Catering for dyslexia – how others benefit

Stephen Rowcliffe

In each class of 30 pupils you teach, the chances are that there is at least one dyslexic pupil who may be struggling to achieve his or her potential in science

ABSTRACT
Dyslexia affects a significant proportion of the UK population and can be a barrier to learning in science for those afflicted. There are a number of techniques teachers can employ to alleviate the problems dyslexic pupils face with both practical and written work in science. These have been found to improve learning conditions for dyslexics, but also represent good teaching practice and can be of benefit to all learners in science.

It is estimated that between 3 and 6 per cent of all children suffer from some degree of dyslexia (Frost and Emery, 1995). Dyslexia is a generic term for a reading disability, describing the symptoms rather than the causes. It is hard to attach a precise definition to the condition, although one thing seems clear: a dyslexic child is one who, in spite of a normal intellectual capacity, has difficulty in interpreting and using the written word.

All teachers have an obligation to make provision in the classroom for pupils with special educational needs (SEN) who do not suffer from severe mental, physical or emotional disorders; these obligations are set out in the DfEE *Code of practice on the identification and assessment of special educational needs* (1994). The inclusion of dyslexic pupils is an important issue, and Johnson (in Peer and Reid, 2001) argues that to exclude dyslexic pupils from lessons is an infringement of their human rights, according to the EU convention. It is therefore important that science teachers become aware of the teaching methods they can employ to help dyslexic learners in their classrooms.

Medical studies have probed the causes of dyslexia, and they suggest that they may be neurological, maturational and/or genetic in nature. Livingstone *et al*. (1991) point to deficiencies in the magnocellular pathway of the visual cortex of dyslexic subjects, the area concerned with response to rapid, low-contrast stimuli, moving objects and overall patterns. Lehmkuhle *et al.* (1993) reach similar conclusions with children aged 8 to 11. What this means is that dyslexics have trouble detecting overall patterns such as words, and with rapidly changing stimuli such as when one's eyes move across a page. Several studies (Blika, 1982; Hiatt, 1984) have found that dyslexia is not linked to problems with eyesight, and that 'eye training' does not contribute significantly to the alleviation of the condition.

Early signs of a child suffering from dyslexia include:

- Disorder in memory, visual perception, oral language and/or thinking.
- Difficulty in speaking, listening, reading, writing and/or maths.
- Problem not linked to other causes, such as impaired hearing/vision, motor disabilities, mental retardation or emotional trauma.
- Discrepancy between academic potential and achievement.

(Bethany School, 2000)

Clearly these signs are somewhat vague, and suggest a hazy definition of the disorder. There is, however, a general consensus among teachers, medics and researchers that a phonological deficit is a defining characteristic of dyslexia. 'Phonological processing impairment' is the name given to the inability to understand, process or identify individual phonemes (monosyllabic sounds) in written or spoken words, or to remember them. Therefore most programmes

of help aimed at dyslexics focus on improving this aspect of their comprehension, and science teachers should be aware of phonology in order to teach dyslexics effectively. A chapter detailing the intricacies of phonology appears in Broomfield and Combley, 1997.

The main obstacles that dyslexics face in science can be split into two fields: problems with written work and problems with practical work. Problems with written work may stem from difficulty in reading from the board and textbooks, and difficulty in assimilating new subject-specific vocabulary. Practical work may suffer due to a lack of the organisational skills (such as mental sequencing of tasks) necessary to plan a practical and follow a sequence of instructions, and the associated clumsiness contributing to poor performance in practical sessions (Bethany School, 2000: 4). A science teacher must understand and address these problems in order to teach a dyslexic pupil effectively.

Many of the teaching methods that benefit dyslexic pupils essentially represent good teaching practice, and would therefore benefit non-dyslexic members of the class as well.

General teaching of dyslexics

Some general points and teaching ideas are suggested by the Dyslexia Institute:

- Be patient, as dyslexics will progress at a slower rate than their classmates.
- Encourage and praise, as the chances are that the pupils will be demotivated in the face of their learning difficulty, and used to struggling.
- Give less homework, with individual points for focus.
- Encourage the use of diagrams.
- Divide long words into syllables using a pencil-line.
- Help with pronunciation of long words.
- Sit them at the front.
- Put important words on the board.
- Give them plenty of time to copy from the board.

It is important to consider certain factors when dealing with dyslexics:

- They tire more easily than other pupils, as they have to concentrate far harder to achieve the same results.
- A dyslexic may read a passage correctly and yet get no sense from it.
- They cannot make notes and listen at the same time.
- A dyslexic may have difficulty in finding their place on a board if they look away and lose their place.
- Never force a dyslexic to read aloud if reluctant.
- Never correct all the spelling mistakes present in a piece of work, as it will look too discouraging.
- Never compare his/her work with others. (Dyslexia Institute *Information pack*)

In addition to this, Webb (1992) stresses the importance of a positive attitude in the pupils themselves. A science teacher must be able to inspire dyslexic pupils to put energy into their learning by helping them to feel successful, promoting their strengths while focusing on their weaknesses.

Hunter (in Peer and Reid, 2001) warns teachers that dyslexics rapidly learn to disguise their difficulty and are anxious to be seen as the same as everyone else. I have personally found that an open, supportive attitude contributes positively to dyslexic children's attitude to science lessons. For example, the pupils do not feel inhibited in asking me to reduce the pace at which notes are taken from the board. I have also changed my handwriting and the colour pens I use and instigated the use of a lined underlay for my overhead projector to keep my writing straight.

The impact of the layout of the science lab on the learning of dyslexic pupils is discussed by Hunter (in Peer and Reid, 2001). She suggests that if dyslexic pupils are seated around benches and not facing the board they will find it more difficult to take notes or copy diagrams from it than if they are facing the board. Pupils constantly turning their heads to and from the board while taking notes may forget how to spell the word that is being copied, or lose their place and become confused. Teachers should therefore ensure that dyslexic pupils are able to face the board whenever copying is required of them. Indeed, most pupils would probably benefit from this consideration.

Problems with written work

The problems that dyslexic pupils have with long words and complex terminology are likely to cause difficulties in science, as the subject introduces unfamiliar word types. Reading is very important in

most subjects, and this is certainly the case in science. If a bright dyslexic child is to do well in investigative science for example, she or he may have to obtain evidence from secondary sources (as well as preliminary work) when planning an investigation. Difficulties in reading independently would thus have a negative impact on a pupil's ability to perform well in this stage of the assignment. Similarly, the entire investigation must be written up for it to be marked, and problems in formulating lengthy pieces of written work are likely to have a detrimental effect on the child's performance if they are not addressed.

Spelling books

Howlett (in Peer and Reid, 2001) suggests that, to improve spelling, it is useful for dyslexic pupils to keep an alphabetically arranged spelling book into which they can enter new vocabulary as they encounter it. This can be referred to when producing written work (homework, for example) to ensure that spellings are correct, and the regular use of correct spellings will help the pupil learn them. Pupils may benefit in a similar way from the purchase of the Letts *GCSE science dictionary*, a pamphlet-sized reference guide that could easily be brought to science lessons with exercise books (Baylis, Booth and McDuell, 2000).

Extra time/shorter tasks

It is suggested by Smith (1990) that dyslexic pupils are able to read more effectively and accurately if they are given more time to complete the reading task. Science teachers should thus be prepared to give more time for a dyslexic to read in lessons, or simply to give dyslexic readers shorter passages to read.

Pairing readers

Smith and Sensenbaugh (1992) suggest that pairing less-able readers with capable readers is also an effective strategy. The able pupil can help the poorer reader by summarising key points for them.

Flow diagrams

Wong and Wilson (1984) imply that dyslexic pupils struggle due to a lack of understanding as to the structure and organisation of a passage of writing. Science teachers can help to alleviate these issues by drawing a summary flow diagram, mind map or 'brainstorm' to illustrate pictorially the progression of ideas throughout a lesson or topic.

Multisensory teaching

The International Dyslexia Association describes multisensory teaching as '*simultaneously visual, auditory and kinaesthetic-tactile*' to make links between these three pathways, and advocates the use of such methods as an approach to teaching pupils with dyslexia. Science tends to lend itself to these sorts of experiences, with experiments, demonstrations and other multisensory activities generally constituting a reasonable portion of the classroom time. Science teachers, made aware of the value of such approaches to dyslexic pupils, may try to design practical exercises incorporating good academic content in order that dyslexics may learn primarily from practical work.

As a teacher in a small school that specialises in teaching dyslexic pupils, I have noticed the value of coordinating a demonstration with some written work, and received positive comments from several pupils for my efforts. One particular example involved the use of a leaf linked to a potometer and placed on the overhead projector so that the water uptake by the plant could be observed on the screen. The note-writing to accompany the exercise was done alongside this set-up, enabling the pupils to observe the phenomenon while describing it. This sort of approach would clearly be of value to any pupil, dyslexic or not.

Linking words with images

A technique described by Carnine and Kinder (1985) could easily be adapted for use with younger pupils in science. It involves the association of words with pictures to develop mental links to be made between physical objects and the novel vocabulary that describes them. Science teachers could use pictures when compiling lists of apparatus for writing up an investigation. This could help the dyslexic pupil to learn the names and spellings of the pieces of apparatus (without which knowledge many tasks in investigative science would be difficult) and assist with their comprehension of the task to be completed.

Phonology training

Schneider *et al*. (1999) studied 191 German kindergarten children, and discovered that phonological awareness training resulted in improved reading and writing performance in later years. The complex terminology involved in science can be a real challenge for dyslexic pupils. It is therefore advised

that science teachers liaise with the person responsible for phonology coaching in their schools, and provide them with lists of subject-specific vocabulary on which the specialist can then focus during their sessions. Science teachers themselves, if aware of the nature of this sort of treatment, could split new vocabulary into its phonemes in order that it can be more fully grasped by dyslexic pupils in the classroom.

Repetition/chanting

Simple repetition of key words to inculcate them into the dyslexic child's mind, when used in conjunction with multisensory methods, has been shown to be effective in a study by Oakland *et al.* (1998). The study of 22 individuals over a two-year period found significantly higher reading recognition and comprehension levels than in a control group. A science teacher could take advantage of this knowledge by ensuring regular repetition of key subject-specific terminology among the dyslexic pupils in the class. This sort of 'chanting' or rote learning has fallen out of favour in recent years, but may be in for a re-evaluation if the results of this research are upheld by further trials. I have noticed the benefits of breaking a new word into its phonemes and having dyslexic pupils repeat it back to me in a chant. Although I was initially reluctant to try this method, considering it old-fashioned, I have since been reassured of its efficacy by my pupils, particularly the dyslexic ones.

Isolating words

In a study involving 15 dyslexic children over a period of three months, significant gains were made in reading levels by the use of a card with a window cut in it. The card is placed over the text, obscuring all words but the one the pupil is reading at the time, revealed by the window. This has been shown to improve reading levels in pupils who have used it; even after the card is removed from the pupil, the gain in reading level remains (Geiger, Lettvin and Fahle, 1994). A science teacher aware of the potential benefits of such a system, could suggest its use during a class book exercise to assist a dyslexic who is struggling with the task of reading. To take advantage of the knowledge that words are better read when not adjacent to other words, a science teacher could isolate new vocabulary on the board to allow dyslexics to recognise and assimilate it. Writing new vocabulary on the board in isolation essentially represents good teaching practice in any case.

Use of ICT

The use of computers in helping dyslexics to learn has been investigated by Sands and Buchholz (1997) and great, largely untapped potential has been revealed. The combination of multisensory tasks and stimuli helps to overcome some of the learning difficulties associated with dyslexia. For example, some CD-ROM applications will read items of text to the user, while others contain animations illustrating visually complex scientific concepts. The use of computers in science teaching could therefore be of use not only to the class as whole, but also specifically to dyslexic pupils. Science teachers should consider allowing dyslexics to use computerised 'talking books' in this way, to overcome their inability to read scientific text effectively, and to obtain as much information as they can from them. I have encouraged pupils in year 9 (13/14 year-olds) to make use of the departmental CD-ROMs that contain the spoken word, and have received good feedback from some dyslexic pupils who find reading scientific texts extremely challenging. Having text read aloud to them is a real help, especially when there are some long and complex words on the page.

A guide to the use of ICT with dyslexic pupils, written by Anna Keates (2000), gives practical advice to teachers and suggests that ICT not only increases the performance of dyslexic pupils but their self-confidence and self-esteem as well. This stems from the fact that they are able to produce neat written work that does not betray the difficulties they may have with their handwriting. The spell-checker function can also help the pupils to learn spellings and gain confidence in their work. However, if pupils come to rely too heavily on this function, interesting anomalies can emerge: a colleague once received a write-up containing the memorable first line '*In my excrement, I found …*'

The University of Nottingham Mental Health, Hidden Disabilities and Learning Support Project (2001) has published guidelines on educating dyslexic pupils using ICT.

Problems with practical work

In order to combat the difficulty dyslexics have with following logical sequences of instructions, it is important that, before they are asked to perform practicals, the purpose of the exercise is explained to put it into context. There should also be a worksheet

that outlines, in a logical and clear sequence, the tasks the pupil needs to perform. Use of simple language will aid the pupils' comprehension of the worksheet, and a vocabulary list at the bottom could help them to cope with unfamiliar or challenging terminology. Providing a table on the worksheet would certainly also be of benefit, as it would combat the short-term organisational deficit in terms of collection of data. Diagrams of apparatus also lend a multisensory side to worksheets. Teachers must be prepared to be patient in explaining the tasks to be performed, reinforcing the instructions verbally.

I have found these approaches to be most beneficial, not only with dyslexic pupils but with the class as a whole.

Pupils' views

I presented the dyslexic pupils I teach with a questionnaire to assess how well my style of teaching was suited to their needs. The results are given in Table 1.

The data seem to suggest that not all dyslexics find reading in the classroom to be too much of a challenge, which is surprising until one considers that dyslexia affects everyone in a different way, and to a different degree. However, the consensus was much in favour of shorter reading exercises and more time to complete them. Some children considered that being paired with a stronger reader would help them, but some were opposed to the idea for personal reasons, and told me so.

Nearly all felt that a flow diagram would be of some help to their comprehension of a subject, and this is certainly something I have used to good effect in my lessons. An overwhelming majority felt that they have understood things better when they have seen them practically, either from personal experience or through a demonstration.

Many felt that seeing pictures or repeating words was a help; I was coming to that conclusion myself, having seen the beneficial effects at first hand. Isolation of words was seen to be helpful, and I write new words on their own on the board much more frequently as a result of this revelation. They were universally in favour of the use of CD-ROMs, and were keen to know more about how they could learn from their laptops.

General comments I have received from dyslexic pupils point towards increased use of multisensory teaching methods and reinforce other ideas and suggestions put forward here:

Showing videos and pictures helps me to learn.

Class discussions really help.

Table 1 Summary of results from dyslexic questionnaire.

Question	*Numbers of responses (*N *= 12)* ***1*** *= agree strongly;* ***3*** *= neutral;* ***5*** *= disagree strongly*						
	1	*2*	*3*	*4*	*5*	*Mode*	*Mean*
Do you find reading in lessons difficult?	0	2	4	4	2	3.5	3.5
Does having more time or shorter exercises help?	5	2	4	0	1	1	2.2
Would pairing you with a strong reader help?	2	4	2	1	3	2	2.9
Do flow diagrams make scientific ideas clearer to you?	8	0	2	0	2	1	2.0
Do you understand things better when you have seen them in a practical or demonstration?	10	0	2	0	0	1	1.3
Do you learn new scientific words better by repeating them or seeing pictures?	3	5	4	0	0	2	2.1
Do you read words better on their own, not in a sentence?	2	2	4	0	4	4	2.3
Do you like to use CD-ROMs that speak to you or show simulations?	7	2	3	0	0	1	1.7
Do you feel that these CD-ROMs help you learn better in science?	5	2	5	0	0	2	2.0
Do worksheets with a planned series of instructions and tables help you in practicals?	7	3	1	1	0	1	1.7

Going over things more than once is useful.

Do less writing and more practicals.

Saying and reading scientific words in class.

Having diagrams, instructions, practicals.

Posters and videos.

Let me get on with it, I'll ask if I don't know.

Put it as simply as possible and use pictures.

Different coloured pens on the board.

Conclusion

Clearly there are a great number of ways in which science teachers can help dyslexic pupils to learn more effectively, and the careful implementation of a few simple measures could lead to greatly increased performance for dyslexics who struggle in the subject. However, it is also clear that many of these methods simply represent good teaching practice, and that any teacher would do well to consider them for use in their teaching.

Howard (1999) presents some encouraging evidence that treatment for dyslexic pupils can be successful; a severely dyslexic pupil he was observing completed a professional training course that would have been extremely difficult or nigh impossible for him had he not received help. The reader is reminded that, not so many years ago, dyslexics were punished in schools and regarded as idiots and failures.

However, the current situation for dyslexic pupils is far from perfect. A pilot study by Osborne (1999) analysed the performance of dyslexic pupils in both coursework and examinations, during which the dyslexic pupils were allowed both extra time and the use of a word-processor. The findings suggested that dyslexic pupils are still significantly disadvantaged by these methods of assessment, in spite of the provision made for them. Perhaps it is necessary to look at the written word itself and ask whether it is the best way to assess the learning of children with dyslexia, although the implications thrown up by this question are daunting to say the least. It may be that multiple-choice questions present a more dyslexic-friendly approach to assessment, if pupils have more problems with writing than with reading. The modular GCSE course currently presented by AQA allows 25% of marks to be gained via six multiple-choice tests spread over the course. It would be interesting to learn whether this method of assessment is less likely to disadvantage dyslexic pupils than traditional written-answer questions.

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Stephen Rowcliffe teaches science at Bethany School in Kent.
E-mail: stephenrowcliffe@hotmail.com

Call for contributions: ***ICT and the science curriculum 11–19***

***SSR* 309** (June 2003) will contain items on the theme of ICT and the science curriculum. Large amounts of money, time and energy have been invested in the use and deployment of ICT in secondary schools, driven by both educational and political imperatives. Science teachers have embraced and developed the use of ICT in all areas of their work, i.e. teaching, learning, assessment and administration.

The general theme of the issue is to disseminate ideas for use in science teaching and to examine critically the extent to which ICT has added value to or enriched science teaching.

This issue intends to include articles and science notes on the use of:

- multimedia, the Internet and web environments in science teaching
- simulations and modelling in science teaching
- spreadsheets, databases in science teaching
- new ICT technologies, e.g. interactive whiteboards, in science teaching.

Contributions, from articles on national or regional projects to accounts from within departments and individual teacher's classrooms, are welcomed. In addition, we are looking for short notes on how ICT has been or is being used in science teaching.

All contributions to the Editor for this special issue, Jerry Wellington, School of Education, University of Sheffield, Sheffield, S10 2JA.
E-mail: j.wellington@sheffield.ac.uk