

PHYSICAL SCIENCES

Principles of inclusive curriculum design

Anticipatory
Flexible
Accountable
Collaborative
Transparent
Equitable

Generic considerations

- cost and financial considerations;
- embedding student and staff well-being;
- promoting student engagement;
- use of technology to enhance learning;
- responding to different approaches to learning;
- avoiding stereotypes and celebrating diversity;
- making reasonable adjustments.

Introduction

It is the responsibility of the every member of staff within HE to respond to the requirements of equality legislation. The basic principle that can and should be universally responded to is that **it is attitudes, barriers and other forms of discrimination within the system rather than individual characteristics or deficits that are the cause of disadvantage**. Employing an inclusive approach is underpinned by the adoption of other principles of inclusive curriculum design, summarised in the adjacent text box and discussed in the introduction section of this guide available at www.heacademy.ac.uk/assets/documents/inclusion/disability/ICD_introduction.pdf

May and Bridger assert, in respect of developing an inclusive culture, “making a shift of such magnitude requires cultural and systemic change at both policy and practice levels” (2010: 2). In essence this change is represented by a shift in focus from responding to the ‘needs’ of individuals or specific groups of students to an approach that anticipates and plans for the *entitlements* of the evolving student population. Thus the onus is on institutions and subject communities to change and adapt their policies and practice rather than expect this of individual or specific groups of students.

There are many generic considerations of inclusive curriculum design, summarised in the adjacent text box, which are discussed in the introduction section. The focus of this section is on subject-specific considerations for those in those subjects aligned to physical sciences. Here examples of innovation and effective practice are provided to demonstrate that effective practice for one group can and should be effective practice for all. The examples, resources and ideas included in this and other subject guides have come from the sector. They were obtained directly in response to a general request made to the sector during 2010, from a review of the HEA Subject Centres or from recommendations made by colleagues teaching in the specific subject.

Where there are examples in other subject guides that may be particularly relevant or worth reviewing for further adaptation these are flagged. However, notably inspiration and ideas for curriculum design can come from many sources, therefore reading strategies employed and ideas in other subject areas can be a useful source of new ideas.

Inclusive curriculum design: subject-specific considerations

Supporting the transition to higher education

The entry requirements set by a programme may result in assumptions about the skills and experiences students have acquired prior to entering higher education (Kelly and Finlayson, 2010). An inclusive approach involves a response to the prior experience and attainments of all students meeting the programme's entry requirements.

The University of Glasgow introduced a 'pre-lecture' as the first session of every lecture-based module. A test of background Chemistry knowledge enabled students to identify whether they needed or were able to offer help while working in pairs to revise prerequisite background material for the module. The result was that in comparison to years in which the pre-lectures were not provided: "End of year examination performance showed that student performance was no longer related to entry qualifications in chemistry: the least well qualified did as well as the better qualified" (Reid, 2003: 27).

The approach could readily be adapted to any subject area and has the potential to build peer support within a cohort.

Responding to different learning approaches

Students studying Physical Sciences will have prior experience of and preferences for different learning approaches and activities. An inclusive approach will embed a variety of learning activities into the Physical Sciences curriculum so that students can build on their previous experiences and have the opportunity to develop new approaches to learning and gain skills in new areas.

The University of Malta introduced an independent learning module with the aim of supporting students to develop independent learning skills and improve their confidence. The *Extraction processes – the aluminum*

industry unit was delivered online through a virtual learning environment where students could work at their own pace within a prescribed time frame. Tutor support was provided via discussion boards and email. Student feedback was positive and the suggestion made that independent learning units should be integrated into all terms. The format particularly benefited students reticent to participate in classroom settings who “became active participants on line” (Role, 2002).

In problem-based learning (PBL) the curriculum is organised around scenarios that drive student learning; students acquire knowledge and hone their problem-solving skills by undertaking self-directed activities to ‘solve’ the problem posed (Physical Sciences Centre, 2005). Many examples are available online, for example *Capital City*, a chemistry case study that focuses on the energy sources for an expanding city produced by the Royal Society of Chemistry (RSC, 2007).

www.heacademy.ac.uk/physsci/home/networking/sig/CPBL

Learning from and engaging students with Asperger’s syndrome

The University of Hertfordshire’s resource pack *Supporting Students with Asperger’s Syndrome a Physical Sciences Practice Guide* (Hughes et al., 2010) offers guidance about how to meet the entitlements of students with Asperger’s syndrome (AS). It has been developed in the physical sciences, but has much wider application across the sector. Its purpose is simple:

... to enable academics to help students with AS achieve the degree that genuinely befits their intellectual capabilities, rather than one that simply reflects the difficulties faced by their condition. (2010: 4)

Drawing on practice at the University of Hertfordshire and on a survey of colleagues working in the physical sciences, the guide is structured into three sections:

1. *Quick Guides* aimed at different members of staff such as lecturers, personal tutors and laboratory demonstrators;
2. *Booklet* with background information on supporting students with Asperger’s syndrome in the physical sciences;
3. *DVD* of an interview with a student with an undergraduate and Masters degree in Astrophysics (a transcript is included in the booklet).

Strategies that would have a wider benefit for all students include:

— planning ahead: providing effective information about assessment requirements, producing examples of revision

- guides and briefings on optional topics to support informed decision making;
- group work: consider assigning specific roles so all students know what is expected of them;
- providing regular specific feedback on laboratory books and other work, such as ‘add a diagram here’ or provide an example;
- providing information about changes as early and clearly as possible (Hughes *et al.*, 2010).

See also Economics, English, and Health Sciences and Practice subject guides for other examples of student engagement in module design.

Transferring good practice and learning from student experience

Laboratory work is an integral element of most Physical Sciences programmes. Many staff, students and employers may view laboratory work as an essential component of ‘being a scientist’. The challenge from an inclusive curriculum design perspective is to identify where practice can be adapted to make it more inclusive for all students and to revisit learning outcomes to ensure that the process (laboratory work) is not being mistaken for outcomes (the skill and knowledge students are expected to demonstrate). Considerable work has been undertaken across the sciences to develop comparable learning experiences that allow students to acquire and test the same skills and attributes required in laboratory work. The following examples illustrate how good practice from one subject to another can be transferred and how working collaboratively with staff and students the overall experience can be enhanced.

For further strategies for making learning in the laboratory more inclusive see the Bioscience, Engineering, and Geography, Earth and Environmental Sciences subject guides.

Teaching a Physics Laboratory Module to Blind Students is guidance structured around potential ‘problems’ and solutions identified when two blind students took a Physics module with compulsory laboratory component (Maddox and Morgan, 2009). Many solutions identified would have advantages for all students or could be readily adapted to meet the entitlements of specific groups of students:

- access to information – an electronic manual makes material more accessible to a wide range of students. It is more portable and can be annotated or adapted by students as they require;
- ask the student – engaging students to identify how the curriculum and its delivery could be adapted to make it more inclusive.

Using technology to support practical sessions

Techdis has produced a number of online tutorials to support inclusive teaching using technology in Physical Sciences. Considering delivery issues at the design and development stage of a new module can save a lot of time and avoid individual adaptation.

The Delivering Learning (Practical/Fieldwork/Placement) section provides a range of suggestions that could be incorporated into the curriculum to benefit all students:

- audio content that is more portable and private and brings the subject matter to life;
- PowerPoint can be set up to be 'mobile friendly';
- video can be 'more accessible than text' to demonstrate an experiment or stage of a practical;
- audio tours (like those produced for museums) can allow students to guide themselves around the laboratory or a piece of equipment at their own pace;
- photographs and video can be used in place of written text, for example to record results or demonstrate competence at a particular skill or task.

(JISC Techdis, undated)

www.jisctechdis.ac.uk/techdis/pages/detail/online_resources/Teaching_Inclusively_Using_Technology

An additional benefit of thinking about teaching and learning materials and activities for use in the laboratory is to challenge the assumptions held by staff and other students and to encourage them to think flexibly about how to achieve learning outcomes.

A key element of inclusive curriculum design is to identify where comparable learning experiences can be developed and incorporated into the teaching, learning and assessment to enable all Physical Sciences students to access the curriculum and meet learning outcomes.

This is particularly important where learning outcomes are required for a qualification to be accredited by a professional body or are required by potential employers of Physical Sciences graduates.

Web-based experiments in Physics and Chemistry

The University of Oxford has devised a number of web-based experiments that can be accessed remotely and allow communication with real equipment. The project's aims were to expand the range of experiments that could be undertaken in schools and FE colleges, to provide remote access to those unable to access campus-based laboratories and to minimise costs by sharing access to equipment. The benefits for all students include:

- access to experiments and equipment prior to entry raising interest in studying Physical Sciences in higher education and thus enhancing student diversity;
- remote and potentially more flexible access to experiments;
- financial benefits of sharing equipment and reducing the need for travel to access specialist equipment (Cartwright, 2003).

Connecting Chemistry concepts with practice online

Bridging to the Lab are online interactive laboratory activities designed to "emphasise the link between chemistry concepts and laboratory experiments rather than just simulating lab experiments" (Tasker, 2002). Students apply their knowledge to 'real-life' problems.

See Health Sciences and Practice, and Medicine, Dentistry and Veterinary Medicine subject guides for examples of virtual and simulated experiments.