

Embedding equality and diversity in the curriculum: a physical sciences practitioner's guide



Mark Hughes



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I. Setting the scene

I.1 Diversity in the physical sciences

As scientists, we pride ourselves on our objectivity, we interrogate the evidence, consider relevant theories and draw conclusions that we hope are free from personal biases and irrational assumptions. We set up systems, such as peer review or sharing of raw data, to help provide the necessary checks and balances and to provide an opportunity for someone with a different perspective to see something we might have missed. We accept this as part of our professional duty and most scientists consider these additional tasks to be of benefit to our wider community and society. We might ask then, do we bring the same level of objectivity, transparency and fairness to our curriculum that we expect in our research? Moreover, having a diverse cohort of students (and staff) enriches our departments, but do we miss opportunities to celebrate this diversity?

I.2 Inclusive for whom?

The Equality Act 2010 specifies that it is against the law to discriminate against someone with specific characteristics.¹ However, thinking in an inclusive manner encourages us to consider our programmes carefully and ask whether *any* group of students is being put at a disadvantage. For example, we might broaden the list to include socio-economic status, direct-entry students, students from other departments taking our courses, etc. The process of looking carefully at our courses and programmes forces us to think hard about the *real* competencies that each student must acquire, as opposed to artificial restrictions that we might be imposing.

I.3 Athena SWAN and Juno

Two important initiatives during the last decade are [Athena SWAN](#) and [Juno](#). These programmes accredit departments (and in the case of Athena SWAN entire universities) and make awards for the commitment to, and progress towards, combating the under-representation of women and improving gender equality. For the departments that engage with these awards, the rewards can be great. Departments must look inwards at their structures and processes, and crucially monitor gender statistics relating to students and staff. Moreover, the department must have a committee to investigate these data and drive gender equality forward. All of these provide a good foundation for looking at the wider equality and diversity agenda.

Building on your Athena SWAN and/or Juno award

If your department already has an Athena SWAN and/or Juno award then you may already have many of the processes in place (e.g. a committee, data monitoring procedures) that could be expanded into a wider equality and diversity agenda, e.g. could your self-assessment team develop into a fully functional equality and diversity committee for your department? Could the processes you developed to collect data on the progression of female undergraduates be extended to disabled students, or international students? Could your department start to look at the ethnic diversity of your students, or the progression of those entering through the foundation year route?

This practice guide builds on an earlier [HEA guide](#) (Morgan and Houghton 2011) and records good practice from around the UK, embedding case studies in its narrative. The focus is on four themes: engaging with the student, communication, monitoring and embedding good practice.

¹ See the Equality Challenge Unit's guidance on this: www.ecu.ac.uk/guidance-resources/equality-legislation, last accessed 31.03.2015.

2. Putting it into practice

As academics, we are often novices when it comes to equality and diversity. Developing expertise in your discipline can be challenging enough, without additional fields of knowledge to tackle. Here we look at some of the good practice that is going on in physical sciences departments at UK universities.

2.1 Gender

The physical sciences are often stereotyped with the lab-coat wearing, geeky male scientist image. Such perceptions were investigated by Tim James in the School of Science and Engineering at Teesside University where students were asked to 'draw a forensic scientist' to investigate student preconceptions about their subject. In subjects where it is likely that female students will be in the minority (e.g. ~20% of undergraduates in Physics are female) several departments have taken measures to ensure that female students do not feel isolated. Those involved in assigning tutorial groups could consider whether it is possible to have more than one female student in each group as seen in the physics departments at Warwick and Durham (Main 2006, p. 5). The Institute of Physics also recommends gender awareness training for all laboratory demonstrators (Main 2006, p. 5). It is also useful to look carefully at any differences in feedback given to different groups of students, and consider how biases will be removed in cases where anonymous marking cannot be used (Institute of Physics 2014).

Some departments ensure female students have more than one senior female academic to contact (as noted by Susan Burrows, Department of Physics, University of Warwick), consistent with Institute of Physics' advice (Main 2006, p. 5). Another good approach, as noted by Carla Molteni from the Physics department at Kings College London, is to have a dedicated tutor for female students who acts as a point of contact for all female students. This is a good idea, but departments seeking to emulate this must take care not to overburden the tutor.

Annabel Cartwright in the School of Physics and Astronomy at the University of Cardiff reports the innovative decision to investigate student feedback by gender. They use 19 questions and look at the general response across all modules. They look at the male/female response to each question across all courses and identify differences by individual module. Initial preconceptions that laboratory work might be least favoured by female students were not borne out in the data, demonstrating the need for monitoring and evidence.

2.2 Disability

Every student is different. It may seem obvious, but the tendency to generalise and pigeonhole people is a strong one for all of us. We cannot assume that every dyslexic student will need exactly the same support (Whitelegg and Conway 2013) or that every student with Asperger's syndrome will have the same difficulty with a particular assignment (Hughes et al. 2010). While we may plan to speak to students with known impairments, how many other issues do we overlook? David Hodgson at the Department of Chemistry at the University of Durham highlights that every student with a declared disability is met early in the first term by someone from the department. This allows discussion of potential barriers and how adjustments can be made to remove them before they disadvantage the student. The department is proactive in raising student understanding of disability services and the support they provide. In addition to providing information, students are taken to the disability services so that they are clear about where it is located. Follow-up by email enables the department to check on progress. Hearing the student's voice is a key part of understanding the challenges they face and their concerns, and David emphasises that a proactive 15-minute meeting can make all the difference for the progress of the student. Such practice could be rolled out to every student: remember not every student declares a disability and not every disability arises prior to arrival at university. The department of Warwick also reports on their extended support for disabled students below:

Supporting disabled students: Department of Chemistry, University of Warwick

The Department of Chemistry at the University of Warwick takes a joined-up approach to supporting disabled students, and provision includes:

Engaging with the student

- individual meetings are held with each student with a disclosed disability (except for dyslexia). The needs of the individual student are assessed.

Embedding good practice

- students are provided with a student mentor from a later year, who can share experiences;
- a tailored plan for support is prepared for each student. Examples might include a postgraduate to help assist with mobility issues, or alternative experiments, if required;
- progress in the teaching laboratory is monitored through further meetings or dropping in to timetabled sessions;
- putting some disabled students in smaller groups to enable greater support, if necessary and agreed by the student (this could also support students with hearing impairments);
- ensuring that rooms allocated to students have disabled access;
- students are assigned to tutors who are known to have good availability throughout the academic year;
- lecture capture is used to allow students who have missed lectures to catch up;
- ensuring that all information regarding students' disabilities is acted on (e.g. new doors to allow wheelchair access).

Communication

- students are made aware of the support that is available to them through Disability Services;
- staff and demonstrators are made aware of the student's situation (for example if a sign language interpreter needs to be present in lectures);
- ensuring that students are aware of all support services available to them (accommodation, finance, etc.).

Adaptability

Again, certain of these practices could be rolled out to every student.

Information provided by Lynne Bayley, Director of the Student Experience, Department of Chemistry, University of Warwick.

2.2.1 Difficult is not the same as impossible

While health and safety must take priority in the teaching laboratory, it is important to consider alternative methods for achieving the same learning outcome in a safe manner. Teaching laboratories can be complex physical and procedural environments; however, many universities have made adjustments to historical ways of learning experimental skills to ensure they are accessible to all.² For example, Debbie Willison, Head of Teaching at the Department of Chemistry at the University of Strathclyde, reports that a bespoke frame was produced to enable visually impaired students to manipulate glassware for chemicals in a safe manner and

² Sophie Carr from the Department of Applied Sciences at Northumbria University reports how students can virtually view an artificial crime scene using a commercial software system (Return to Scene), allowing students who might have difficulty accessing the crime scene room to participate and still meet the learning outcomes of the course.

allows them to learn the function of the equipment (figure 1). In addition, figure 2 shows adjustments made for a student prone to fainting.³

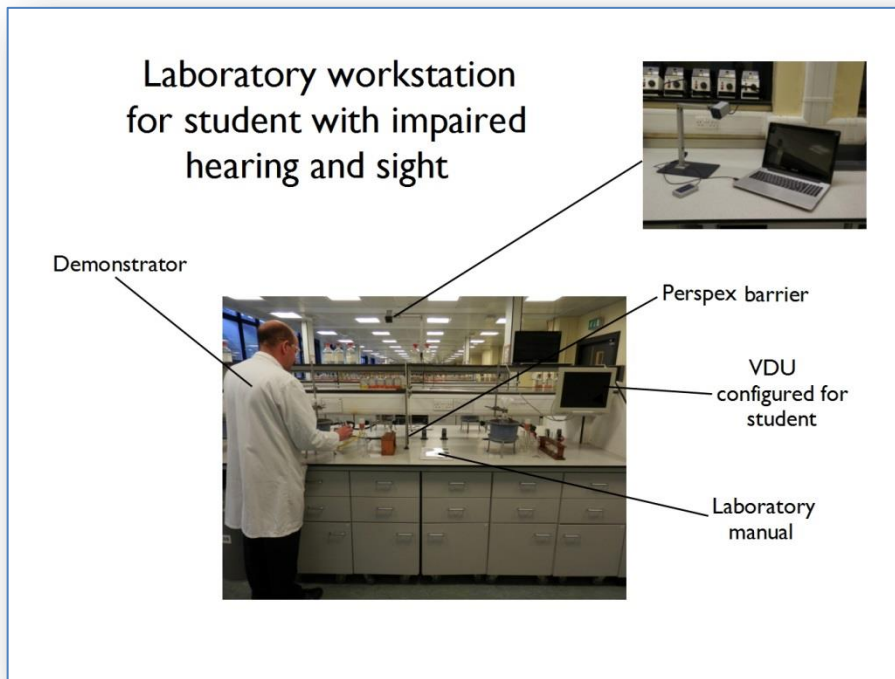


Figure 1: A novel method to enable students with visual impairments to manipulate glassware for chemicals in a safe manner. (credit: Debbie Willison, Department of Chemistry, University of Strathclyde)

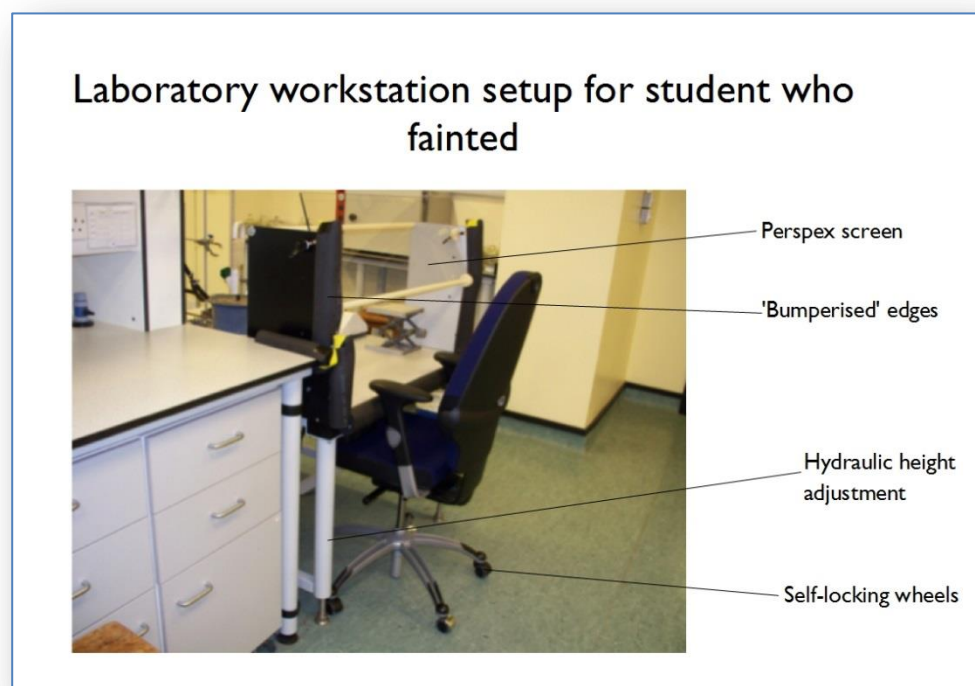


Figure 2: Adjustments made for a student who was prone to fainting. (credit: Debbie Willison, Department of Chemistry, University of Strathclyde)

³ In another example of how students with visual impairment might be supported in the lab, Janette Dunn of the Department of Physics at the University of Nottingham successfully supported two blind students through a teaching laboratory programme. See the [HEA guide](#) by Maddox and Morgan (2009).

In recent years, the number of students disclosing Asperger's syndrome (AS) has increased. AS is part of the autistic spectrum and students can encounter difficulties with social interaction and with organising their time. Hughes et al. (2010) have produced a [resource pack](#) to help staff support students with AS. Designed to get staff up to speed as quickly as possible it consists of three components:

- quick guides tailored to staff roles (e.g. head of department, admin staff, tutor, lecturer, laboratory demonstrator etc.). These guides provide a quick overview of AS and a few hints for people in each particular role;
- a practice guide containing example scenarios and suggestions for those who want to learn more about Asperger's syndrome;
- a video of a former student with AS talking about his experience of university. The video can be used as part of a staff training session.

The School of Physics and Astronomy at the University of Manchester piloted the use of [induction videos for students with Asperger's Syndrome](#) to help support their transition to university. Modern video techniques often involve fast changes and high graphics content. While these techniques may suit a university's marketing needs these can be difficult to process for people with particular sensory impairments. Consequently, the induction videos are deliberately designed to have lower sensory input than traditional marketing videos.⁴

Equality and diversity audits: School of Physics and Astronomy, University of Manchester

It is useful to plan ahead for disability provision; indeed the expectation in the Equality Act 2010 is that disability provision should be *anticipatory*. The School of Physics and Astronomy at the University of Manchester recently conducted a disability audit of its teaching labs.

Conducting a disability audit

The School of Physics and Astronomy has significant lab space spread over multiple floors of the main building. Recognising that communication between staff who are knowledgeable about the experiments and disability experts is essential for effective student support, a disability audit was conducted. The audit consisted of the lab technician, the academic responsible for the lab and a member of the university's disability team walking around each laboratory and discussing each experiment in turn. This allowed an informed discussion about how students with different impairments might be able to conduct each experiment.

The result was that the vast majority of experiments were considered to be easily adaptable for all students, with the exception of one laser-based experiment. The concern with the laser experiment was that while the optical table could be lowered for a wheelchair user, the student would then be at eye-level to the laser beams from other students' experiments, putting the wheelchair user at significant risk. However, this will also be made accessible in the future in a reorganisation of the laboratory provision.

Adaptability

Such audits could be adapted as part of regular equality impact assessment activity.

Information provided by Mark Hughes, School of Physics and Astronomy, University of Manchester.

⁴ The resource was released through a Creative Commons licence. The practice guide can be found on the [HEA website](#), whilst the resource pack can be found on the [Jorum repository](#). The videos include a guide to the department with advice on how noisy it might be between lectures and where a quiet place of refuge can be found. Logical, step-by-step instructions for getting to the main university Disability Support Office are also provided, with advice on an alternative route if the lifts are not working (which might cause some students difficulty making their appointments).

2.3 Other groups

Equality and diversity is about more than gender and disability. Any group who might be at a disadvantage should be considered, whether one of the protected characteristics (e.g. ethnicity) or another group such as international students, foundation year students or students from another department taking your courses. For example, Robert Allan in the School of Applied Sciences notes that the University of Huddersfield goes beyond gender statistics to provide three-year data for both ethnicity and age for their annual reviews. A typical physical science degree will contain many opportunities for students to mix (group work, labs, presentations, social events) and meet others from a different background. Having a diverse student cohort provides opportunities for students and staff to learn from each other and can therefore help foster good relations.

Differences in opportunity between different ethnic groups are a complex matter, and there can be widely different factors affecting each ethnic group, sometimes influenced by underlying socio-economic factors (Springate et al. 2008). There are also significant differences in choice of pre-university courses between ethnic groups, affecting the number of students beginning a degree course. For example, Chemistry A-level generally has a greater percentage of Asian-British students than Physics owing, so Elias and Jones (2006, iv) argue, to its use as a route into medicine.⁵ While the number of students from ethnic minority backgrounds entering the physical sciences may need a national initiative to address, what is directly in the control of departments is the achievement of their students. Worryingly, there is evidence of significant differences in the achievement of first/2:1 grades by different ethnic groups. For example, on average half the number of black British Caribbean and black British African students get a first/2:1 compared with white students (Springate et al. 2008). The latest HEA report [Undergraduate retention and attainment across the disciplines](#) shows little change: in the physical sciences 31% of those identifying as black British Caribbean and 46% of those identifying as black British African attained first/2:1 grades compared with 68% of those identifying as white (Woodfield 2014, p. 67-68).⁶ The picture may be complicated by socio-economic factors, but highlights the pressing need to monitor the progress of our students, and investigate the causes of any particular biases in our programmes. It should also be noted that many students will belong to more than one characteristic group, and so those investigating the statistics should be careful of over simplification.

Marina Resmini and Nathalie Lebrasseur in the School of Biological and Chemical Sciences at Queen Mary University London recognised the diverse range of socio-economic backgrounds of their students, in particular their exposure to practical experiments prior to attending university. To support students from schools without good laboratory provision the School constructed 'virtual labs' to enable all students to develop experimental skills.

3. Next steps

In the following I identify three imaginary academics in different roles: someone who teaches but has no control over the course content (e.g. lecturer/tutor), someone in charge of the degree programme so can influence course content (e.g. director of teaching) and finally the head of department.

⁵ Cf. also the Equality Challenge Unit's latest statistical report (Equality Challenge Unit 2014, p. 122).

⁶ See the Higher Education Academy's work on improving the retention and degree attainment of BME students for further guidance on this: [Berry and Loke 2011](#) and [Stevenson 2012](#).

3.1 Engaging with the student

Do not assume that all students from a particular group will either act in the same way or have the same needs and aspirations. Your idea of a typical forensic scientist, chemist, physicist or astronomer may be different from your students' concept. Students can also be a great source of ideas for changes you may wish to make to your curriculum. They may have had experience of what has or has not worked prior to arriving at university.

3.1.1 Lecturer/tutor

Make your lectures, tutorials or seminars welcoming so that students feel they can contact you, but be aware that some students will experience problems communicating their difficulties (see section 3.2.1). Where possible, consider the diversity of students before they arrive in your lectures. For example, you may already know that a significant percentage of your students will be from Brazil, perhaps studying in the UK educational system for the first time. This could provide an opportunity to find out more about the Brazilian university system, and any differences in expectations or background of the students.

3.1.2 Director of teaching

Consider whether some students need extra introductory meetings at the start of term. Alternatively, you could arrange for training for tutors so that they provide the best welcome to the diverse cohort of new students. Check that introductory meetings have taken place. Learn about the prior experience of your students. Have international students directly entering your second year had the same laboratory experience at their previous university as UK students? Have all your students had the same opportunities at school to develop effective study skills? If your aim is to encourage students to think like a chemist, a physicist, astronomer or a forensic scientist, can you expect all your students to be starting from the same place? Make it clear that any student can contact you if there is a chance of them slipping through the net but provide other routes for communication if the student is shy or embarrassed.

3.1.3 Head of department

You have the opportunity and influence to develop both the scientific and working culture of your department. Make it welcoming to new students. Find opportunities to celebrate the diversity of your students, for example international celebrations, or student-led networking events with successful alumni, taking care to ensure a diverse range of role models. If students feel welcome enough that they can talk about the challenges they face to staff, you will halt the progress of many problems before they become insurmountable.

It is important to consider how you might foster good relations and celebrate the diversity of students (and staff) in your department. Good practice can occur both through activities specifically planned to enhance good relations and indirectly, especially through student-led activities. As an example of a directly planned diversity event, the School of Physics and Astronomy at Manchester organises an annual 'International Event' to celebrate the diverse background of staff and students. Participants are encouraged to bring some food typical from their home country which allows everyone to get a 'taste' of other countries. In contrast, the same School has student-led 'Random Walks in Physics' seminars where researchers are invited to discuss their subject. Despite the School having the typical undergraduate intake of ~20% female students, approximately 40% of the students who attend these seminars are female. The implication of both these events is that we can directly or indirectly create an environment that makes everyone feel comfortable and can celebrate diversity.

It cannot be stressed enough: talk to your students. You will get a much deeper insight into the challenges they face and they may provide you with some ready-made solutions that you can implement straight away.

3.2 Communication

Communication is vital if problems are to be addressed in a timely manner. If things go wrong, are there alternative members of staff for the student to contact? Do staff know whom to contact regarding an issue? Do you need to appoint an academic to act as liaison between your department and the university's disability unit?

3.2.1 Lecturer/tutor

Ensure students know how and when they can contact you. In addition, you could arrange for one or more of the students to act as a spokesperson, providing a safe, anonymous route for student feedback and questions. If a student does contact you, see it as an opportunity to broaden your own world-view and learn more about any specific challenges they might face. See such discussions as part of your own development as a well-rounded academic.

3.2.2 Director of teaching

Ensure that colleagues know whom to contact if they have any teaching related issues that affect specific groups of students. Make students aware of your commitment to equality and diversity and let them know that they can contact you. Are there opportunities where you can celebrate student success? Perhaps you have a competition for the best student poster, could you celebrate this on your web page? Role models can be an important source of inspiration for other students.

3.2.3 Head of department

Establish clear lines of communication within your department. Ensure that colleagues know whom to contact for each type of issue. Ensure there is no chance that information will be lost, and implement a follow-up system if necessary. A good communication infrastructure can help to resolve problems quickly.

A problem left for too long can transform from a molehill into an insurmountable mountain, so establish clear lines of communication and let everyone, staff and students, know whom to contact when issues arise.

3.3 Monitoring

As scientists, we appreciate the need for reliable and accurate data. It should be obvious then if we wish to ask questions such as “are international students as likely to progress to the fourth year as home students?” or “are female students as likely to get a first as male students?” then we need evidence. It is all too easy to just assume that everything is working correctly. At the very least, reliable data can reassure you that your processes are robust.

It is recommended that you go beyond the analysis of gender data for your student cohort and consider other characteristics. How many of your students need wheelchair access? How many students are from a particular country? How many are from a particular ethnic group? In practice, there is likely to be data you will not be able to get, and there is data that some students would not be willing to divulge. Where statistics are not readily available, it is still possible to gain an insight into potential issues by accumulating qualitative data (see Equality Challenge Unit 2010 for advice on this), such as through surveys or focus groups.

3.3.1 Lecturer/tutor

If you notice any issues affecting a particular group of your students, then consider the possible reasons, e.g. are some international students not performing as well as home students in your assessments? If you are unsure what to do contact your director of teaching, or equivalent.

3.3.2 Director of teaching

Consider what would be the appropriate level of monitoring. Will it allow you to react in real-time or will you analyse data on an annual basis? How will you spot potential issues? Will you monitor exam results by gender and other characteristics? You may wish to engage colleagues to develop a consensus on what should be monitored. Look at your student representation on your departmental committees. Are the numbers biased towards one particular group of students? Do you need to do some awareness raising of the benefits of student representation to encourage wider student participation?

3.3.3 Head of department

Do disabled students get marks in the laboratory comparable with students without disabilities? Are students coming from your foundation year as likely to progress to the fourth year as other students? If you are not sure, you (or your director of teaching) could answer these questions then open up a discussion about what could and should be monitored. The discussion itself will help to raise the profile of equality and diversity in your department.

Effective monitoring of student data allows you to investigate whether your systems are fair and robust. It may also reveal problems that were not immediately apparent.

3.4 Embedding good practice

If you really want to make your curriculum inclusive then training should be an essential component. The first part of this training would likely be awareness raising of the issues, ideally including unconscious bias training.

Unconscious bias training

For anyone who has attended a session on unconscious bias the realisation about how fragile our objectivity can be, even with the best intentions, can come as a shock. A head of department wishing to truly embed equality and diversity would do well to start with unconscious bias training for all staff, if only to encourage people to question their own assumptions and realise the need for change. The Equality Challenge Unit has provided [good research and resources](#) on this that could be easily adapted (Equality Challenge Unit 2013).

3.4.1 Lecturer/tutor

A diverse cohort of students provides a great opportunity for students to broaden their worldview, an important aim for anyone wishing to work in the diverse, international world of scientific research. Consequently, you might want to facilitate interactions between students from different backgrounds through group work. For example, do you always allow students in the teaching laboratory to select their own partner? Do students always tend to work together with students from their own country? Would it be an opportunity to mix the students, and give them the experience of working with someone from another

culture? Modern science often involves significant levels of collaboration between diverse groups of individuals from different countries. As you communicate the enthusiasm for your subject, students may not be aware of this diversity so consider whether there are places where you can bring it to their attention. It could be as simple as showing a photograph of members of an international collaboration at CERN, the European organisation for nuclear research, working on a new particle physics experiment, or a group of forensic scientists considering similar problems at a recent conference you attended. This will help students to realise the collaborative nature of science, and for some students it may be the first time they see role models of successful scientists from a similar background to their own.

As professional academics, we should consider learning about our students as important as learning about our research fields.

If you have a student with dyslexia for the first time, then spend an hour learning about the condition and the challenges the student faces. Consider how you can make your teaching more inclusive, this could include reviewing the clarity of your slides/handwriting, or considering the language you use. Do you always refer to the generic student as 'he', or do you need a good understanding of UK culture to understand all your amusing anecdotes? Inclusivity in teaching and learning is *not* about making your lectures boring, but it is about recognising that your students will come from different backgrounds and bring different experiences to your course. It encourages you to think deeply about the real core competencies that you hope to teach. Does a student really need to be able to read a dial on an experiment or is the core skill actually the ability to judge when to take a reading or how often to repeat it? When you write an exam question, are you obscuring the real chemistry problem to be solved with wording that adds an unnecessary level of complexity for international students? Consider also how you communicate results and the feedback you provide. For some international students 70% may appear to be a bad mark, so may need some reassurance that it is first class.

3.4.2 Director of teaching

Consider how good practice can be embedded when courses are created. Consider organising an equality and diversity audit and/or equality impact assessments of your programmes. Encourage lecturers to think deeply about the learning outcomes for their courses and whether any group of students might be at a disadvantage. Are courses presented in manner easily accessible for students with dyslexia? Are opportunities provided for students to mix? Is the language used biased towards one gender? Do panels considering the preparation of exam papers consider gender bias in questions, or the impact of wording on international students? You might produce a simple checklist to help colleagues focus on the task.

Start early. In your induction programme for new students, consider running icebreaker sessions that involve mixed groups of students. It does not need to be over engineered, and random groups are probably sufficient. Even better, consider activities that require groups to change a few times so that new students meet as many different students as possible. Friendships are often formed at the start of the degree, so this is a good opportunity to allow students to meet others from different backgrounds. Moreover, some students may feel particularly isolated and these fun sessions could lead to the formation of informal support networks between students. Opportunities to foster good relations within a diverse student cohort can also occur when you are arranging formal groups.

The single enthusiast or embedded practice?

It is all too easy for a head of department simply to pass on the role of advancing equality and diversity to a known enthusiast without giving much thought to the necessary structures and resources that need to be deployed. The enthusiast may do an excellent job and for many years things may run smoothly, but what happens if they leave? Will their expertise also be lost? How did their role fit into the operational running of the department, was it arranged on an ad-hoc basis or is it truly embedded? A truly inclusive curriculum is one which will persist even if key people leave.

3.4.3 Head of department

Make training an essential part of academic development in your development. Do you need a session on supporting students with Asperger's syndrome, or the experience of Chinese students in the UK? Consider holding an unconscious bias session to help staff realise the need for taking E&D seriously. Crucially, do not leave equality and diversity considerations to the few enthusiasts, make it an embedded part of your department and involve all staff.

Good practice needs to be implemented by everyone. Students will encounter many members of staff and effective training should be an important first step to making your curricula inclusive.

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Contact us

**The Higher Education Academy
Innovation Way
York Science Park
Heslington
York
YO10 5BR**

**+44 (0)1904 717500
enquiries@heacademy.ac.uk**

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