A DEVON APPROACH TO UNDERSTANDING CHILDREN AND YOUNG PEOPLE WITH MATHEMATICAL DIFFICULTIES

(INCLUDING GUIDANCE ON THE USE OF THE TERM DYSCALCULIA)

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KEY POINTS FROM THE DOCUMENT

Devon Local Authority takes the view, based on current published research, that:

- **Mathematics is not a single, unitary ability at which children are either good or bad, but is rather made up of a range of interacting component skills.**

- **A psychological model which recognises the plasticity of the brain throughout life and the importance of wider, interacting environmental factors is helpful in promoting change.**

- **There is no one reliable test of mathematical difficulties. Rather, assessment should take place over time and involve careful evaluation of the pupil's responses to teaching and targeted interventions.**

- **It is more helpful to focus on the early identification of a child's individual strengths and difficulties with maths and then to find the most appropriate way to provide support than it is to seek to label these difficulties.**

- **Educational settings have a responsibility to identify specific strengths and weaknesses of individual children or young people and investigate particular misconceptions and incorrect strategies they may have. Interventions should be targeted toward an individual child's or young person's particular difficulties.**

- **Strategies to address mathematical difficulties are discussed further in the companion document, "A Devon Approach to Supporting Children and Young People with Mathematical Difficulties"**

1 INTRODUCTION

The purpose of this guidance is to outline Devon Local Authority's approach to meeting the needs of children and young people with severe and persistent mathematical difficulties. It provides clarity on the use of the term 'dyscalculia' and aims to support schools in:

- the early identification and assessment of children experiencing mathematical difficulties
- understanding the factors affecting mathematical development
- supporting children's mathematical learning
- accessing additional support and advice
- understanding their responsibilities in meeting the needs of these children.

This document draws on current research into mathematical difficulties and in particular guidance and summaries of research outlined in Dr Ann Dowker's 'What Works for Children with Mathematical Difficulties' (2009).

A companion document entitled "A Devon Approach to Supporting Children with Mathematical Difficulties" is scheduled for publication in Summer 2016 and provides a range of practical interventions and approaches as well as an overview of further training available.

PERSPECTIVES ON MATHEMATICAL DIFFICULTIES

1.1 Mathematical skills are complex and many of them do not develop naturally. Consequently many of these skills need to be taught and children need to learn and to practise in order to develop them.

1.2 Parents/carers, as well as teachers and other staff, play a vital role in helping their child to master the skills involved in mathematics.

1.3 If a child does not make progress with the development of mathematical skills in school, the teaching and support the child experiences should be reviewed and possibly modified.

1.4 As with any area of learning we recognise there are links between mathematical difficulties and low self-esteem, but most notably research points to the relationship between early mathematical difficulties and later adult trajectories e.g. low income and poor mental health. Effective support in overcoming the barriers to achievement presented by mathematical difficulties are seen as important in securing children's social and emotional adjustment and positive approaches to learning.

1.5 **No two people with mathematical difficulties are the same. It is important to find out what specific strengths and weaknesses an individual child or young person has; and to investigate particular misconceptions and incorrect strategies they may have. Interventions should be targeted toward an individual child's or young person's particular difficulties.**

1.6 **Devon recognises that mathematics is not a single, unitary ability at which children are either good or bad, but is rather made up of a range of interacting component skills.**

2. FACTORS AFFECTING THE DEVELOPMENT OF MATHEMATICAL UNDERSTANDING

2.1 **There are many factors that will influence the development of mathematical understanding and lead to individual differences in achievement. Progress in the development of mathematical understanding will result from a complex interaction between biological, cognitive, emotional and behavioural, and environmental factors.**

2.2 Biological

2.2.1 There is evidence for a genetic basis for mathematical attainment as research has shown that identical twins (who share nearly 100% of their genes) were more similar in their mathematical attainment than non-identical twins (who share about 50% of their genes).

2.2.2 Studies indicate that different areas of the brain are associated with different aspects of maths, e.g. exact and approximate number processing, number words (five), and digits (5). Furthermore, there is evidence for structural differences in certain regions of the brains of children with number sense difficulties (see section 4.4.2).

2.3 Cognitive

2.3.1 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 (see 2.3.7). Domain-general abilities are related to performance in maths but also to performance in other academic tasks. These include: short term memory; working memory; executive functioning; processing speed; visual-spatial ability; long term memory; verbal reasoning; non-verbal reasoning; and logical reasoning.

2.3.2 Working memory and executive functioning seem very important because they co-ordinate which items of interest receive attention, when, and in what order they are processed. Such functions are essential in calculations which require the continuous selection and co-ordination of several processing steps and items in memory (see section 4.6.1 and 4.6.2 for more information).

2.3.3 Difficulties with long term memory could result in problems with retrieving mathematical knowledge and facts.

2.3.4 Difficulties in visual-spatial ability can affect: 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.

2.3.5 Language difficulties can affect following instructions, understanding verbally presented information, and answering verbally presented maths problems.

2.3.6 There is some evidence that logical reasoning ability is linked to mathematical attainment. Training in logical reasoning has been found to improve children's performance in maths, which has practical implications for interventions.

2.3.7 Domain specific abilities relate only to mathematical understanding. These include:

- 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)

2.4 Emotional and Behavioural

2.4.1 The following emotional factors are all thought to impact upon engagement with, and subsequent progress in, mathematics:

- Motivational Styles
- Mastery orientation – motivation to succeed, persistence in the face of difficulty, inclination to seek solutions to problems, interest in new opportunities and challenges.
- Self-worth motivation – anxiety about own ability, belief in ability to achieve in difficult tasks but reluctant to try due to risk of failure, motivation to maintain an illusion of competence and therefore avoid threatening self-worth.
- Learned helplessness – lack of belief in own abilities, perceive a lack of control and accept failure as inevitable, no persistence.
- Growth mind-set – beliefs relating to whether intelligence is fixed or fluid.
- Locus of control – beliefs relating to whether achievement is due to internal or external factors.
- Self-efficacy – beliefs about one's ability and competence.
- Enjoyment
- Maths anxiety - It is unclear whether maths anxiety can cause maths difficulties, or vice versa, or whether there is mutual causality.

2.4.2 It is important to note that motivational styles, beliefs and feelings about mathematics are not fixed, and individuals can move between different approaches to learning depending on the task and other environmental factors.

2.5 Environmental

The effects of environmental factors on the development of mathematical understanding have received less research attention than have cognitive factors. However, studies have shown that factors in the environment at school and at home can impact upon learning outcomes.

2.5.1 Home learning environment

Children from higher socio-economic status (SES) homes tend to perform better on tests of mathematical reasoning than children from lower SES homes. There are likely to be many causal and mediating factors which could explain this. However, the wider evidence strongly suggests that the development of mathematical understanding is linked to experiences, opportunities and attitudes within the home.

One factor that has been cited in research is the positive association between access to learning resources within the home, such as books or computers and later development of maths skills.

Another interesting finding is that the amount and the 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). More specifically, it has been found that the act of counting objects (e.g. counting apples as they come out of the shopping bag) and in particular referring to sets of 4-10 objects before the age of four years can make a significant difference to numerical development.

2.5.2 School learning environment

There has been extensive research around the relationship between certain instructional principles and mathematical achievement. One significant factor within this area of study is distributed practise, i.e. 'little and often'. For example, teaching mathematical skills on a little but often basis was significantly more effective in terms of long term retention than massed practice (less often for longer periods). The research also showed great benefits of 'interleaving', that is, the opportunity to rehearse information over time by mixing older learning with the new.

It has been found that where teachers have high estimation and expectation of students' understanding, this has a positive impact on maths achievement and reduces anxiety around maths assessment. Conversely, when teachers underestimated students' understanding, pupils showed lower expectancy for success, lower academic self-concept, and higher test anxiety.

Mixed attainment groups may sometimes be more helpful with regards to self-concept and subsequent achievement. For example, grouping children according to attainment has been found to have mild positive effects for primary school children in the top attainment groups, but negative effects for those in the other groups. In addition, students placed in a high attainment group have reported a decrease in maths self-concept and an increase in anxiety.

There is evidence that collaborative learning in small groups in a supportive learning environment is most conducive to reducing anxiety and encouraging risk taking in maths. This is then likely to promote achievement in maths.

Quality of teaching including classroom management and ethos will also have an impact on mathematical achievement, as it will in any other area of learning. Please see the companion document, “A Devon Approach to Supporting Children with Mathematical Difficulties” (publication expected in Summer 2016).

Table 1: An Interactive Factors Framework for Mathematical Understanding

<table>
<tr>
<td rowspan="3">
Environmental Factors

School Learning Environment

Quality of teaching
Teacher expectations
Instructional practice
Attainment-based grouping

Home Learning Environment

Socio-economic status
Parental education levels
Exposure to maths e.g. number talk
Parental attitude to mathematics
Access to resources

Family Stressors

Relational discord
Financial stress

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Biological Factors

Evidence for a genetic basis
Different areas of the brain are linked to different components of mathematical understanding
Structural differences in certain brain regions associated with dyscalculia

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Cognitive Factors
Domain General:

Working memory and executive functioning
Short term memory
Visual spatial ability
Phonological processing
Processing speed
Attention
Non-verbal reasoning
Verbal ability (e.g. word problems, verbal presentation)
Long term memory
Logical reasoning ability

Domain Specific to Maths:

Number sense (Subitising, Quantity Discrimination, Estimation)
Number and symbol recognition (Encoding and Decoding)
Counting (One to one correspondence, Cardinality, Ordinality)

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Emotional and Behavioural Factors

Motivational Style
Maths self-concept and self-efficacy
Self-theory and Locus of Control
Enjoyment
Maths anxiety

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3 DYSCALCULIA

3.1 It is recognised that there are many definitions of dyscalculia. Dyscalculia is commonly defined in research studies as a severe and persistent difficulty in mathematics that cannot be accounted for by low general cognitive ability, educational deprivation or sensory deficit or by dyslexia or ADHD. However, debate continues around the question as to whether dyscalculia represents a specific neurological difference or simply the extreme end of a spectrum of mathematical understanding. Unresponsiveness to intervention is sometimes included in the definition, but the research literature remains undecided on this point as well, as even quite significant arithmetical difficulties are often responsive to interventions targeted at a pupil's specific strengths and weaknesses. The Department for Education and Skills have defined dyscalculia as "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." (DfES, 2001)

3.2 The above definition carries with it a danger of locating difficulties solely within the child, rather than considering the barriers that exist in the environment that may be hindering development. There is continuing debate about the helpfulness of the term, especially when non-neurological factors have not been taken into consideration. **Devon Local Authority takes the view that a psychological model which recognises the plasticity of the brain throughout life and the importance of wider, interacting environmental factors is more helpful in promoting change.**

3.3 The DfES definition focuses on observed and observable difficulties rather than on possible underlying causes. This reflects continuing debate in the field of mathematical development and the absence of a single agreed causal explanation. For example, Dyscalculia has been variously described as:

- an impairment of number sense associated with structural differences within the brain (see 4.4.2)
- resulting from an impaired connection between magnitude representation and symbolic number systems
- a verbal and/or visual working memory deficit
- an inhibitory or switching deficit

3.4 Dowker (2004) suggests that children who have not reached NC Level 1 by the age of seven, or Level 3 by the age of eleven can be considered to have significant difficulties, though these criteria do not address the underlying causes of these difficulties, which may or may not be due to dyscalculia. The move away from nationally-agreed descriptions of attainment levels may lead to a need for a different set of criteria to be developed in the future.

3.5 An inability to retrieve over-learned single-digit facts (e.g. 3x5) is consistently present across studies and it is thought this may prevent pupils from making the transition from concrete strategies to retrieval strategies. This research may suggest that interventions that derive unknown facts from known facts - whilst helpful for many - may not be beneficial for all learners.

3.6 The question as to whether dyscalculia represents a domain-specific or domain-general difficulty (affecting only specific areas of mathematical development or a wider range of skills across different subjects) has yet to be fully resolved.

3.7 Based on the above evidence, Devon Local Authority takes the view that:

- there is some research evidence pointing to a neurological difference associated with mathematical difficulties that cannot be accounted for in terms of other factors
- there is, however, no single reliable test for dyscalculia
- there is no one particular profile of cognitive skills that needs to be identified in order to classify a child as having dyscalculia
- **it is more helpful to seek to understand a child's individual strengths and difficulties and to investigate their particular misconceptions and incorrect strategies than it is to seek to label these difficulties**
- such mathematical difficulties may be specific or part of a more general learning difficulty
- co-occurring difficulties may be seen in aspects of language and literacy, motor co-ordination, concentration, impulsivity and poor personal organisation, but these are not by themselves markers of dyscalculia

4 THE DEVELOPMENT OF MATHEMETICAL UNDERSTANDING

4.1 **As the National Strategies document 'What works for pupils with mathematical difficulties?' states, there is by now overwhelming evidence that arithmetic is not a single unitary ability at which people are either 'good' or 'bad'.**

It is recommended that efforts to address mathematical difficulties adopt the principles of individual identification of needs; low distraction and structured environments; fluency and process-based approaches (progressing at the speed of the child); distributed, interleaved practice; errorless learning and attributional change programmes. These terms are discussed further in the companion document.

For a detailed consideration of the development of mathematical understanding, please see Appendix 3.

5 IDENTIFICATION AND ASSESSMENT

5.1 **In Devon we agree that there is no one reliable test of mathematical difficulties. Rather, assessment should take place over time and involve careful evaluation of the pupil's response to teaching and targeted intervention. Although we do not discount the concept of dyscalculia, we believe it is more helpful to focus on the early identification of a difficulty with maths and then to find the most appropriate way to support this difficulty.**

5.2 "There is little evidence at present that children with specific mathematical difficulties are fundamentally different, or need to be taught in different ways, from children whose mathematical difficulties are linked more to other problems. In all cases of mathematical difficulties, children show considerable diversity of strengths and weaknesses within mathematics, and it is arguable that the nature of these specific strengths and weaknesses should be the main determining factor in the types of intervention that they receive" (Dowker, 2009).

5.3 Some difficulties occur more commonly than others. These may warrant particular attention when assessing pupils and include:

- difficulty in retrieving arithmetic facts leading to excessive reliance on counting strategies, whilst peers rely much more on fact retrieval
- word problem solving
- multi-step arithmetic

5.4 Assessment leading to intervention can take place at any time in a child's school career, but ideally should take place relatively early, both because mathematical difficulties can affect performance in other areas of the curriculum, and in order to reduce the risk of children developing negative attitudes and anxiety about mathematics. Assessment should be diagnostic in the sense that it should attempt to capture a profile of individual strengths and difficulties which informs future provision, rather than administer timed measures of performance yielding standardised scores.

5.5 Schools are expected to implement the 2015 Code of Practice for SEND when considering the needs of any child who is experiencing difficulty in accessing any part of the curriculum including maths.

5.6 The 2015 SEND Code's staged approach to identification, assessment and intervention is rooted in sound educational practice – teachers should plan teaching approaches based on assessment, implement those approaches and review the outcomes in terms of progress made by the child. Teachers can call upon a range of advice to help them in this work.

5.7 Where schools need further advice they may request the assistance of professionals from outside the school in a cycle of assessment, planning, intervention and review. Such professionals may include an educational psychologist or maths advisory teacher.

6. RESPONSIBILITIES OF SCHOOLS

6.1 The Children and Families Act (March 2014) aims to reform the way children and young people access Educational, Health and Care services. This lays out changes to the system of identification and support for those with Special Educational Needs, including severe and persistent mathematical difficulties and related Specific Learning Difficulties.

6.2 **In relation to mathematical difficulties, schools should work to promote the underpinning principles of effective Special Educational Needs and Disability (SEND) policy, provision and practice. These focus on:**

- the child's perception of their strengths and difficulties and strategies to help
- working in partnership with parents / carers,
- early identification, intervention and ongoing monitoring
- inclusive education/ equality of opportunity (that is, enabling all children as far as possible to learn together in schools with appropriate support)
- overcoming emotional barriers to mathematics
- multi-agency working
- raising attainment and
- a coherent support framework for school staff

There is an expectation that schools will:

- implement high quality, structured and systematic teaching of early mathematical skills for all pupils.
- identify specific strengths and weaknesses of individual children or young people and investigate particular misconceptions and incorrect strategies they may have. Interventions should be targeted toward an individual child's or young person's particular difficulties.
- provide a tight, structured programme of small group support or individualised support that has an evidence base for pupils who have fallen below expected levels of progress in maths.
- involve support from outside professionals where difficulties persist, such as advisory teachers or Educational Psychologists to assist with assessment and targeted interventions.

Please see companion document "A Devon Approach to Supporting Children with Mathematical Difficulties" (scheduled for publication in Summer 2016).

6.3 Under the new SEND legislation, Local Authorities are required to publish detailed information of the support available in their area. This is known as the 'Local Offer' and provision may vary according to local need (see Appendix 2 for further reading).

6.4 **There are a variety of teaching approaches and support strategies suitable for students identified with mathematical difficulties. Schools should draw on a range of structured and multi-sensory teaching programmes and approaches suited to individual needs.**

6.5 Schools have a duty to make ‘’reasonable adjustments’’ to enable a child with a disability to be educated in their local mainstream school and not to treat such a child less favourably than their peers. This places significant obligations on the Governing Body and head teacher.

6.6 Devon policy on the development of inclusive education reflects national policy and the LA is committed to developing the capacity of schools by helping to improve staff skills and confidence in working with children with diverse needs, including persistent mathematical difficulties.

6.7 Schools are expected to implement the 2015 Code of Practice for SEN when considering the needs of any child who is experiencing difficulty in accessing any part of the curriculum.

6.8 Teachers should plan teaching approaches based on assessment, implement those approaches and review the outcomes in terms of progress made by the child. Teachers can call upon a range of advice to help them in this work (see Sections 8 and 9 and Appendix 2 below).

6.9 Where schools need further advice they may request the assistance of professionals from outside the school in a cycle of planning (sometimes including consultation and/or assessment), intervention and review. Such professionals may include an Educational Psychologist or advisory teacher.

7. STATUTORY RESPONSIBILITIES

7.1 **The LA has the same statutory responsibilities to children experiencing mathematical difficulties, including those of a severe and persistent nature, as it does to all children with special educational needs and disabilities.** The LA uses the 2015 SEND Code of Practice, working, wherever possible, with young people, parent/carers and schools. A large proportion of the SEN budget is delegated to schools in Devon, enabling the needs of the majority of children to be met by schools, using differentiated approaches to curriculum delivery through the Devon Assessment Framework (DAF).

7.2 Details of all of the above procedures are available from the 0-25 Team or the Devon Information, Advice and Support for SEND (see Appendix 2).

7.3 Where a child has a statement of SEN, Educational, Health and Care Plan, or is supported by the DAF process, the school is responsible for ensuring that his/her progress is formally reviewed regularly with parents /carers.

8. THE ROLE OF PRIMARY MATHS ADVISERS

8.1 The Babcock LDP Primary Maths Team support the teaching and learning of mathematics.

8.2 The maths team provides support tailored to meet the needs of groups of schools, individual schools and individuals within schools. Their work focuses on developing conceptual understanding, making connections and exposing the structures within mathematics.

8.3 The advisers work with all those involved in learning and teaching maths at the primary level - children, teachers, teaching assistants, subject leaders, senior leadership teams, head teachers, governors and parents. - and provide training in all aspects of primary maths.

8.4 Babcock LDP Primary Maths team offer training courses for a range of maths interventions which support pupils working below age-related expectations (see companion document and Maths Advisers' Intervention Catalogue).

8.5 Where pupils are not making good progress, an adviser can provide support to identify gaps and misconceptions through detailed diagnostic assessments which can inform a personalised learning programme.

9. THE ROLE OF EDUCATIONAL PSYCHOLOGISTS

Educational Psychologists work to support schools to meet the needs of pupils and young people with a range of mathematical difficulties including those of a severe and persistent nature. Contact details for support services are attached in Appendix 2.

9.1 Educational Psychologists (EPs) have a wide role in supporting schools with their provision for children experiencing mathematical difficulties and in discussing the needs of individual pupils where concerns arise. They will usually only become involved in further individual assessment where children are not making adequate progress (as defined in the SEND Code of practice and supporting LA guidance), and following school intervention.

9.2 Educational Psychologists (EPs) offer staff training around the identification and understanding of mathematical difficulties, as well as training related to specific interventions for those pupils not making age related progress.

9.3 EPs also offer consultation and assessment in order to share a better understanding of individual need as well as work with staff and parents to find helpful ways to support those needs.

9.4 Where a detailed assessment from an Educational Psychologist is called for to gain a deeper understanding of a pupil's needs, the school EP may examine the interaction between the learning opportunities provided and teaching methods employed and explore the cognitive, emotional, social and environmental factors that may be involved.

9.5 Psychologists undertaking detailed assessment will make use of the most recent professional guidelines available to them on appropriate assessment tools as well as up-to-date research relating to development of mathematical skills and the barriers to such development.

9.6 Psychological assessment may:

- use a combination of observation, individual work with the child/young person, and consultation with key adults
- involve the child/young person and parents/carers as essential contributors to the process
- consider the young person's strengths and difficulties
- generate hypotheses that consider the range of issues
- draw, where appropriate, on the views of other professionals
- look at progress over time and in relation to different contexts
- be formative and provide the necessary evidence to inform any required intervention

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APPENDIX 1: FREQUENTLY ASKED QUESTIONS

1. Does the policy suggest that all children with mathematical difficulties are dyscalculic?

No. There are many reasons why children struggle with mathematics, for example not having had access to appropriate teaching, maths anxiety or certain specific cognitive difficulties such as working memory. Mathematical difficulties exist on a continuum. There is no clear or absolute cut off point where a child can be said to be dyscalculic.

There is not one agreed definition nor reliable test for dyscalculia and so rather than focus on whether or not a child can be described as 'dyscalculic' we believe it is more helpful to focus on the early identification of a difficulty with maths and then to find the most appropriate way to support this difficulty.

2. Why do some children experience maths difficulties?

The processes underlying the development of mathematical skills are complex and it is likely that there are a number of different reasons as to why a child experiences mathematical difficulties. Factors that contribute to a difficulty with maths include those related to the environment such as instructional approaches; early exposure to maths (e.g. counting in the home); hereditary factors; and cognitive factors which are general to thinking (such as working memory or processing) or specific to maths (such as general number sense).

3. Are mathematical difficulties hereditary?

Problems with mathematics can sometimes run in families although the interaction between genes and environment is complex. At present it is not possible to 'test' for severe and persistent mathematical difficulties or identify these difficulties from genetic analysis. Placing mathematical difficulties in an educational context shifts the focus onto the teaching and wider educational environment. Certainly it is here that there is the greatest potential for positive change, whatever the child's genetic make-up.

4. Can mathematical difficulties occur across the full range of abilities?

Yes. There is evidence that mathematical difficulties can occur at all levels of attainment, and across all socio-economic demographics and ethnic groups.

5. Is it necessary to involve an educational psychologist in the recognition of mathematical difficulties?

It is not necessary to have an educational psychologist or other specialist to describe a child as having mathematical difficulties, although staff in schools will usually like to discuss the possibility of severe and persistent mathematical difficulties with their link educational psychologist.

6. An independent assessment carried out has concluded that a child has dyscalculia. What are the next steps?

The school should read the report and discuss its contents with parents/carers. It is worth noting that there is no one agreed definition or description of dyscalculia and that professionals working outside the local authority may be using an alternative definition and/or a different assessment framework.

The school should consider any recommendations made in the report and discuss with parents/carers how these may fit with existing support in school, and which of these they feel are appropriate and feasible given the available resources. Parents/carers should be reassured that appropriate support is available in school to support the child, dependent on need, and not dependent on any label.

7. If a child is identified as having mathematical difficulties what support should they be receiving?

Children with severe and persistent mathematical difficulties should receive a graduated response to their needs in line with the SEND Code of Practice. Support should include effective mathematics teaching and intervention; on-going assessment to pinpoint specifically which aspects of mathematics need to be targeted; and emotional support that is sensitive to the frustration often resulting from mathematical difficulties.

8. **What level of mathematical skill can I expect a child with maths difficulties to achieve?**

Pupils with mathematical difficulties may have greater difficulty in learning core number skills. Some individuals may struggle with mathematics for the greater part of their school and adult lives. However, with appropriate learning opportunities, support and encouragement the expectation would be that almost all pupils attain functional mathematical skills before the end of their secondary education.

9. **If a child has been identified as having mathematical difficulties, does this mean that the LA should be asked to put an EHC plan in place?**

No, not for this area of need in isolation. The needs of most pupils with mathematical difficulties can be met within school through differentiation and appropriate programmes of support. Through the DAF process additional support could be considered for any pupil who requires a level of support over and above what the school is able to provide from existing resources. Further advice relating to DAF processes and EHC plans can be obtained from the County 0-25 Team or the Devon Information, Advice, and Support for SEND Service.

10. Should I be using a particular teaching approach specifically for pupils with mathematical difficulties?

No. ‘Mathematical difficulties’ is a broad umbrella term covering a heterogeneous group. Therefore it is important to use assessment to identify an individual’s particular strengths and difficulties in order to inform targeted intervention. Any teaching programme should be based on sound principles of effective mathematics teaching and intervention, and adapted to take account of each child’s individual needs. Further information about effective interventions can be found in the publication ‘What works for Children with Mathematical Difficulties’, by Ann Dowker (2009).

11. What can I do if I am unhappy with the support my child is receiving in school?

Pupils make most progress when schools and parents work in partnership. Request a meeting with the special educational needs co-ordinator (SENCo) or the head teacher at which you can express your concerns and ask questions. The Devon

Information, Advice and Support for SEND Service can provide advice and support with regard to meetings in school (see contact details in Appendix 2).

12. How will a child with mathematical difficulties cope at secondary school?

Transferring to secondary school can be an anxious time for pupils and parents. Most children make this transition without any problems. All Devon secondary schools are expected to aware of the needs of pupils with mathematical difficulties and make provision for them. They will receive records and information about pupils' needs from the feeder primary school. It can be helpful to identify, early on, a contact – perhaps the form tutor or special educational needs co-ordinator - with whom you can discuss your child's needs at the start of the year, and who you can contact if you have any concerns.

13. Is a child with mathematical difficulties eligible for support with exams?

A specific difficulty in maths does not usually qualify a child for additional support in exams. However, if a child has significantly impaired information processing speed, they may qualify for additional time in exams. This concession is not dependent upon the pupil having been given a 'dyscalculic' label. The school SENCo will be able to provide further information and advice.

14. Where can I go for further advice and support?

There are a number of sources of support and information in Devon listed in Appendix 2 of this policy. The SpLD team based at Queen Elizabeth's School, Crediton are **not** able to offer support in the field of mathematical difficulties at this time.

APPENDIX 2: USEFUL CONTACTS

- **Educational Psychology Service:**

  Tel: 01392 287233 michaela.cole@babcockinternational.com
  andrew.eaton2@babcockinternational.com

- **Maths Advisory Service:**

  Tel: 01392 287399 carolyn.wreghitt@babcockinternational.com

- **Special Educational Needs (SEN) Adviser:**

  Tel: 01392 880765 jeanette.savage@babcockinternational.com

- **Devon SEN 0-25 Team**

  Tel: 01392 383000 specialeducation0-25-mailbox@devon.gov.uk

- **Devon Information Advice and Support for SEND:**

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Appendix 3: The Development of Mathematical Understanding

AP3.1 **As the National Strategies document 'What works for pupils with mathematical difficulties?' states, there is by now overwhelming evidence that arithmetic is not a single unitary ability at which people are either 'good' or 'bad'.**

AP3.2 Just as the study of literacy development has identified skills and difficulties at the word, sentence and text level, so it can be helpful to consider numerical knowledge and skill development at the (overlapping) levels of:

- number (or numerical quantification)
- number sentences (or numerical calculations), and
- number texts / word problems (or numerical reasoning).

AP3.3 Studies of mathematical difficulty continue to investigate delayed or disordered development at each of these three levels of number.

AP3.4 Numerical Quantification

Cognitive research identifies three quantification processes:

AP3.4.1 Subitising

Subitising refers to the rapid (from *subitus* meaning 'sudden'), effortless and accurate assessment of 1-4 dots. Current research is investigating the links between subitising, visual tracking and shape recognition (as groups of 1-4 dots always have characteristic spatial relationships). There is some evidence that children with severe and persistent mathematical difficulties have to serially count groups even this small, for example when reading dots on the face of a die.

AP3.4.2 Estimation

The brain activity supporting quick estimation is referred to as the Approximate Number System (ANS). This ability to discriminate between quantities improves from birth to around 9:10 in most adults. Children with severe and persistent mathematical difficulties as well as children diagnosed with ADHD have been found to have poorer discrimination ratios, for example when identifying the larger of two groups of dots.

The Approximate Number System

There is evidence that the ANS is:

- involved in greater/less judgements and aspects of calculation
- present at birth
- found in many non-human species, and therefore likely to be independent of language and symbolic learning
- located in a region of the brain (known as the intraparietal sulcus) whose functions relate to hand-eye co-ordination, visual attention and visuo-spatial working memory. This region has direct links to the executive control areas of the frontal cortex (see 4.6.1).
- operational across sensory modalities e.g. sound, touch etc.
- approximate (or 'noisy').

The ANS is likely to be fundamental to acquiring counting and arithmetic skills in the early years. The link diminishes with age as maths tasks become more abstract, suggesting a growing reliance upon logical reasoning and working memory.

AP3.4.3 Serial Counting

Serial counting involves the slower, more accurate enumeration of more than four objects and represents a move into numerical skills. There is evidence that these skills are associated with the development of later calculation and retrieval skills and that difficulty with serial counting skills is predictive of severe and persistent mathematical difficulties.

Early Counting Skills and Gender

On average, boys are less likely than girls to use counting strategies and counting aids, preferring risky guesses in competitive environments and the use of known facts (despite being less skilled at this than girls in the early years).

AP3.5 Numerical Procedures

There exist a range of skills that support mathematical problem-solving, including some relating specifically to numerical procedures:

- Number naming or reading
- Naming of maths symbols
- Knowledge of decades and units
- Procedural knowledge and skills

A lack of accuracy and fluency in numerical quantification skills is likely to compromise the acquisition of these numerical procedural skills.

A Note on Fluency

This document makes several references to the term 'fluency', which has now become part of the language of the National Curriculum. Within the context of this document, this term is used to describe the effortless call upon facts , procedures and concepts which then frees the mind to devote itself to the things that require thought (Drummond, 1922). This supports Haring's notion that fluency is a prerequisite to mastery, generalisation and adaptation of these skills (Haring, 1978). This process of becoming fluent facilitates what Thurston (1990) terms as mental compression i.e. the process by which an individual really understands a concept to the extent that it can be filed away and recalled quickly and completely when needed. For example, knowing and trusting a procedure for working out a percentage rather than having to revisit a series of steps or ideas.

AP3.6 Numerical Reasoning

The research literature focusses on the closely-related areas of executive functioning and working memory as well as meta-cognitive (or reflective reasoning) skills.

AP3.6.1 Executive Functioning

Executive Functioning is a term used to describe the cognitive abilities needed to intentionally carry out goal-directed activities. They share a need to disengage from the immediate environment.

The three areas of executive functioning commonly associated with learning in studies of mathematical difficulties are:

- Updating - the manipulation and updating of temporary information stored in working memory
- Inhibition - the ability to deliberately inhibit dominant or automatic goal-directed responses
- Shifting - the ability to move backwards and forwards between multiple tasks or mental sets.

It is thought these skills may act as a unitary function promoting maths development in early life, with updating emerging as a separate skill in the early years of education and inhibition and shifting becoming discrete skills later on.

Executive Functioning and Gender

Girls develop executive functioning skills about a year ahead of boys, and rely more heavily on this skill in early maths tasks. This may also explain girls' more accurate assessment of their own abilities, another factor associated with better rates of progress.

There is evidence that these skills support the development of pattern skills, sequence recognition and algebraic skills and the identification of general rules. There is also evidence that accuracy and fluency alone (see 4.5) may cease to be sufficient to ensure progress in maths beyond the level of following mathematical procedures. In this way executive functioning skills are important in helping children to purposefully organise the things that they know in order to solve a problem.

AP3.6.2 Working Memory

Working memory has been defined as holding in mind the information needed to complete a task whilst maintaining attention in the face of competing distractions. This ability is linked to maths achievement, and over-taxing working memory may play a significant role in reducing rates of progress in maths.

Recent research has supported the notion of independent verbal and visuo-spatial working memory skills and has found evidence that harnessing the relatively-stronger of these two can improve the efficacy of interventions. For example, using a visuo-spatial grid has been found to help children with poor verbal working memory skills to retain information. There is also evidence that the ability to resist distraction is the key area of executive control involved in working memory.

Working memory skills have been found to be independent of IQ levels, and are associated with high attainment levels regardless of socio-economic status.

Premature birth is a risk factor predicting poor working memory skills and leading to poorer maths achievement.

Please see companion document "A Devon Approach to Supporting Children with Mathematical Difficulties" (scheduled for publication in Summer 2016).

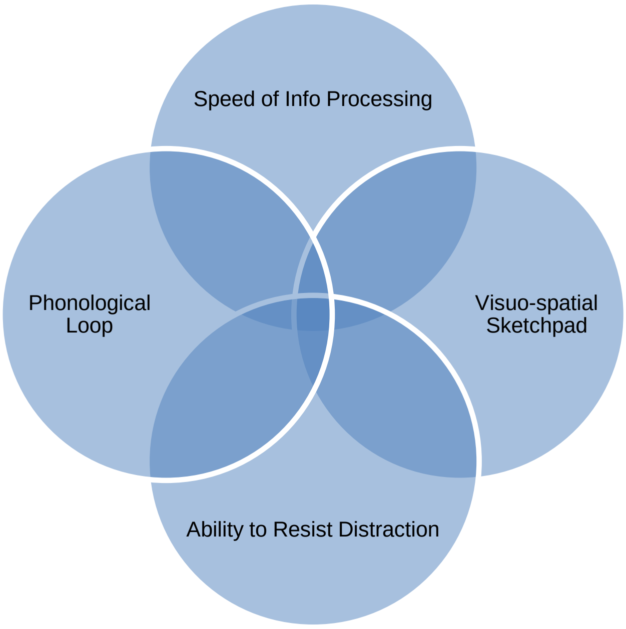

Figure 1: A Model of Working Memory

AP3.6.3 Meta-cognition

Some pupils are better able than others to reflect upon and talk about their own mathematical thinking. The research literature suggests that this ability:

- promotes the linking of mathematical ideas and the ways they relate to one another
- promotes the transition from fluency in maths skills into the generalisation and adaptation of these skills
- helps pupils to make links between previous and current learning.

Lower achieving children benefit from interventions that support meta-cognitive strategies (rather than worked examples) but the modest gains may not justify the additional time needed.

An alternative response may be to offer distributed (little and often) and interleaved (combining previous and new learning) teaching episodes which have been found to promote meta-cognitive skills, rather than cramming / booster classes which promote a reliance on procedural skills. In combination with efforts to shift motivational beliefs, encouraging pupils to attribute success to their own ability and failure to a lack of effort, this may provide a more helpful model for intervention programmes.

AP3.7 Other factors relating to the development of mathematical skills

Dowker (2009) argues that it is not possible to establish a strict hierarchy whereby any one component of mathematical skill invariably precedes another. However, there is evidence that although number domains (counting, place value and number operations) may develop independently, progression through a sequence of stages is necessary ***within*** these domains e.g. Steffe et al, 1983; Fritz, Ehlert and Balzer, 2013.

Haring argues that pupils need to become fluent in newly-acquired mathematical skills before they can generalise and adapt these (Haring et al, 1978). Solity (2003) likewise recommends distributed instructional practices that focus on developing fluency.

Moreover, the recent evidence reviewed above suggests that the area of primary reliance in successfully-developing numerical skills may gradually shift from innate quantification abilities in pre-school children, through the development of numerical skills in the early and early Primary years, to a greater reliance on numerical reasoning skills and executive brain functions through the upper Primary and the Secondary phase (see Figure 2: A Visual Conceptualisation of Typical Mathematical Skill Progression below).

It is recommended that efforts to address mathematical difficulties, therefore, adopt the principles of individual identification of needs; low distraction and structured environments; fluency and process-based approaches (progressing at the speed of the child); distributed, interleaved practice; errorless learning and attributional change programmes. These terms are discussed further in the companion document.

Figure 2: A Visual Conceptualisation of Typical Mathematical Skill Progression