies** to promote their development across the curriculum. High quality teaching is the first step when a pupil is not making expected progress and the vast majority of children and young people will have their needs met through this. In order to ensure high quality maths teaching across a school, it is important that senior leaders **promote a whole school ethos** that recognises and promotes individual differences, and inclusion of pupils with SEN. Some children will need intervention to support their maths development, although it is imperative that maths intervention is delivered alongside universal support to promote inclusion and wider learning experiences. To ensure that teachers feel confident in applying high quality principles for supporting maths, **regular professional development is recommended** alongside implementation support. It is also advised that certain members of staff have training to develop expertise in maths.

Maths mastery is an approach reflected within the government educational reforms in 2014 and endorsed by the Department for Education and Ofsted. This approach stems from high performing Asian nations such as Singapore. The concept of maths mastery is that students develop their mathematical fluency without resorting to rote learning. Within the approach, the whole class moves through the content at the same pace to ensure all students have a secure understanding of the concept. This inclusive approach aims to build self-confident learners. Differentiation is achieved through depth of the topic, rather than acceleration (Drury, 2018).

The education endowment foundation has produced a guidance report to offer five practical recommendations to support the learning of children aged 3 to 7 (early years and key stage 1) based on the best available international research. This guidance draws largely on a review of the evidence on mathematics teaching conducted by Professor Jeremy Hodgen, Dr Nancy Barclay, Dr Colin Foster, Dr Camilla Gilmore, Dr Rachel Marks, and Dr Victoria Sims.

Develop practitioners understanding

- CPD to raise the quality of practitioner's knowledge of maths.
- Developmental progression highlights how children learn maths and can inform teaching.

Dedicate time and integrate throughout the day

- Dedicate time to focus on maths every day.
- Explore through different contexts (e.g. stories, puzzles, songs, puppets, and rhymes).
- Seize chances to reinforce maths vocabulary.

Use manipulatives and representations

- Ensure children understand the links between manipulatuives and math ideas.
- Ensure there is a clear rationale for their use.
- Use to encourage discussions.
- Encourage use of fingers.

Ensure that teaching builds on what children already know

- Assess what they do and do not know to extend learning for all.
- Consider the right questions to ask to reveal understanding.
- Formative assessment to inform next steps.

Use high quality targeted support

- Children with greatest need supported by most experienced staff.
- Sessions should be brief and regular.
- Explicit connection between intervention and every day learning.
- Use of evidence-based approaches.

Please follow this link for further information from the EEF on these five principles.

KS2 and KS3 recommendations

The educational endowment foundation has also created a guidance report that focuses on the teaching of mathematics in Key Stages 2 and 3. It offers eight practical, evidence-based recommendations that are relevant for all pupils but especially those struggling with maths.

Assessment to build on knowledge and understanding

- Inform the planning of future lessons and the focus of targeted supported.
- Feedback should be clear and specific.
- Knowledge of common misconceptions can be invaluable in planning lessons to address errors.

Manipulatives and representations

- Need to be used puposefully and appropriately to be effective.
- Should be temporary to act as a scaffold that can be removed once independence in achieved.

Teaching strategies for problem-solving

- Select problem solving tasks for which pupils do not have ready-made solutions.
- Teach them to use and compare different approaches, using existing knowledge.

Developing a rich network of math knowledge

- Ensure development of fluent recall of facts.
- Teaching procedures to follow.
- Teach pupils that fractions and decimals extend the number system beyong whole numbers.

Developing independence and motivations

- Developing metacognition - ability to independently plan, monitor and evaluate their thinking and learning.
- Encourage pupils to explain their thinking.
- Encourage enjoyment of maths for all.

Tasks and resources to challenge and support

- Use assessment to inform use of task.
- Use tasks to address misconceptions.
- Provide evamples and non-examples.
- Use stories and problems.
- Technology is not a silver bullet.

Structured interventions

- Guided by pupil assessment
- High quality implementation is key.
- Ensure pupils understand links between intervention and class learning.
- Intervention needs to motivate.
- Avoid intervention fatigue.

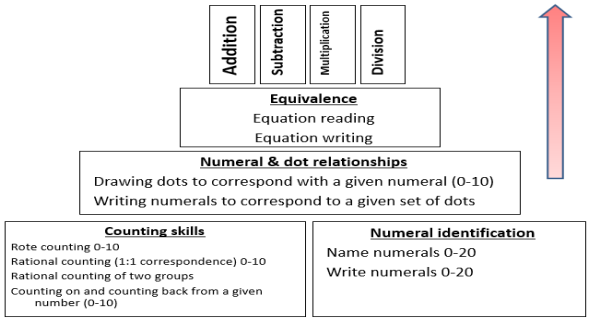
Successful transition between primary and secondary

- Pattern of dip in math attainment from Y6 to Y7.
- In Y7, quickly attain an understanding of strengths and weaknesses.
- Consideration of grouping.
- Be responsive to need and provide structured intervention early.

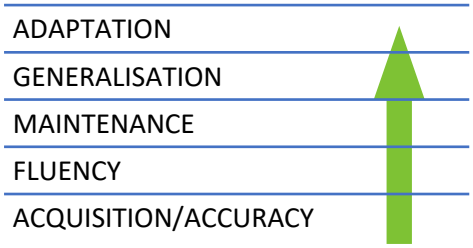
Please follow this link for further information from the EEF regarding these principles.

Research has also highlighted that teaching of maths in the classroom and within interventions is most effective when it includes the following.

Prioritising learning by ensuring one new skill is taught at a time, taught in hierarchical sequence (starting with the most basic prerequisite skills first).

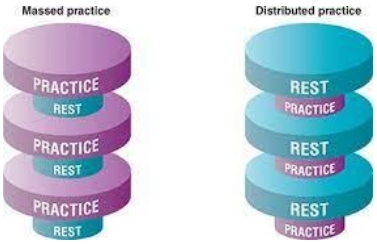


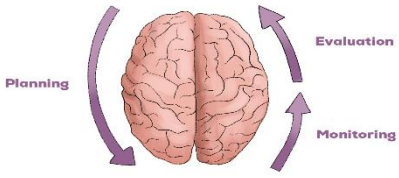
Interleaving: Taught material is interleaved with new learning for practice and consolidation. Research highlights that this precision monitoring is important for maths development, especially for those experiencing difficulty (Rohrer, 2012).



Generalisation of skills: The hierarchy of learning (Haring et al., 1978) describes how we all acquire skills by progressing through five stages (as shown in the diagram). Research highlights the importance of teaching maths to the point of generalisation before moving on to new topics.

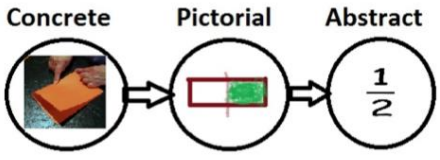
Distributed practice is a learning strategy where practice of a skill is broken into a number of short and frequent sessions over a longer period of time. Research highlights the importance of teaching through distributed practice for long term retention of maths (Dunlosky et al., 2013).





Meta-cognition: Ensuring students are fully informed about the purpose of interventions, their achievements, rate of progress, their own strengths, challenges, and compensatory strategies (Izzati & Mahmudi, 2019; Karaali 2015).

Concrete, Pictorial, Abstract (CPA) by Jerome Bruner is a core feature of supporting CYP with numeracy difficulties, often complimented with the Singapore maths mastery approach (Salingay & Tan, 2018).



Peer-assisted learning has shown to be conducive to reducing maths anxiety and encouraging risk-taking, which is likely to promote achievement in maths (Tsuei, 2012; Holmes & Hwang, 2016).

Retrieval practice by actively recalling information to strengthen memory, contrasted by passive study techniques. This can include quizzes, practice questions, and group discussions (Lyle et al., 2020).

Evidence-based interventions

The SEN Code of Practice (2014) emphasises the need for early identification and for the use of well-founded interventions.

Anne Dowker's publication 'What Works for Children with Mathematical Difficulties' highlighted the following evidenced based maths interventions and approaches:

- ✓ Training in Metacognition – see link.
- ✓ Using Derived Fact Strategies – see link.
- ✓ Mathematics Recovery – see link.

Evidence-based maths interventions include:

- ✓ Accelerated Math – see link.
- ✓ FASTT Math - see link.
- ✓ Catch-Up Numeracy – see link.
- ✓ Numicon – see link.
- ✓ Numbers Count – see link.
- ✓ Rapid Maths – see link.

Interventions based on evidence-based principles without further research include:

- ✓ Plus 1 and Power of 2.
- ✓ This is 5, this is 10, this is 20.

Early numeracy approaches aim to develop number skills and improve young children's knowledge and understanding of early mathematical concepts. Activities in this area might be structured through programmes designed to develop children's'number sense' or using mathematical games including computer games or play activities involving counting or using other mathematical language.

It is particularly important to teach the full breadth of the mathematics curriculum. Where numeracy was focused solely on number operations or on maths as a supplementary activity, impacts were lower. Targeted early numeracy approaches may help children from disadvantaged backgrounds to catch up with their peers by the beginning of formal schooling. Professional development may be particularly important in teaching early numeracy.

Important principles for intervention

- ✓ Interventions do not need to be time-consuming or intensive to be effective.
- ✓ Interventions should take place at an early stage to reduce the likelihood of pupils developing 'mathematics anxiety' which can inhibit further progress.
- ✓ It is important to present materials in a variety of contexts and a variety of sensory modalities and encourage children to make links.
- ✓ Peer tuition and group collaboration can be effective, but unlikely to be a complete substitute for adult intervention, particularly for those with more severe needs.
- ✓ Difficulties with arithmetic are highly appropriate for intervention.
- ✓ Training in formal operations (the manipulation of symbols and abstractions) can positively impact on the mathematical development of older children and adolescents.
- ✓ Training in meta-cognitive skills has been shown to be effective in some cases, but more research is needed on exactly which aspects of meta-cognition are important.
- ✓ There is limited evidence in primary schools and even less in secondary schools that maths ICT programmes are effective.
- ✓ There is no evidence for any one program being the best; it is likely that different programs suitable for different levels of need.
- ✓ Assessment of a child's specific strengths and weaknesses should be the main determining factor in the type of intervention that they receive.

Home-school liaison

Robust evidence strongly suggests that the development of mathematical understanding is linked to experiences, opportunities, and attitudes within the home (Silver & Libertus, 2022). It is argued that parental maths anxiety strongly influences children's maths anxiety Maloney et al., 2015). It is therefore important to promote parental maths confidence through workshops and signposting to resources.

In addition, research shows that embedding maths at home during every-day activities is more effective in developing number abilities than activities such as workbooks (Metzger et al., 2019). Interestingly, the amount and nature of number talk that parents engage in with their children is robustly related to a child's cardinal number knowledge (e.g. knowing that the word 'three' refers to a set of three entities). Therefore, it is important to promote maths at home and encourage families to integrate maths in a fun, accessible, and practical way.

Example activities at home to promote maths include:

- ✓ Encourage children to use money when shopping.
- ✓ Ask children to estimate the cost of buying items such as milk or bread.
- ✓ Measure ingredients when cooking.
- ✓ Talk about different ways of measuring e.g. filling the bath and estimating how many litres of water in the bath.
- ✓ Sing counting songs and rhymes, and chant times tables.
- ✓ Talk about number in everyday life, e.g. when driving look at road signs, in restaurants look at the menu, names of solid shapes e.g. cube, cone, sphere.
- ✓ Try to encourage the use of mathematical language such as *more, less, greater, smaller, lighter, heavier.*
- ✓ Becoming familiar with telling the time and being aware of the passage of time e.g. using clocks, timetables, calendars so that children understand the concept of a day, week, month, year. Use TV magazines to look at the times of their favourite programmes.
- ✓ Writing/drawing numbers, playing with shapes through games and activities.
- ✓ Use objects, coins, and counters to help children practically with counting.
- ✓ When watching a sport programme talk about the scoring, league tables etc.
- ✓ Be patient and allow children plenty of 'thinking' time.
- ✓ Most of all, try to make maths fun!

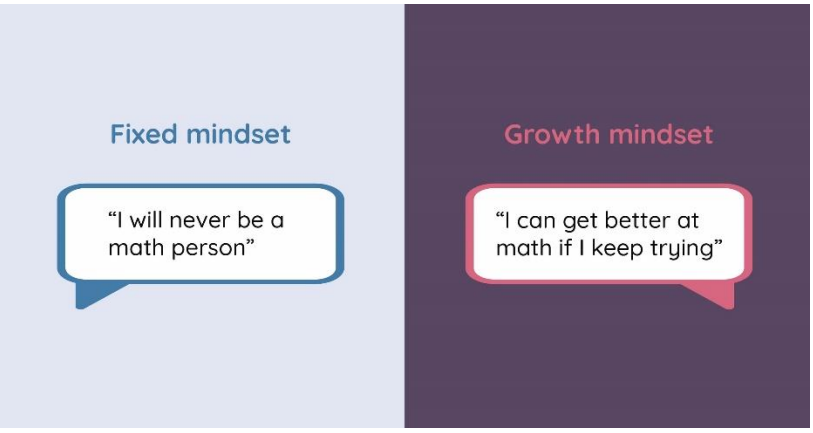
Links for parents

- ✓ https://www.nationalnumeracy.org.uk/challenge/
- ✓ https://mathsnoproblem.com/blog/author/judyhornigold/
- ✓ www.stevechinn.co.uk
- ✓ https://www.mathsexplained.co.uk/
- ✓ https://www.understood.org/en/learning-thinking-differences/child-learningdisabilities/dyscalculia/what-is-dyscalculia
- ✓ Dyscalculia Pocketbook 2015 by Judy Hornigold
- ✓ Maths Learning Difficulties, Dyslexia and Dyscalculia: Second Edition (Dyslexia Essentials) Paperback – Illustrated, 18 Oct. 2018

Overcoming maths anxiety

If you notice that a student is experiencing maths anxiety, it is important to put steps in place in a timely manner to reduce their worries before anxiety becomes entrenched. The following provides a list of suggestions that can be tried in school and at home. Further information can be found on this link and schools can contact their attached educational psychologist for further information if concerns remain.

- ✓ Recognising the emotion and validating and normalising their experience.
- ✓ Break new teaching moments down into their smallest components so that students can continue to have small wins on their way to experience challenge.
- ✓ Create standard ways of explaining concepts and definitions so that children can learn them by heart and build confidence in their skills.
- ✓ Provide additional concrete resources (even for secondary aged students) to make things easier and build their confidence.
- ✓ Make maths fun – use of games to increase engagement.
- ✓ Consider maths intervention to support, coach, and nurture an anxious young person with their maths.
- ✓ 10 minutes a day is better than a gruelling 45-minute session on a Sunday afternoon.
- ✓ Be aware of potential maths anxiety in the adults surrounding the student and be mindful of the language used.
- ✓ Growth mindset approaches and affirmations can be helpful. Feedback should be focused on efforts and progress rather than outcomes.
- ✓ Provide time for the child to talk about their anxieties; listen and validate their feelings before moving onto problem-solving.
- ✓ Support the child in feeling able to ask questions when they don't understand; this is crucial for learning within the classroom.
- ✓ Deliver a maths-based anxiety intervention which focusses on using cognitive behavioural approaches. For example, reflecting on their thoughts, feelings, and behaviours as it relates to maths.
- ✓ Mixed ability grouping can reduce anxiety, as grouping students according to their abilities can reinforce a negative perception of math and limits exposure to the curriculum.



First steps

We have generated five key recommended steps we suggest taking as a school to review and improve maths. Please contact your attached educational psychologist if you require further guidance.

1. Parental workshop to increase confidence at home to engage in maths and reduce maths anxiety.

2. Staff audit of teaching staffs' confidence and competence of maths and consideration of further professional development where appropriate.

3. Exploration of the maths curriculum within the early years, identifying children demonstrating difficulty in their core maths skills.

4. Identification of maths anxiety in young people and tailored support in place at an early stage.

5. Review of the maths provision to ensure interventions are evidence-based, there is high fidelity, and impact is shown.

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