Mathematics Support for Dyslexic Students

Clare Trott
Loughborough University

c.trott@lboro.ac.uk

More information on the Dyscalculia and Dyslexia Interest Group (DDIG) is available at:

http://ddig.lboro.ac.uk

Students with dyslexia are characterised by a "marked inefficiency in their working or short term memory" [1]. This means that they may have problems retaining the meaning of text when reading at speed or fail to recall learned facts. Their written work may be disjointed. Dyslexics may have "inadequate phonological processing skills" [1] which can affect reading, spelling and comprehension. They may have difficulties with motor skills or co-ordination and particular difficulty listening and taking notes simultaneously. Dyslexics can also have visual perceptual problems. This can also affect reading, especially when dealing with large amounts of text.

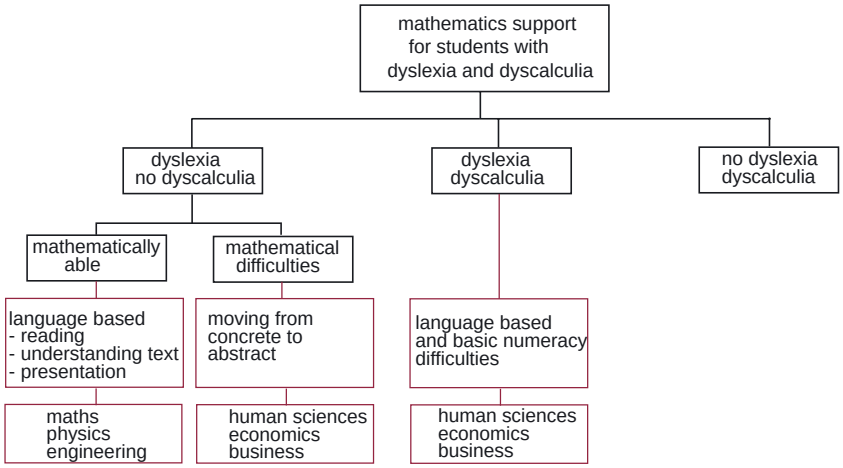
On the other hand, dyscalculia is "the inability to conceptualise numbers, number relationships and the outcomes of numerical operations" [2]. Dyscalculia in adults is described in detail in [3]. These difficulties, in turn, can affect the learning of mathematics in several ways as described below. Most institutions of higher education provide dyslexia support, but this is traditionally language, rather than mathematics, support. In many institutions mathematics support is provided in support centres but it is usually the case that there is no specialist expertise for dealing with students who have dyslexia. A recent development has been the provision of specialist mathematics support specifically for dyslexic and dyscalculic students, bringing together both these areas of support. There has been little or no previous work done in this field although it is clear there is a growing interest.

Dyslexia and mathematics

Dyslexia can affect the learning of mathematics in several ways: dyslexics may have poor arithmetical skills and find that mathematical procedures and sequences of operations are difficult. They may have difficulty recalling the theorems and formulae they need. In multi-step problems, students frequently lose their way or omit sections and fail to hold all the relevant aspects of a problem in mind and combine them to achieve a final solution. They may have problems in sequencing complex instructions, and past/future events. Some students will experience difficulties reading the words that specify the mathematical problem, especially if the problem is embedded in large amounts of text. Dyslexics may be slow at reading, mis-read frequently or not understand what has been read. They often substitute names that begin with the same letter, for example integer/integral, diameter/diagram, classify/calculate, and may have problems remembering and retrieving specialised mathematical vocabulary. Frequent problems occur in associating the word with its symbol or function, for example relating 'integration' to its symbol and knowing what procedure to carry out. There may be visual perception difficulties and reversals, for example 3/E or 2/5 or +/x.

Work is often poorly presented and positioned on the page. Students can make transcription errors when transferring between mediums, for example question paper to computer or calculator, and frequently lose their place. Further copying errors can occur from line to line, for example X+3 becomes X-3. Whilst copying errors are common in many students, the problem appears to arise more frequently amongst dyslexic students. They may have an inadequate documentation of their methods. Slow information processing means that students may have few notes. In a lecture, for example, they may copy down Example 1 and then Example 9, with nothing in between. Dyscalculic students will have difficulty with basic numeracy, in seeing how numbers relate to each other and in the interpretation of data. Overload occurs more frequently, and the student is forced to stop.

It has become clear that dyslexic and dyscalculic students fall, broadly, into three categories. The first category comprises students who are dyslexic but not dyscalculic. The second group consists of students who experience difficulties as a result of both dyslexia and dyscalculia, and the final group are dyscalculic but not dyslexic.



Experience at Loughborough University suggests that the first group is generally the largest, and more students in this group are currently receiving support. This group can be further divided into two sub-groups. The first sub-group could be described as mathematically able and these students tend to choose to study mathematics, physics or engineering, avoiding the subject areas that contain a high language content, since their difficulties are predominantly language based and are entirely as a result of their dyslexia. They may experience difficulty reading and understanding text or inefficiencies in their short-term memory with a resulting inability to retain information. Mathematics plays a central role in their course. The mathematics, for these students, is of a high level. The other sub-group has mathematical difficulties, in addition to the dyslexia based language difficulties. The students who fall into this group would probably never consider studying maths, physics or engineering; instead, they often choose Human Sciences, Social Science, Economics or Business Studies. The level at which they are able to operate mathematically varies considerably, but this sub-group can not be described as dyscalculic, because their difficulties are not with basic numerical skills. They have difficulty in generalising and in moving from concrete numerical examples to more abstract algebra. They may also have difficulty with remembering and retrieving symbolic material. In particular they may experience problems with equations and rearranging formulae, recognition of like terms and understanding basic calculus.

The second group is both dyslexic and dyscalculic. In addition to the problems that dyslexic students face, they will have fundamental difficulties with basic numeracy. This includes not only poor numerical skills, but also an inability to see how numbers relate to each other. Alongside these difficulties, is usually an acute anxiety about mathematics. The dyscalculic student is likely to be studying social or human sciences or business, avoiding subjects that rely heavily on mathematics. However, many of these students are initially unaware of the important role statistics plays in their course.

Experience of the third group of students is, at present, limited. It is more difficult to diagnose dyscalculia in isolation; although it is believed about 4-6% of people are dyscalculic but not dyslexic [3]. Students in this category would again choose to avoid subject areas containing large amounts of mathematics, but may opt for business studies or human sciences. Their difficulties involve basic numerical skills and an impaired sense of number size, which clearly affects the understanding of number concepts.

Facilitating mathematics learning for dyslexics

There are several ways in which to facilitate mathematics learning for dyslexics:

- Break up large sections of text with page breaks and bullet points, using sans serif fonts such as Arial, which are easier for dyslexic students to read.
- Avoid justifying text, because this can make it more difficult to read.
- Use coloured overlays to reduce the glare from black type on white paper, which is often a problem for students with visual perceptual problems.
- Reading from the textbook with the student, especially if directed reading is set. As mentioned earlier, maths books can be particularly difficult to read. It is sometimes helpful to photocopy sections and reorder them. Diagrams, tables and charts often intersperse text and require the reader to move backwards and forwards between pages.
- Break down a multi-step problem into small, manageable steps.

- Use various pieces of specialist equipment to help with specific problems, for example a line reader can be used to highlight a specific line. This can reduce copying errors from line to line. It is a horizontal magnifier that will highlight a single line on a page and the other lines fade into the background. The dyslexic student is able to focus clearly on the specific line of work.

- Use coloured pens to highlight various aspects of a question. For example a triple integration can cause dyslexic students difficulties, as they frequently lose their place and miss out an integral. It helps the student if three colours are used, one for each integral, and the integrals are numbered. Three colours can also be used for quadratic equations, one for each term.

- Colour can further facilitate greater clarity and understanding when using software; for example the cells on a spreadsheet can simply be coloured in different colours to aid visual perceptual problems with the rows and columns.

- Edit down the output tables of statistical analysis, so that the student is able to focus on the relevant sections. This is particularly important in reducing the anxiety levels in dyscalculic students.

- Supplement missing or incomplete notes.

- Provide as many "memory hooks" as possible, such as using large wall posters. For example, making a large wall poster for a student who was having difficulties with inequality signs, and another for a student who had problems distinguishing between differentiation and integration. This is particularly important for students with poor short-term memory.

- Use of card indexes and pocket size "card carrying" cases as an aid to memorisation. One theorem or formula can be put on each card. This is particularly relevant to maths students who have many theorems and formulae that they need to be familiar with or to students of any subject where there are large numbers of formulae to learn.

- Provide flow diagrams or tree diagrams for clarifying procedures. For example, a tree diagram can be used for partial differentiation, using one branch for each derivative. The use of different colours will further clarify the problem. Dyslexic students will often lose their way and omit one or more of the derivatives. This provides a structure for the problem.

- Provide mind map diagrams to help with more extended pieces of work such as projects. These can also employ the use of colour, and can clearly show the various aspects of the project that need to be considered as well as the ways in which they interplay.

- Many dyslexic students are very visual learners. They usually find it helpful to 'see' the functions they are considering. It is helpful to take a function from their tutorial sheet or from their notes and to draw its graph on the calculator or computer screen. The student has an immediate visual image. Try to encourage the students to do this on a regular basis, for themselves.

- Provide a "gallery" of graphs to show various functions, transformations or plots. The student can then refer to this and match their function to one in the "gallery". This is again visual and aids short-term memory.

- Go through the work at the student's own pace. This is particularly important for dyslexic students, as overload can occur frequently and this results in an inability to absorb anything.

- Students will frequently need help with general organisational skills, study skills and time management. Focusing on revision techniques prior to exams is useful. Many dyslexic students struggle to learn and recall information for exams, due to their poor short-term memory.

Progress is often slow and frequent revision is necessary. The same ground may need to be covered many times. However, by providing the student with appropriate strategies and a framework they can relate to, it is possible for the dyslexic or dyscalculic student to grow in confidence, become independent in their learning and, above all, to succeed.

Anyone suspecting that dyslexia or dyscalculia might be hindering the progress of a student they are trying to support should consider:

- employing some of the above suggestions,

- talking to the student, in confidence, about the difficulties dyslexia and dyscalculia can cause in the learning of mathematics,

- referring the student for dyslexia assessment which will lead to the student receiving a needs assessment, extra time for examinations if appropriate, and

possibly, funding from the Disabled Student's Allowance.

Resourcing additional support

Clearly, there are resourcing issues associated with the provision of additional support for dyslexic students which need to be resolved locally. However, for students who are registered as dyslexic it may be possible to recover some costs through the Disabled Student's Allowance administered by their local authority. The university's disability unit will be able to offer advice about this. From time to time there are also Government initiatives associated with widening participation, educating students with disabilities, and also the Disability Discrimination Act Part iv (DDA iv).

Readers with additional suggestions for supporting dyslexic or dyscalculic students are invited to send these to Clare Trott <c.trott@lboro.ac.uk> for incorporation in future editions of this guide and other related publications.

Clare Trott is a mathematics tutor based in the Mathematics Learning Support Centre at Loughborough University. She specialises in helping students with dyslexia and dyscalculia and has been instrumental in the establishment of a Dyscalculia and Dyslexia Interest Group (DDIG) with a website at http://ddig.lboro.ac.uk

The Group comprises both those involved in dyslexia support and those involved in mathematics support. It aims to exchange information and experiences about the mathematical needs of dyslexic and dyscalculic students in Higher Education, to promote awareness of the difficulties experienced and develop appropriate resources. This will include creating guidelines for identifying and working with these students and developing samples of mathematical resource material, appropriate to the needs of students with dyslexia and dyscalculia. DDIG meets on a regular basis, and would also like to establish contacts with others working in the field of mathematics and dyslexia. It is hoped that the web site will become a focal point for the Group's activities and for it to provide information and support and to act as a point of reference for others interested in this area. There are also plans to run conference workshops and to publish papers relating to its work and to promote exemplar case studies.

References

[1] Singleton, C (1999), *Dyslexia in Higher Education: policy, provision and practice*. The National Working Party on Dyslexia in higher Education, University of Hull
[2] Mahesh Sharma, Cambridge College, Cambridge, Massachusetts http://www.dyscalculia.org/BerkshireMath.html
[3] Butterworth, B (1999) *The Mathematical Brain*, MacMillan, ISBN 0-333-73527-7

DDA Update

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Skill: National Bureau for Students with Disabilities is offering free of charge until 31 Dec 2003 copies of Into Work Experience... a new guide for disabled people about doing work experience, important in developing employability skills and self confidence. To request a copy email: sue@skill.org.uk or visit the website at: www.skill.org.uk

***Inclusion* is out...** *Inclusion* is a joint publication from Action on Access and the National Disability Team (NDT). The first issue has recently been published and aims to promote "...knowledge and awareness of disability within the broader widening participation agenda....". More info at: www.inclusion.ac.uk

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The Dyslexia and Dyscalculia Interest Group (DDIG) is developing support for Mathematics in Higher Education... see full article on p17

YOUR HELP IS NEEDED....We need more similar articles, case studies and suggestions. Are you or any of your students disabled in ANY way? Do you or a colleague want to share your experience in *MSOR Connections* of supporting teaching and learning maths, stats and operational research where some students have special needs? Email your suggestions to the editors at info@mathstore.ac.uk - ALSO you may wish to join our email discussion list at:

http://www.jiscmail.ac.uk/lists/DDA-LTSNMSOR.html