BIOSCIENCES FEDERATION


# Science and Learning

## A response to the DCSF/BIS Science and Learning Expert Group

September 2009

***Introduction***

The **Biosciences Federation** (BSF) is a single authority representing the UK's biological expertise, providing independent opinion to inform public policy and promoting the advancement of the biosciences. The Federation was established in 2002, and is actively working to influence policy and strategy in biology-based research – including funding and the interface with other disciplines - and in school and university teaching. It is also concerned about the translation of research into benefits for society, and about the impact of legislation and regulations on the ability of those working in teaching and research to deliver effectively. The Federation brings together the strengths of 45 member organisations (plus nine associate members), including the Institute of Biology.

The **Institute of Biology** is an independent and charitable body charged by Royal Charter to further the study and application of the UK's biology and allied biosciences. It has 12,000 individual members and represents 32 additional affiliated societies. This represents a cumulative membership of over 65,000 individuals, covering the full spectrum of biosciences from physiology and neuroscience, biochemistry and microbiology, to ecology, taxonomy and environmental science.

***Q30. What are the most effective ways of encouraging engagement, participation and progression in science/maths, particularly for the most promising students?***

i) **Provide quality teaching**
One of the key factors is the quality of the teaching and of teachers. While young people can be attracted to science by exciting practical work, news features,

exhibitions, museums, stories of interesting discoveries which they can relate to, retaining interest and excitement is often the consequence of inspirational teachers. High calibre people need to be encouraged to become science teachers and once qualified, teachers must be supported. Science knowledge and its interpretation are constantly changing as new evidence and theories become available making CPD for teachers in terms of their knowledge base, in addition to pedagogy, particularly important. There is also a case for providing additional training in contemporary science for those coming to teacher training some years after studying science themselves.

ii) **Ensure science is marketed well and that accurate, informed careers advice is available to children**
Science is not perceived by many of the adult population (i.e. parents) as interesting or valuable; furthermore, many are ignorant of the career opportunities open to science/maths graduates. It is important to show science to be relevant to and critical to the world around us and that it provides exciting, well paid jobs which are crucial to the knowledge-based economy and are valued by society. Graduates from our main science/technology/medicine university enjoy very high employment levels and earn salaries within 5 years of graduation that are second only to the LSE; we need to be able to get this information to young people at critical stages of their education. More accessible and local UCAS and careers fairs could aid this.

Appreciation of the diverse variety of careers that an education in science and maths can offer (including non-science careers) is essential and this requires good, positive marketing of the sciences/maths through media campaigns that young people can identify with, and ensuring that schools and colleges have access to fully informed careers advisors. Programmes such as Silent Witness are very effective in recruiting students (here to forensic science courses) – however in this case we have an example of how using the media can go wrong. If the authors of potentially popular programmes were prepared to work with scientists they could incorporate a good educational component that would help direct students in the right direction and use such programmes to benefit.

More extensive engagement with the research community and experience of practical science in university and other environments can be a means of providing information and experience of the context and application of the specific subject to provide young people with answers to questions such as : What makes the subject important? Where is it used? What is the diverse range of careers that these subjects can lead to?

iii) **Deliver inspiring curricula and outreach opportunities**
Including more open-ended practical work and give students a sense of ownership by having a say in curriculum development could help as would increasing awareness of outreach opportunities (eg STEM directories; outreach days at Universities including lab tours and talking to real scientists).

***Q31. What are the major barriers to ensuring that young people feel engaged in science/maths and that those with the potential progress to more advanced levels?***

i) **Relative Difficulty**

There is an ethos that science and maths are more difficult than other subjects and there is evidence for this being the case for some subjects and levels (2008 Relative Difficulty report; see http://www.score-education.org/2projects/relative_difficulty.htm). Students are therefore put off choosing these subjects knowing they have less chance of achieving high grades, and presumably schools too (no good for league tables); A level biology entries were down this year and this is very worrying. Students may also find they have inappropriate qualifications for entering HE courses at the start of A2 (or equivalent) when completing UCAS applications when it is too late to change courses. This issue of relative difficulty and its impact needs addressing.

ii) **Peer pressure/role models**
There are too few appropriate role models in those aspects of public life appreciated by young people. This is exacerbated by the people profiles with short CVs that frequently appear in the newspapers – only very occasionally have those people interviewed read science or maths at university. Another example is that once identified as a good science presenter, often the presenter is asked to cover all areas of science often distinct from her/his area of expertise. It is still not 'cool' to do science or to be seen to be clever or a swot, this negative attribute needs challenging.

iii) **Lack of support**
Lack of support from home can vary from no interested in education at one end of the spectrum to family traditions and beliefs that the 'arts and classics' are superior and provide a more rounded education (also prevalent in some teachers) at the other. For those who do support their children in science education, the range of qualifications (iGSCEs, GCEs, new diplomas, NVQs, BTECs, A levels, international baccalaureate, pre-U's etc) must seem bewildering. Within GCSE sciences for example there are many levels, exam boards, specifications and awards (single/double/triple, foundation/higher, combined/additional/applied; aqa/edexcel/ocr/wjec etc).

iv) **Schools and curricula**
The curricula are very broad, prescriptive with large amounts of material. Teachers are not necessarily informed or enthused about all aspects of the curriculum and teaching can reflect this. Mechanical and assessment-based teaching does not allow students to become engaged and have some ownership of the subject.

v) **Inadequate careers advice**
See 30 (ii). Knowledge of careers and progression routes is inadequate.

***Q32. Why, and at what stage in a young person's education do you think engagement of promising young people in science/maths reduces?***

i) **Secondary school**
Some students become disengaged at around year 9. The initial inherent enthusiasm for science and the world around them that can be highly developed in primary school children is lost at this stage because:

- The science subjects are seen as hard

- Science is not see as relevant (i.e. the context and applications are not well presented to them).
- Time dedicated to investigative practical work may be reduced.
- There is significant over assessment so that the purpose of studying science is to pass the exams.
- Exam boards construct the syllabuses with the primary aim and focus of designing the assessment. This constrains the skills taught and emphasises the dominant role of assessment in the teaching and learning.
- See also reasons discussed above.

ii) **Primary school**

In relation to primary school, with the recent abolition of key stage 2 SATS in science there is a worry that science will now not be considered as important as maths and English, and with less formal SATs assessment, there is concern that science will not be taught as extensively as in the recent past. Sadly, some young people never have a chance to engage in science because the teaching at primary school is so poor they fail to acquire the basic skills necessary in maths and English to progress.

***Q33. What suggestions do you have for overcoming the barriers to improving engagement, participation, and progression in schools and colleges?***

These could include:

- recruit more talented teachers who can inspire and educate young people, and to re-engage teachers with the subject to promote enthusiasm
    - ring fence funding and timetable slots for nationally comprehensive teachers CPD
    - ring fence funding and appropriate reward/appreciation for tertiary academics to deliver teachers CPD
- raise the profile of the teaching profession and paying them a salary commensurate with the important role they fulfil for society would be good step forward.
- address the discipline problem in some schools as potentially good teachers are put off and either leave the profession or go to the private sector.
- provide facilities for practical work, resources for consumables and good IT support.
- reduce assessment and put more emphasis on student-centred learning with less importance given to factual recall
- provide and advertise good outreach opportunities (eg STEM directories) and encourage links between schools and organisations (eg HE)
- make teaching relevant to the real world (eg climate change, genetic modification) and portray in a positive light On this point, it often seems that thought that the positive light shone on science is not even Medical/molecular advances eg stem cell, new cures for cancer)are phrased in a very optimistic and positive light, whereas other areas such as climate change and plants, particularly GM are portrayed as pessimistic and negative (eg Frankenstein foods, messing with nature, climate change as humans fault. The classic example in GM foods; risk

benefit analysis always emphasizes the risk and does not weigh this against the benefits.

Thus the language used to describe context and opportunities need to be considered carefully and 'spun' positively wherever possible.

***Q34. What skills, qualifications and experience are most important for a school/college to be able to deliver effective science/maths teaching?***

i) **Teachers**
There is a need to recruit and retain high quality, enthusiastic and qualified teachers who have a passion for science including practical aspects (including ability to deliver real student centred learning) which at secondary level must be educated to degree level in the science they teach or maths for maths teachers; for primary school teaching, a degree in science. A physicist teaching biology, for example, is not appropriate. There is concern that biology teachers may be encouraged to teach other sciences due to financial incentives. Funded resources for demonstrating 'how science works' components of the curriculum would be helpful. See comments on CPD in other sections.

ii) **Leadership and facilities**
Good leadership within the school which values the importance of science and promotes its study and a supportive and objective Board of Governors is important as is good IT support and library facilities. Adequate facilities/resources and training for those with limited laboratory experience undertaking practical teaching, and well trained technicians and removal of any health and safety barriers that prevent practical and field work.

***Q35. What are the most effective ways of providing young people with information, advice and guidance about higher education and careers in science and engineering?***

i) **Provide quality careers and post-16 progression advice**
Many careers advisors do not have a science background and hence may lack confidence and knowledge when it comes to advising on science careers. Science subjects are hugely diverse and for even an active scientist to be able to confidently distinguish between different disciplines can be challenging. A well resourced Careers Department that engages with HEs and potential employers and specialist science careers advisors is a way forward here. Of importance:

- Linking secondary and tertiary careers information delivery.
- Funded, comprehensive interaction with tertiary education
- Two way communication and interaction with employers
- Use of modern technology
- Teacher CPD in contemporary science to appreciate the possibilities
- Provision of careers information for pre-GCSE children (especially now some schools teach GCSE from year 9 following abolition of key stage 3 SATs.

ii) **Role models and media**
More extensive communication through media that young people engage in and encouraging parents, retired scientists etc. who will devote time to talking to pupils about the potential of studying science could be encouraged.

***Q36. What more could be done to improve the skillset of science/maths students to help them progress successfully to pure science subjects and engineering in higher education and science-related employment?***

In addition to the general points raised above in relation to quality and support of specialist teachers, and careers advice (particularly clear information about applications (contexts) and careers in the science subjects), there is scope for making improvements in the curricula of GCSEs and A levels to ensure that students are better prepared for university. This could be helped by a closer collaboration between HE, employers, bodies such as ABPI and the curriculum developers and government (through partnerships such as SCORE). Additionally, increased inquiry based learning and open ended investigative work (with emphasis on appropriate practical, field and maths skills) rather than summative assessment will in the long term aid reasoning and other higher level skills required for HE and the workforce.

***Q37. What skills do you think should be developed further as part of a science education to enable young people to succeed in employment?***

Skills to develop the ability to interpret, apply and communicate scientific knowledge in new contexts and situations (rather than in an exam situation). Thus:

- Communication skills (oral and written), including debating
- Critical thinking
- Critical analysis and interpretation of data and other material
- Understanding of the importance of evidence base
- Awareness that things are not black and white
- Ability to marshal facts/information and develop logical evidence based reports
- Awareness of ethical issues – increasingly important in the biosciences
- Team working skills
- Experimental design, and especially basic maths and statistics and knowledge of standard units
- IT skills
- A positive attitude to diversity
- An awareness of how to advance their career
- Basic concepts of business, including IP awareness
- A balanced portfolio of extracurricular activities
- Recognition of their individual strengths and weaknesses
- Independent learning (i.e. PBL)
- Objectivity
- Integration of skills from different sources

- Appropriate practical skills and ability to use investigative skills in novel situations
- Ability to write extended prose, and better grammar

***Q38. What skills do you think society values in science students and graduates?***

There are important challenges that our society is facing in relation to issues of biological importance such as implications of stem cell research, food supplies, loss of biodiversity, obesity, genetic manipulation, medical advances and threats and climate change. Scientists have the ability to identify such key challenges, increase public awareness and address these issues. Scientists have the ability to evaluate data critically and to marshal facts/information to develop logical evidence based views and have numerical and IT skills which can be applied in a wide range of contexts. Scientists have potential to contribute to society and the economy through research and development. However, the importance of scientists in the 'knowledge economy' we now live may not be appreciated by society. Good communication, in particular to non-specialist audiences to de-mystify science is important and valued by society.

***Q39. How could links between schools, colleges, universities, employers and other institutions be improved to support engagement, participation and progression in pure science subjects and engineering?***

Most HEs, learned societies and other organisations do a lot through their outreach programmes and, in the current economic climate, may be stretched to do more. It's important to ensure that credit is received for both teachers and researchers for engaging in schools liaison (and is considered as important for career development as research and teaching). Conventional teaching and assessment time in HEs could be freed up for communication between schools and tertiary education. Fully fund projects would be welcomed to engage in mandatory two way communication between researchers and schools. Advice is needed before inappropriate subject choices are made and both advisors and students need to be made aware of how selection processes take place (eg performance in level 3 qualifications, predicted grades, unit breakdown, personal statement).

More, however, could be done by employers to engage with schools and help the pupils understand the place of science in these companies and how a science degree has helped the employees to succeed in their careers.-perhaps there could be better tax breaks to encourage employers to do this. Work placements can be effective. However, they are very costly to employers as the students are rarely there long enough to make a useful contribution (or indeed to get a real appreciation of the work ongoing). Health and Safety legislation and new laws on working with children under 16 will make it more difficult for employers to provide effective placement schemes. A greater opportunity for apprenticeships that have the potential to lead to degree courses – better partnerships between employers, FEs and HEs would help in this regard. The new diplomas may help integration here. More opportunities for undergraduates to do interns in industry as part of their undergraduate degree – these positions are becoming more difficult to attain in the current economic climate,

particularly for short-term placements (e.g. 3 months). Greater opportunity for sandwich years for undergraduates would also be valuable.

If the curricula were more open and less prescriptive, more opportunities would become available for these types of collaborations.

***Contact***

We should be happy to provide additional information to the Science and Learning Expert Group. Any queries regarding this response should in the first instance be addressed to Dr Caroline Wallace, Policy Coordinator, Biosciences Federation, c/o 9 Red Lion Court, London EC4A 3EF email: cwallace.bsf@physoc.org.

## Appendix

**Member Societies of the Biosciences Federation**

Association for the Study of Animal Behaviour
Association of the British Pharmaceutical Industry
AstraZeneca
Biochemical Society
Bioscience Network
British Andrology Society
British Association for Psychopharmacology
British Biophysical Society
British Ecological Society
British Lichen Society
British Mycological Society
British Neuroscience Association
British Pharmacological Society
British Phycological Society
British Society of Animal Science
British Society for Developmental Biology
British Society for Immunology
British Society for Matrix Biology
British Society for Medical Mycology
British Society for Neuroendocrinology
British Society for Plant Pathology
British Society for Proteome Research
British Toxicology Society
Experimental Psychology Society
Genetics Society
Heads of University Biological Sciences
Heads of University Centres for Biomedical Science
Institute of Animal Technology
Institute of Biology
Institute of Horticulture
Laboratory Animal Science Association
Linnean Society
Nutrition Society
Physiological Society
Royal Microscopical Society
Royal Society of Chemistry
Society for Applied Microbiology
Society for Endocrinology
Society for Experimental Biology
Society for General Microbiology
Society for Reproduction and Fertility
Syngenta
Universities Bioscience Managers Association
UK Environmental Mutagen Society
Zoological Society of London

**Associate Member Societies**

Association of Medical Research Charities
BioIndustry Association
Biotechnology & Biological Sciences Research Council
GlaxoSmithKline
Merck, Sharp & Dohme
Pfizer
Royal Society
Wellcome Trust
Medical Research Council

**Additional Societies represented by the Institute of Biology**

Anatomical Society of Great Britain & Ireland
Association for Radiation Research
Association of Applied Biologists
Association of Clinical Microbiologists
Association for Veterinary Teaching and Research Work
British Association for Cancer Research
British Association for Lung Research
British Crop Production Council
British Microcirculation Society
British Society for Ecological Medicine
British Society for Research on Ageing
British Society of Soil Science
Fisheries Society of the British Isles
Freshwater Biological Association
Galton Institute
International Biometric Society
Marine Biological Association of the UK
Royal Entomological Society
Scottish Association for Marine Science
Society of Cosmetic Scientists
Society of Pharmaceutical Medicine

**Additional Societies represented by the Linnean Society**

Botanical Society of the British Isles
Systematics Association