Education for Sustainable Development

Sustainable development is a wide ranging, multi-disciplinary topic, but within some discipline areas it can be difficult to find links to sustainability. This paper aims to bring together some ideas for introducing Education for Sustainable Development (ESD) into teaching within different physical science disciplines. This paper is intended more for those who teach topics where ESD is not an integral part, but may also provide some useful ideas for those who already include ESD in their teaching.

What is the meaning of sustainable development?

One of the most widely quoted definitions of sustainable development, coined by the Brundtland Commission, is development that "meets the needs of the present without compromising the ability of future generations to meet their own needs"[1].

Why bother?

Although the concept of sustainability is not new, there is increasing realisation of the current impact humans have on the environment and that this may be placing an unsustainable burden on the planet. As well as enabling students to develop knowledge of sustainability concepts, ESD can also support the development of a range of skills in students, including critical thinking, the ability to evaluate and assess material, and problem solving-skills. The StudentForce for Sustainability report in 2008 to the Higher Education Academy[2] indicated that employers were increasingly looking for graduates with skills related to social and environmental responsibility. The report highlighted the need for HE Institutions to provide undergraduates with the opportunities to develop these skills. The need for sustainability skills has also been pointed out in a number of government reports, e.g., implementing the Leitch review[3].

Getting the ball rolling

If sustainability is peripheral to your subject area and you feel you lack knowledge of sustainability issues and developments, then you might want to think about bringing in outside expertise, going on a training course or working in conjunction with colleagues who have an environmental focus in their work. On pollution and 'green issues' direct attention to what can be done, not the mistakes of the past, e.g., the very positive efforts made by physical scientists to bringing attention to sustainability issues in the first place. In general students are more positively disposed towards future thinking and not 'all our yesterdays'. Consider keeping a record of any teaching practices implemented and their impact on students – this could form the basis of a case study or research paper.

Make some changes

Seminar series - Invite speakers with an environmental or sustainability background to give talks on their research. Local environmental or conservation groups or representatives from UK or worldwide groups with a focus on the environment could also be appropriate.

Tutorials - Discuss a paper with an environmental/sustainability theme. Nature[4], New Scientist[5], the Royal Society of Chemistry[6] and Scientific American[7] all have sections on their websites which bring together environmentally-themed papers and news which could provide a starting point for discussion. The Environmental Physics Group of the Institute of Physics produces a Newsletter two or three times a year[8].

Debate sessions - Consider topical issues. For example, Sir David King the former UK chief scientist suggested that the most brilliant minds should be directed to solving Earth's greatest challenges, such as climate change, and that less time and money be spent on endeavours such as space exploration and particle physics[9]. Students could be encouraged to research a topic and look at both the benefits and issues surrounding a particular activity or standpoint. Groups or individuals could adopt roles within a scenario, e.g. the head of a company that wants to replace an old polluting chemical plant with a more profitable one on an adjacent greenfield site, the company's chief chemist who monitors pollution, a local pressure group who don't want any new chemical plants, a local MP who raises questions in Parliament, a representative of Greenpeace, and a government minister who does not want the chemicals produced by the plant to be imported from the USA[10, 11].

Open educational resources - Much effort currently is being expended on setting up open educational resources (OER), so helping to avoid replication and reduce the time and cost of resource development. For example, the Skills for Scientists (OER) project will provide a wide range of resources for physical scientists, including some covering sustainability issues[12]. Context and problem based learning materials, some of which cover environmental issues, are available to download from the UK Physical Sciences Centre site[13]. OU Open Learn has a number of environmentally and sustainability-focussed online modules[14] which may be of interest to you or your students. The Toolbox for Sustainable Design[15] has resources and information to help plan a sustainability lecture or module. Although developed for engineering disciplines, much of the information is transferable to the physical sciences.

Is your department sustainable? - Making changes within your department to increase the sustainability of teaching practices and the department, then highlighting these changes and initiatives to students, could form the basis of discussion of sustainability concepts. Information sheets are available on how to make your practicals more sustainable[16] and how to make your office more sustainable[17]. These consider aspects such as paper usage, green purchasing and energy efficiency. As a department you might also consider getting involved with local conservation groups or activities.

Employability - Use discussions around employability to highlight sustainability and the Corporate Social Responsibility (CSR) reporting many companies undertake[18]. If students are considering an environmentally-focussed career, this could be essential for them.

Going further - Think about including aspects of sustainability as module aims and outcomes[19]. 'Hot topics' of environmental concern may be popular with students, for both laboratory and library-based research projects.

"But my discipline has little to do with sustainability"

Some subject areas within the physical sciences may seem, at first glance, to have relatively little to do with sustainability issues and the inclusion of ESD can feel like an add-on. The following topics could give you a starting point.

Chemistry

- Green chemistry, i.e., the design of products and processes that reduce or eliminate the use and generation of hazardous substances[20]
- Carbon footprinting, including determining an individual's carbon footprint[21]
- Processes of pollution, for example, production of ozone
- Development of CFC replacements[22]
- Carbon capture

Forensic Science

- Crimes of pollution including contaminated land and marine pollution[23]
- Wildlife crime including crimes involving species which are endangered or of conservation concern[24]
- Analytical methods for detecting environmental crime

Physics & Astronomy

- Physics of climate change
- Development of energy saving and so-called 'green' materials
- Do we need nuclear power?[25]
- Environmental impact of the Large Hadron Collider

References

1. World Commission on Environment and Development (1987). Our Common Future: Report of the Brundtland Commission. Oxford University Press, Oxford.
2. A. Cade. Employable graduates for responsible employers. [www.studentforce.org.uk/pdf/employablegraduates2008.pdf] *Research on the links between sustainability and employability in the graduate job market in relation to higher education teaching and learning.*
3. DIUS. World Class Skills: Implementing the Leitch Review of Skills in England. [www.eauc.org.uk/sorted/files/world_class_skills_final.pdf]
4. Nature. [www.nature.com/nature/focus/#earth]
5. New Scientist Environment section. [www.newscientist.com/section/environment]
6. Royal Society of Chemistry; Environment, Sustainability and Energy. [www.rsc.org/gateway/subject/envenergy] *Links to all content on the RSC website related to environment, sustainability and energy.*
7. Scientific American. [www.scientificamerican.com/energy-and-sustainability]
8. Institute of Physics, Environmental Physics Group. [www.iop.org/activity/groups/subject/env/index.html] *Information about the Environmental Physics Group and link to the Newsletter which highlights the Group's activities and environmental items of national and international importance.*
9. BBC News. 'Climate crisis' needs brain gain. [news.bbc.co.uk/1/hi/sci/tech/7603257.stm]
10. BBC News. Mixed reaction to chemical plant extension. [news.bbc.co.uk/1/hi/wales/742091.stm] *The investment at American-owned Dow Corning's plant in Barry had already created 200 jobs, but environmental groups were worried about the impact of the new development.*
11. Reuters. China approves controversial chemical plant in new city. [www.reuters.com/article/idUSTRE50C0YP20090113] *China's Environment Ministry has approved a petrochemical plant that drew fierce opposition over feared pollution in one eastern city; its construction will now be several miles away.*
12. UK Physical Sciences Centre, Higher Education Academy. Skills for Scientists (OER) project. [www.heacademy.ac.uk/physsci/home/projects/skillsforscientists] *Making a wide range of learning resources created by academics freely available, easily discovered and routinely re-used by both educators and learners.*
13. UK Physical Sciences Centre, Higher Education Academy. Context and problem based learning Special Interest Group. [www.heacademy.ac.uk/physsci/home/networking/sig/CPBL] *Teaching resources to download with environmental themes include: 'Capital City', 'CFCs', 'Dip on the Dribble' and 'Tales of the River Bank'.*
14. OU Open Learn Science and Nature. [openlearn.open.ac.uk/course/category.php?id=10]
15. Toolbox for sustainable design. [www.lboro.ac.uk/research/susdesign/LTSN/introduction/Introduction.htm]
16. How to… make your practicals more sustainable. [www.bioscience.heacademy.ac.uk/ftp/esd/howtopracticals.pdf]
17. How to… make your office more sustainable. [www.bioscience.heacademy.ac.uk/ftp/esd/howtooffice.pdf]

Briefing papers are designed to provide a condensed discussion on issues and topics related to teaching and learning in the physical sciences. Each guide focuses on a particular aspect of higher education and is written by an academic experienced in that field.

18. Values and Corporate Social Responsibility (CSR). [www.gees.ac.uk/projtheme/emp/valuesandcsr.doc] *Includes a list of key publications and links to relevant websites*.
19. How to make your modules a bit more sustainability oriented. [csf.plymouth.ac.uk/?q=node/585] *Guidance from the Centre for Sustainable Futures (CSF) on embedding sustainability into the curriculum with examples from a number of Schools at the University of Plymouth*.
20. Green Chemistry Network. [www.greenchemistrynetwork.org/index.htm] *The Green Chemistry Network (GCN) aims to promote awareness and facilitate education, training and practice of Green Chemistry in industry, commerce, central, regional and local government, academia and schools. Includes a series of undergraduate practical experiments*.
21. Carbon Footprint. [www.carbonfootprint.com/index.html] *Explains the concept and provides carbon footprint calculators*.
22. Alan Heaton, Simon Hodgson, Tina Overton & Richard Powell (2006). The challenge to develop CFC (chlorofluorocarbon) replacements: a problem based learning case study in green chemistry. Chemistry Education: Research and Practice, 7 (4), 280-287.
23. Contamlink - Contaminated Land Resources. [www.contamlinks.co.uk] *A portal for anyone seeking information about the assessment, management and remediation of contaminated land*.
24. Partnership for Action against Wildlife Crime. [www.defra.gov.uk/paw] *PAW is a multi-agency body comprising representatives of the organisations involved in wildlife law enforcement in the UK*.
25. Do we need nuclear power? [physicsworld.com/cws/article/print/128] *Discussed by a nuclear physicist, who says yes, and an economist, who says that we should first explore the possibilities of renewables and other forms of energy.*

Other resources

Forum for the Future. [www.forumforthefuture.org] *Forum for the Future works with leaders from business and the public sector to create a green, fair and prosperous world.*

Higher Education Academy. [www.heacademy.ac.uk/esd] *A portal to ESD in higher education.*

UK Physical Sciences Centre, Higher Education Academy. [www.heacademy.ac.uk/physsci/home/pedagogicthemes/sustainabledevelopment] *A portal to ESD in the physical sciences.*

Acknowledgement

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