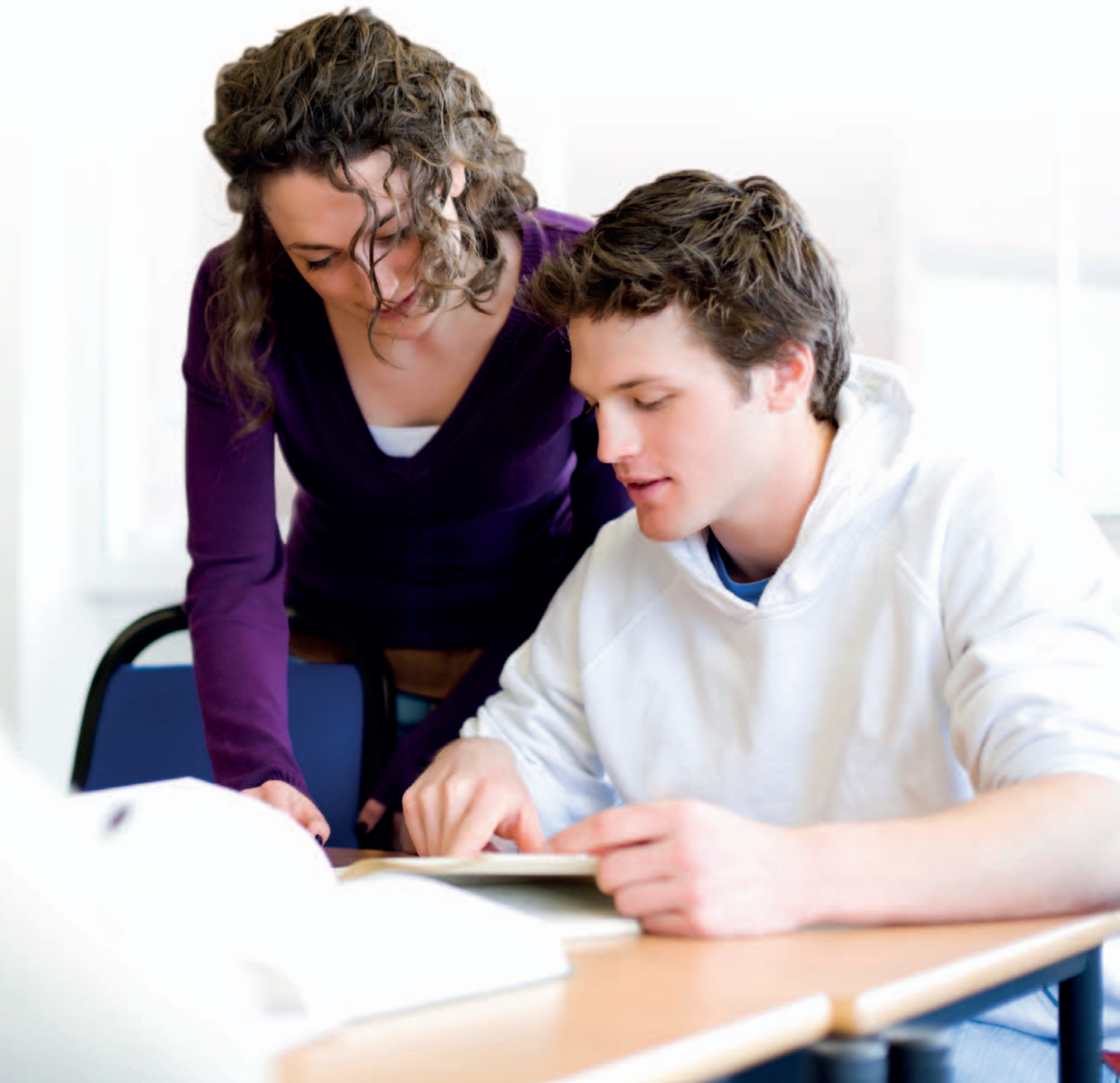
An Institute of Physics guide | **July 2013**

Supporting STEM students with dyslexia

A good practice guide for academic staff



IOP Institute of Physics

The Institute of Physics is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application. We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.

Foreword

The aim of this guide is not to duplicate information but to provide you with particular knowledge and good practice on how dyslexia may impact on students' learning experiences in STEM subjects. Making changes to everyday teaching and learning practice means that, over time, inclusive practices become more embedded and changes are made that benefit all students, not just those declaring a disability. I hope that by reading this guide, you will reflect on your practices and the ways that you support all students, as well as those with dyslexia, and remember that whatever we recommend in terms of inclusive practice is also of benefit to almost all of your students.

Ms Liz Whitelegg

Open University and Chair,
IOP Diversity and Inclusion Committee

The numbers of disabled students in STEM subjects vary between around 11% (agriculture and related science) and 6% (engineering and technology). About half of all disabled students declare an SpLD, which means that between 3% and 5% of your students may have some kind of specific learning difference. Because of the increasing numbers of disabled students entering HE, the STEM Disability Committee was established as a group of like-minded professional bodies to work together to improve provision for disabled people across the whole STEM pipeline, from schools through to HE and then employment. The Committee seeks to fund projects and produce good practice to ensure that there are no intrinsic barriers in the STEM environment. I hope that this guide will contribute to a more inclusive STEM environment, enabling all students with dyslexia to achieve their goal of successfully studying STEM subjects at university.

Dr John Conway

Royal Agricultural University and Chair,
STEM Disability Committee

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National HE STEM Programme

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Purpose of this guide

This guide focuses on good practice in supporting students with dyslexia studying STEM subjects in higher education (HE).

The aims of this guide are to provide:

- knowledge and understanding of the impact of dyslexia within the STEM environment
- the particular adjustments that STEM students with dyslexia may require
- information on how to ensure that your STEM teaching and learning practices become more inclusive over time

Throughout the guide there are case studies and specific examples of good practice, and there is a checklist of good practice at the end, which poses questions about your own, and your departmental, policies and practice. These questions are designed to encourage you to think about how you support STEM students with dyslexia and to think about how to improve provision. You could also use this as a starting point for discussion in your department, because departmental consistency is important in ensuring that all staff, including those involved in seminars and small-group teaching, adopt inclusive practice.

A note about language

Specific learning difficulty (SpLD) is the most frequently used and widely accepted term that refers to conditions such as dyslexia, dyscalculia and dyspraxia. Increasingly, “specific learning difference” is used as the preferred term because it emphasises the concept that dyslexic students think differently from other learners and therefore should be encouraged to make use of their natural learning preferences. This term also plays down the notion that the students are deficient in some way. Additionally, the term “neurodiversity” has been adopted to describe a wider range of conditions, including not only dyslexia, dyspraxia and dyscalculia, but also attention deficit (hyperactivity) disorder (AD(H)D) and Asperger syndrome (Griffin & Pollak 2010).

To ensure ease of reading, this guide uses the terms dyslexia and dyslexic interchangeably with the abbreviation SpLD because dyslexia is the most commonly occurring specific learning difference within the HE student body.

> “Since it has been argued that many of the principles that underpin inclusive teaching practice are beneficial to the wider student body (May & Bridger 2010, Healey, Morgan & Houghton 2011) it is hoped that the guidance provided here can be utilised for the benefit of all students studying on your programme.

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The Equality Act (2010) and higher education

There are several guides available that refer to the Equality Act (2010) and legislation that preceded it, such as the Disability Discrimination Act (1995). Comprehensive information can be found on the websites of the Equality and Human Rights Commission (EHRC) (**www.equalityhumanrights.com**) and the Equality Challenge Unit (ECU) (**www.ecu.ac.uk**). The Institute of Physics also produced *Access for All: a Guide to Disability Good Practice for University Physics Departments* (**www.iop.org/publications/iop/2008/file_42866.pdf**). You may also want to refer to guidance that has been produced by your own institution.

The Act defines a disabled person as a person who has a "physical or mental impairment and the impairment has a substantial and long-term adverse effect on his or her ability to carry out normal day-to-day activities".

The Act defines discrimination in six different ways for disabled people: direct, indirect, victimisation and harassment, discrimination arising from disability and a failure to make reasonable adjustments. The duty to make reasonable adjustments in education is anticipatory, which means that HEIs must think through reasonable adjustments they may be asked to make.

The Act makes specific reference in education to "competence standards", which are defined as being "an academic, medical or other standard applied for the purpose of determining whether or not a person has a particular level of competence or ability". There is no duty to make adjustments to competence standards, although the duty to make adjustments to the way standards are assessed remains.

Understanding competence standards is key

All programmes of higher education impose various requirements and conditions on students – these are usually defined by the assessment protocols that are embedded into the design of the programme at the outset. However, in order to be a competence standard – and therefore not adjustable under the Act – these conditions must be these standards must be fair, valid, apply equally to everyone and be designed to demonstrate relevant competence or ability. Prescribing a specific time limit in a test, for example, is likely only to be considered a competence standard if a certain procedure is required to be performed within a particular time period – this may be the case in some laboratory situations but not in others.

> “It is easy to think of disability as being limited to visible conditions such as mobility difficulties (wheelchair users), blindness or to people who are deaf and wear hearing aids. However, the Act protects people with a range of conditions, which can be hidden disabilities (including dyslexia) and long-term injuries, conditions or ill-health. People who experience these conditions may not think of themselves, or be considered by others, as being disabled.

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Dyslexia in higher education

There are certain general characteristics that are evident in most people with dyslexia; for example, they generally have difficulties with the acquisition of literacy. It is a condition that is biological in origin and, therefore, from which one cannot "grow out of".

Students with dyslexia may experience a range of issues, including:
- a marked inefficiency in working or short-term memory
- problems retaining the meaning of text
- failure to marshal learned facts effectively in exams
- disjointed written work or omission of words
- inadequate phonological processing skills
  - affecting the acquisition of phonic skill in reading and spelling
  - affecting comprehension
- difficulties with motor skills or co-ordination
  - particular difficulty with automatising skills, e.g. listening and taking notes simultaneously

Singleton Report (1999)

Others have suggested that people who are dyslexic may have strengths in areas such as creative thinking and problem solving (Davis 1997, West 1997). Each student with dyslexia is likely to experience different combinations of the characteristics listed above and therefore each student is likely to present with a different learning profile, and have their own unique coping strategies. It should be emphasised that they often need to make additional efforts to ensure that they keep pace with learners within their peer group and that these efforts can add to the stress of studying. Often this additional stress is not recognised by teaching staff because it is hidden.

A significant proportion of students with dyslexia also experience difficulties when reading text, generally described under the umbrella term "visual stress". The most common form is a condition called Meares-Irlen syndrome, which results in text that appears to move on or off the edge of the page, overlapping or floating lines, or a whirlpool effect where the central focus of the text fades. These problems are often exacerbated when black text is presented on a white background. The most common way of alleviating these difficulties is to use coloured overlays or glasses with tinted lenses in them.

As the number of students declaring an SpLD in HE has increased significantly in recent times there has been an increased level of awareness about their support requirements.

All staff are responsible for inclusivity

Support services have increased to meet this demand and most HEIs have adopted practices that support the successful learning of this group of students. For example, many HEIs will have central or departmental policies related to ensuring that teaching and learning is accessible, and these might include:

- guidelines on recording lectures
- providing notes and lecture outlines on departmental websites in advance of lectures
- making hand-outs and notes accessible to a wide range of disabled students, using accessible fonts with good line spacing, clear headings and avoiding cramped layouts
- ensuring that presentations are delivered in an accessible way, e.g. ensuring that background colours are set to a neutral shade (not white)
- ensuring that hand-outs and notes are available in non-PDF format for screen-reader accessibility
- adjustments to assessments

Institutions should try to provide staff development opportunities for all staff involved in teaching and learning, including part-time teaching staff, postgraduate research students and teaching assistants, as well as the full-time lecturing staff, regarding these issues. Many HEIs deliver workshops through their staff development units and increasingly through PCAP programmes and similar professional development programmes for new teaching and learning staff.

> “Your ideas can be a messy jumble up there. If you’re able to organise them and get that right then it will come so much clearer in the end – clearer both to yourself and to everyone else. And don’t think that dyslexia is a hindrance. You happen to have this different approach to what you do and that gives you an edge.
> **David, Plant and Animal Sciences**

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Supporting dyslexic students in the STEM environment

Overview

In STEM subjects, there is a need for students to assimilate new scientific and technical terminology and notation, which has to be read, pronounced, remembered and reproduced. There is also a need to make associations between words, symbolic notation and a certain procedure, e.g. differentiation, dy/dx and the process of differentiating. All of this is coupled with a large volume of new material and usually a fast pace of delivery.

Scientific notation can be a barrier

Scientific notation can present a barrier in itself, particularly where it is interspersed with text and subtext. In many course textbooks, hand-outs and notes, the figures and graphs are not necessarily on the same page as the text, and this can be confusing for the reader, who then has to go back and forth between several pages.

Different notation is also often used for the same variable or concept and conversely the same symbol used for different variables. Developing some uniformity between modules and across subject areas so that the same notation is used for the same variable or concept would be helpful.

When a student also has visual stress, using calculators and reading arithmetical operations, such as fractions or superscripts and subscripts, matrices and tables of data and results, can be made more difficult because the digits will appear to move or overlap with each other.

Case study

Ruth is an extremely able physics student with strong motivation and perseverance and a real interest in her chosen course of study. She was identified as dyslexic at the age of eight but her transition to university has meant that she has had to take more responsibility for her own learning and organisation. As a result, she initially struggled to meet deadlines and fell behind in taking notes in lectures, until she was given support for organisation and time management.

She highlights her difficulties with word and letter order, and processing information at speed. Ruth needs to re-read information to take in the meaning and has some difficulty tracking the print as she finds that letters and numbers start to move. Her main issues remain keeping pace in lectures, effective time management, note organisation and presentation.

A number of adjustments have enabled Ruth to move forward, especially the use of note takers, one-to-one support, extra time in exams and the availability of coloured squared paper. Additionally, the provision of structured, easy-to-follow notes with colour coding significantly helps. Breaking material down into small manageable steps and being actively engaged with the mathematics herself, rather than watching or reading it, is also beneficial to Ruth.

Examples of good practice

- Providing a general departmental or module glossary at the start of term is helpful. This could include items such as technical vocabulary, notation and the Greek alphabet. Providing a visual diagram for new technical words is extremely helpful.
- Where possible, try to choose core textbooks that follow the general accessibility guidelines outlined in this guide. More recently written textbooks are likely to be more accessible.
- Prioritise reading lists, with the most essential reading at the top of the list, to ensure that students who may take longer to read are reading the most important information first.
- In lectures, seminars and other presentations, it is helpful to introduce new technical words with a visual representation, where possible, or a picture.
- When interspersing notation into notes, texts and slides, ensure that they are in a logical order and that the notation relates directly to the text around it, in order to create a logical flow through the material.
- When presenting data on spreadsheets, use alternate colouring of columns, rows and/or cells in data tables and spreadsheets to make them easier to read. Some websites provide a self-design for centimetre-squared and graph paper, whereby the user can specify the colour, spacing and size of the grid. For example, see **www.printfreegraphpaper.com**.
- While information in any current presentation slide should be clearly visible, the need to scroll down a page means that information from the top is lost.
- Different representations of fractions are shown in figure 1. Try to use the clearest and preferred format, i.e. in this example diagram (c).

Figure 1: Different representations of fractions

(a) ${}^{a}\!/_{b} + {}^{c}\!/_{d}$ (b) $a/b + c/d$ (c) $\frac{a}{b} + \frac{c}{d}$

Seminars

Because of the more intimate setting and discursive nature of seminars, they offer the opportunity for staff to get to know their students as individuals and to become more aware of their needs. However, they also present different challenges for dyslexic students that teaching staff need to be aware of.

If different types of resources are utilised, such as hand-outs, notes, videos and interactive whiteboards, teaching staff should ensure that the materials and media being used are made accessible to all learners.

In seminars students are actively encouraged to discuss problems and potential solutions, but be aware that some STEM students with dyslexia may find on-the-spot calculations more difficult. Some students may require more time to prepare in a public setting.

Case study

When Alison is working in her peer group, she will tell her fellow students about her dyslexia so that she can promote her stronger areas and ensure that when different tasks are being allocated, she can be involved in those areas she is most comfortable with. For example, she recognises that her presentation skills are one of her weakest areas but she feels under much less pressure giving a presentation when it is small-group work than with the whole class.

Examples of good practice

- Ensuring, if other students' work is being presented for peer review, that the students themselves present materials in an accessible format.
- Students should be made aware of the sensitivities around feedback related to poor spelling and grammar, which might be as a result of a fellow student's dyslexia.
- Try to allow students time to organise their work for seminars by providing information in advance.

Practical work

Laboratory and/or field work is essential in most STEM subjects and can present many barriers to students with dyslexia. Students have to listen to and remember instructions, take accurate (and usually handwritten) notes, organise their time appropriately, work in groups, record data and make on-the-spot mathematical calculations. Students do not always have the time to correct their notes, fill in the missing parts and complete their comprehension while carrying out the laboratory task.

Understanding competence standards in laboratory or field work is crucial; understanding what it is you are asking the students to do, the time that they are required to do it in and the notes that they must submit all need to be considered carefully.

For example, writing contemporaneous notes is crucial in some settings and this will not allow for adjustments "after the fact". Nevertheless, there are adjustments to practice to allow all students to demonstrate their competence, such as submitting an annotated diagram instead of free text or allowing a small amount of time after the session to proofread the work.

Where time is a competence standard (i.e. it is the time that the student takes to do the task that is being assessed), this cannot be adjusted.

Group work is also important in laboratory or field work and some students with SpLDs will find this more stressful, for example, if they are nominated to be the scribe, or have to give an on-the-spot presentation of their findings.

Case study

Marianne is in her final year of a chemistry degree. She is highly motivated and engaged, putting in considerable time and effort to overcome her barriers to learning. Marianne was first identified as dyslexic at the age of 13 and she feels that this helps to explain why she had difficulty learning to read as a child. She experiences difficulties with the speed and accuracy of her reading, frequently needing to re-read the same piece of text to gain meaning, and she also experiences visual stress with the text appearing to move around on the page. This has implications for her comprehension and effectiveness, which in turn means that she has to work significantly longer hours than her peers.

She used colour coding to keep track of information, using different colours for different variables. She developed her own glossary of standardised measures and technical terms throughout her course, which aided her memory recall. She also developed a set of mind-maps for her lab sessions (one map per lab). This enabled her to succinctly display, in a non-linear format, a visual reminder of each session. This proved a useful tool kit for her to revise from.

Examples of good practice

- Written instructions, in any form, should be structured with keywords, examples and symbols clearly highlighted. Keywords will provide a clearer focus and act as a future reference point.
- It is particularly helpful to provide a practical handbook at the beginning of term, which sets out all laboratory and field work procedures in advance so that the student can prepare for the sessions. Providing generic report templates would also be helpful for practical work.
- Try to give all students the opportunity to volunteer rather than being nominated to undertake tasks.
- Being prepared to accept differences in assessment, where this is possible, will ensure that all students can fully access this part of the programme.

Written work

The written work of a dyslexic student can seem disorganised, poorly aligned and without sufficient structure for coherence and flow. The speed of writing when composing a written piece of work or algebraic argument, however short, can be slower, which has implications for writing *in situ*, such as in tutorials or labs, where difficulties with writing speed, handwriting and accuracy may be significant factors.

Issues in writing can also centre on speed and accuracy of copying, particularly copying notes from the screen in lectures. This may include students confusing digits or letters, such as 3 and 5, B and E or + and X. There are often specific problems with Greek letters, which can be confused with more familiar letters, e.g. alpha α (with a), eta η (with n) or omega ω (with w).

Different types of academic assignments require different structures. In mathematical subjects, tasks and assignments are frequently presented with an array of instructional terms such as “evaluate”, “generalise”, “prove”, “show”, “solve” or “simplify”. Each term uniquely determines what output is expected. Students with SpLDs may need some further guidance or assistance in distinguishing between these different terms.

Case study

Matthew is a final-year, part-time mechanical engineering student, who is studying a degree on a day-release basis from his apprenticeship. At the beginning of the year, he was particularly concerned about the dissertation. The first thing he did was to develop a "big mind-map" with his tutor, to help him note down his initial thoughts. His tutor supported him to develop a sequence of operations and tasks to establish a sensible, step-by-step list of priorities. This led into producing a chart for project management so he knew what his intermediate deadlines were towards his larger goal. This pre-planning stage enabled him to get a rough outline of the "shape" of his dissertation and provided him with a sequence that seemed sensible to him, so he could then tackle one part at a time.

Examples of good practice

- At the beginning of the academic year, give clear, written guidelines to help students understand the requirements in terms of the acceptable structure for a piece of work. For example, full essay format, short paragraphs/notes, mathematical solutions or explanations, or a set of bullet points.
- Provide clearly defined information about the differing expectations of the various commonly used words in mathematical tasks (e.g. "prove" or "show").
- Marking schemes should not penalise handwritten work that is less well structured or presented less neatly with poor alignment or copying errors, unless these affect the specific learning outcomes, or competence standards, of the module.

> "My dyslexia gives me an incentive to improve my writing. I write better now partly from improving some techniques and from using small tips like the Google search engine for spell check (which is far better than Word for guessing what a mistake should be), but mostly from editing what I write. I may never be able to write accurately the first time, but I have found that I can edit it eventually to be near to what I want. It would be very nice to have a five-credit module on scientific writing at the beginning of the second year. Students don't want to learn halfway through the third year how to write properly because they've already lost all those marks in the second year and third years.
>
> **David, Plant and Animal Sciences**

Assessment and feedback

Speed of processing, organising information, sequencing, short-term and working memory, reading accuracy and automaticity, and fluency in writing can all be particular issues that can prevent a dyslexic student from achieving their potential in exams. Stress related to the examination process may exacerbate these difficulties.

There are a number of relatively standard adjustments for dyslexic candidates, which may be applied to all tests and exams, including short class tests, essays and computer-aided assessments. These will include extra time (+25% is normal) to allow, for example, for organising work or checking spelling and grammar, a reader or scribe, or using a computer with assistive software instead of handwriting.

Many current assessments and exams rely predominantly on recall of factual information. However, genuinely inclusive exams and assessments will be designed to assess a student's understanding of the material and not just how well they can remember certain facts.

Understanding what the core competence standards of your programme are and exactly what it is that is being assessed will aid in the provision of accessible examinations and in making alternative arrangements. Reviewing the genuine competencies of your programme regularly will enable you to ensure that all your students can demonstrate their understanding on a level playing field. When setting an essay, for example, requiring that the arguments are well-researched, clearly set out and in a logical order may be a competence standard; requiring that it is handwritten may not.

Examples of good practice

- Review the core competencies and assessment processes of the programme.
- Consider how to set tests and exams that will allow students to demonstrate their understanding as well as their ability to recall information.
- Consider offering alternative assessments for all students.
- Ensure that the accessibility of all types of tests have been considered, including in-class tests and computer-aided assessments (CAAs).
- Where competence standards allow, consider providing formula sheets and notation lists, theorems and/or a glossary of terms
- Ensure that feedback on assignments is detailed and clearly written so that there is no misunderstanding, particularly if it is handwritten.
- Consider providing feedback electronically.

> “Yes I got my first, but I had to work three times harder than anyone else
> **Matthew, Agricultural Sciences**

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Checklist of key questions for inclusive practice

Departmental practices

- Does the department provide prioritised reading lists for all of its programmes?
- Is a booklet available that contains all technical terms, notation, standardised measures and a glossary of terms used throughout course?
- Is there a standardisation of notation across the department?
- Does the department have a consistent policy on fonts?
- Is there a recommended calculators policy that takes account of visual stress?
- Are podcasts or full lecture videos available?
- Are there clear, written guidelines on the acceptable structures for a piece of work?
- Do the recommended course textbooks have a clear layout?

Teaching and learning

- Do you provide clearly structured notes, covering the content in advance?
- Are these notes in sans-serif font with good line spacing and clear headings, avoiding small text and cramped layouts?
- Do the notes include clear definitions of all notation and terms used?
- Are these notes available in non-PDF format for screen-reader accessibility?
- Are all diagrams in notes, hand-outs, presentations, etc, clearly labelled and positioned so that there is a logical order with the related text?
- Are new technical words given visually, where possible, and a glossary provided?
- Is symbolic notation clearly written to avoid confusion with other characters?
- Are screenshots visible long enough to allow students to assimilate information?
- Do you avoid the need to copy complicated mathematics from the screen or board?
- Do data tables and spreadsheets have shaded or coloured columns to aid clarity?
- Are generic templates available to help structure written work, particularly for laboratory or field work?
- How have you assessed your competence standards in laboratory or field situations?

Assessment

- Are the assessment tasks clearly set out so that students understand the requirements of the question and solution?
- Are formula booklets and/or a glossary of terms available in exams and tests, where competence standards allow?
- Is coloured graph paper or squared paper available in exams?
- Do questions avoid rote learning and recall by focusing on understanding?
- Do you have a marking scheme that avoids penalising messy work?
- Do you provide alternative assessments (e.g. presentations/posters/portfolio of work/annotated diagrams instead of written work)?
- Is detailed and clear feedback, available in alternative formats, given to enable students to see how to move forward?
- Have you reviewed all of your tests (including in-class and CAA) for accessibility?

STEM Disability Committee

The STEM Disability Committee has been established as a cross-STEM collaborative group of professional to consider practical ways to improve policies, practices and provision for disabled people. It exists within the wider picture of diversity in STEM but has specific focus on all aspects of disability. Its area of interest spans the whole STEM pipeline, including those aspiring to a STEM career as well as those already employed in a STEM role.

Core Members

- Institute of Physics (IOP)
- Royal Academy of Engineering (RAEng)
- Royal Society of Chemistry (RSC)
- Society of Biology (SoB)
- Campaign for Science and Engineering (CaSE)
- Royal Society (RS)

Core members are those organisations in the STEM community who have made a clear commitment to increasing disability access for people studying or working in STEM. Committee representatives should be those who are responsible for diversity in their respective organisations. The Committee is currently chaired by Dr John Conway of the Royal Agricultural University.

For more information on the work and projects of the STEM Disability Committee, visit our website: **http://www.stemdisability.org.uk/** or contact us at: **contact@stemdisability.org.uk**

Networks of Departmental Disability Co-ordinators

The Institute of Physics, Society of Biology and Royal Society of Chemistry also host electronic discussion networks for their respective Departmental Disability Co-ordinators. To find out more about these networks, or if you are interested in joining the appropriate network for your subject, please contact us at: **contact@stemdisability.org.uk**

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