Science and Learning

Consultation Response Form

The closing date for this consultation is: 18 September 2009
Your comments must reach us by that date.

department for
children, schools and families

BIS | Department for Business Innovation & Skills

THIS FORM IS NOT INTERACTIVE. If you wish to respond electronically please use the online or offline response facility available on the Department for Children, Schools and Families e-consultation website (http://www.dcsf.gov.uk/consultations).

The information you provide in your response will be subject to the Freedom of Information Act 2000 and Environmental Information Regulations, which allow public access to information held by the Department. This does not necessarily mean that your response can be made available to the public as there are exemptions relating to information provided in confidence and information to which the Data Protection Act 1998 applies. You may request confidentiality by ticking the box provided, but you should note that neither this, nor an automatically-generated e-mail confidentiality statement, will necessarily exclude the public right of access.

Please tick if you want us to keep your response confidential. ☐

Name David Montagu

Organisation (if applicable) The Royal Society

Address: 6–9 Carlton House Terrace, London SW1Y 5AG

If your enquiry is related to the policy content of the consultation you can contact Rory Gallagher (DCSF) or Alex Morris (BIS):

Rory Gallagher
Telephone: 0207 925 5631
email: rory.gallagher@dcsf.gsi.gov.uk

Alex Morris
Telephone: 0203 300 8723
email: alex.morris@dius.gsi.gov.uk

If you have a query relating to the consultation process you can contact the Consultation Unit on:

Telephone: 0870 000 2288

e-mail: consultation.unit@dcsf.gsi.gov.uk

Please mark ONE box which best describes you as a respondent.

☐ School Sector	☐ Further Education Sector	☐ Higher Education Sector
☐ Employer	☑ Science Association/Body	☐ Union/Professional Association
☐ Local Authority	☐ Training Provider	☐ Parent
☐ Young Person	☐ Other	

Please Specify:

The Royal Society is the world's oldest scientific academy in continuous existence, and has been at the forefront of enquiry and discovery since its foundation in 1660. The backbone of the Society is its Fellowship of the most eminent scientists of the day, elected by peer review for life and entitled to use FRS after their name. There are currently more than 60 Nobel Laureates amongst the Society's approximately 1,400 Fellows and Foreign Members. Throughout its history, the Society has promoted excellence in science through its Fellowship and Foreign Membership, which has included Isaac Newton, Charles Darwin, Ernest Rutherford, Albert Einstein, Dorothy Hodgkin, Francis Crick, James Watson and Stephen Hawking. The Society is independent of government, as it has been throughout its existence, by virtue of its Royal Charters. In 1663, The Royal Society of London for the Improvement of Natural Knowledge was granted its Arms and adopted the motto 'Nullius in verba', an expression of its enduring commitment to empirical evidence as the basis of knowledge about the natural world.

Supporting excellence in science is at the heart of all the Society's work.

More information can be found at http://royalsociety.org.

This response form is split into four different sections - please note that you only need to complete the section which is relevant to you.

Please only answer:

Section 1 (Questions 1-13): If you are from the schools or further education sector
Section 2 (Questions 14-23): If you are from the higher education sector
Section 3 (Questions 24-29): If you are an employer
Section 4 (Questions 30-39): For all other respondents

SECTION 4: FOR ALL OTHER RESPONDENTS

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

Comments:
Essential requirements are that of (i) a curriculum and qualifications structure that is conducive to providing students of all abilities and ambitions with a solid, stimulating grounding in science and mathematics; (ii) sufficient numbers of teachers with specialist knowledge of these subjects capable of bringing these subjects to life, and of challenging, supporting and motivating their students so they may fulfil their potential in them; (iii) appropriate mechanisms of assessment that put emphasis on enabling students to show understanding of scientific concepts and apply mathematics as opposed to reproducing facts and testing numerical skills; and (iv) the demand among employers, and in wider society, for STEM professionals. Unfortunately, the curriculum and qualifications structure is becoming progressively more complicated and inequitous (*Science and mathematics, 14–19* (Royal Society 2008)), there are insufficient numbers of specialist science and mathematics teachers (*The UK's science and mathematics teaching workforce* (Royal Society 2007)) and the assessment of, for example, mathematics at Key Stage 2 and science at Key Stage 4 is, respectively, inappropriate (*The mathematics education landscape in 2009* (ACME 2009) and requiring improvement (*GCSE Science 2008 examinations* (SCORE 2009)).

In addition, an array of initiatives and activities, including both formal and informal learning experiences, can excite and engage young people about science and mathematics, and it is vital that as much is possible is done to encourage, engage and enthuse students' interest in these subjects. Through the STEM programme, the STEM education community has been making significant efforts to improve the impact of projects to develop scientific and mathematical literacy in young people, in particular, the greater co-ordination of enrichment and enhancement (E&E) activities. In September 2008, STEM Directories in each of Science, Mathematics, and Engineering & Technology were published, providing a listing of nationwide and regional E&E schemes for schools and colleges. This initiative is designed to provide teachers with a coherent picture of the E&E activities on offer, to identify gaps in provision, to enable providers to identify and learn from good practice, and also to increase the breadth of appropriate provision. Continued commitment to this programme of activity, with strategic leadership provided by the Science Community Representing Education (SCORE), the Advisory Committee on Mathematics Education (ACME) and Education for Engineering (E4E), should provide positive impacts for teachers and young people.

The Royal Society has shown sustained commitment to a unique and

successful E&E initiative since 1996 through its Partnership Grants scheme, with some 65,000 pupils taking part since 2001. In 2008 the Partnership Grants scheme awarded 57 grants totalling *ca*. £125,000 to 30 Primary schools and 27 Secondary schools or sixth form colleges, enabling them to work with a scientist or engineer on imaginative and relevant science projects. These projects often include the school or college's local community and parents.

The Society also supports several other successful initiatives including the Nuffield Science Bursaries for Schools and Colleges, the Big Bang Fair and the British Science Association's CREST awards.

In addition to these initiatives, each year the Royal Society runs a significant public programme to *inspire an interest in the joy, wonder and excitement of scientific discovery*, which includes lectures, panel discussions, library talks and a Summer Science Exhibition. The Society's lectures are webcast live and made available online as video on demand (library talks are available as a podcasts) to allow the widest number of people to access the public programme. The Summer Science Exhibition provides a chance for several thousand visitors to engage with cutting-edge science, technology, art and history of science exhibits over four days, at the Royal Society's premises in central London. Over 1,000 schools visitors attended the exhibition in 2009, with evaluation showing significant impact on their interest in and knowledge about science. In 2010, as part of the Society's 350th anniversary celebrations, the exhibition will be expanded into a nine day *Summer of science* festival at London's South Bank Centre, which will incorporate an expanded and enhanced Summer Science Exhibition with an accompanying public programme of lectures, debates and concerts as well as family and school workshops. Our anniversary programme includes partnership activities with major London museums and galleries to highlight the often neglected role that science plays in the cultural life of the capital. We are also working with over 60 museums and galleries across the UK on a celebration of local scientific heroes – from pioneers of the Industrial Revolution to contemporary scientists finding solutions to today's problems.

Additionally, the Royal Society's Press Office works to engage the wider public with science through media coverage of the Society's activities, and by drawing attention to research published in the Society's peer review journals.

31 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?

Comments:
Teachers have a central role in developing young people's interest in science and mathematics and encouraging them to pursue studies in these subjects post-16. As per our response to question 30, we believe that it is crucial to have a motivated workforce with the subject knowledge and pedagogical expertise to bring these subjects alive inside and outside the classroom, and to overcome an ingrained cultural negativity towards these subjects. In addition, there are insufficient numbers of subject experts teaching science and mathematics and too few of them are taking advantage of the professional development opportunities being made available to them by the National Network of Science Learning Centres.

The Society's recent reports, *Exploring the relationship between socioeconomic status and participation and attainment in science education* (2008) and *Science and mathematics education 14–19* (2008), included analyses of existing datasets for evidence of a link between socioeconomic status (SES) and participation and achievement in science, a review of existing studies and literature, and (in the case of the former) the results of focus groups with young people, parents and teachers about their perceptions of this issue. These analyses found that evidence for a direct causal relationship between SES and participation and attainment in science is inconclusive, and that the main barrier to participation in science by young people of low SES is poor prior attainment.

The former report (available at http://royalsociety.org/downloaddoc.asp?id=5997) highlighted that there are instances of successful pedagogies and interventions supporting young people from low SES backgrounds to be high attainers in science, and those individuals and organisations responsible should be given more opportunities to share their good practice with others. Notably, it also concluded that further research is required in order for greater understanding to be gained of the changes between SES and attainment in science.

In 2004 the Society produced *Taking a leading role – a good practice guide* for all those involved in role model schemes aiming to inspire young people about science, engineering and technology. Research has suggested that positive role models can play a major part in challenging the stereotype of science and engineering between unsuitable for some groups. This resource included practical advice for scheme organisers, role models and schools & teachers in how role model schemes can better engage young people, especially girls and those from ethnic minority backgrounds, in SET. The resource (and associated research) is fully downloadable from our website at www.royalsociety.org/rolemodels

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

Comments:
The Royal Society's 2008 report *Science and mathematics education, 14–19* provides a comprehensive review of research into students' attitudes to science and mathematics. It concludes that attitudes to science become less positive through the years of secondary education, with the most acute fall-off in interest occurring between the ages of 11 and 14. During the years of secondary education, negative attitudes towards science are associated with perceptions that the curriculum is overly full, fact-laden and hard. The perception of difficulty is reinforced by evidence that students are less likely to achieve higher examination grades in science and mathematics, and continuing negative views of scientists and misperceptions of the earnings potential of those who pursue careers in STEM.

A further, more recent study (*Primary–secondary transfer in science*, Wellcome Trust 2009) has provided further evidence that students' attitudes towards science and mathematics dip between Years 6 and 7 (during the primary–secondary transition), and this appears to be closely linked with, among other factors, lacklustre teaching.

The Royal Society believes that more research is needed in this area and, with support from the Ogden Trust and Shuttleworth Foundation, has just launched two Education Research Fellowships that will investigate, respectively, the impact of 'enrichment' activities on STEM and the mismatch between the intention behind and assessment of GCSE mathematics.

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

Comments:
It is vital that the Government holds to its commitment to ensure that there is at least one mathematics specialist in each primary school in England, and it should work hard to achieve a similar result in respect of science teachers. Similarly, investment is required to ensure that there are sufficient numbers of committed subject specialist teachers in science and mathematics at secondary school level. In all cases, opportunities for subject-specific continuing professional development in science and mathematics must be funded and actively encouraged. Making this an entitlement for teachers would be beneficial.

It is equally important that the curriculum should be modified (i) to ensure that it is not overly prescriptive, but flexible and encouraging of imaginative approaches to teaching and learning; (ii) and reviewed in a systematic (rather than the current piecemeal) manner in order to help ensure that learning across all phases of 5–19 education is progressive. Further, mathematics tests at Key Stage 2 should be abolished for precisely the same reasons that the Expert Group on Assessment marshalled in recommending the abolition of national tests in science at Key Stage 2.

Research is needed into patterns of socioeconomic and ethnic participation and attainment, making use of NPD data. In addition, the Government should attend to the fruits of its own research, eg that into *Progression to post-16 science: the report* (DCSF 2009).

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

Comments:
There is no straightforward answer to this because the ability to teach science or mathematics well is not necessarily connoted by an individual's qualification or level of qualification. The Royal Society's 'state of the nation' report on *The UK's science and mathematics teaching workforce* (Royal Society 2007) makes it very clear that while the degree class of applicants to initial teacher training courses may provide a reliable indication of their subject knowledge and expertise, it is certainly not an indication of their ability to teach.

Teachers in schools and colleges require access to high quality subject-specific professional development, which too few are accessing currently. Making this an entitlement for teachers would be beneficial (see 33 above).

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

Comments:
The Government's strategy set out in *Science and Innovation Investment Framework 2004–2014: Next Steps* (2006) highlighted the importance of partnerships between science centres and other stakeholders such as universities, learned societies and Research Councils in demonstrating to young people some of the exciting and inspiring opportunities that studying science can lead to. It is encouraging then that science and engineering clubs, for example, one of the commitments for Collaboration and Partnership, are already part of the UK Network of Science Centres and Museums (The Association for Science and Discovery Centres).

In addition, more needs to be done to communicate online resources of information on STEM careers, notably the Future Morph and MathsCareers websites (http://www.futuremorph.org/; http:www.mathscareers.org.uk). Anecdotally, it is understood that there are few careers advisers who have a background in science and mathematics. An audit of the STEM skills/experience of information, advice and guidance (IAG) practitioners is desperately needed, with a view to developing a strategy to recruit sufficient numbers of these to meet national needs.

36 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?

Comments:
Many of the answers to this question are provided in our response to Question 33. In particular, SCORE's recent report on the 2008 science GCSE examination papers has raised issues over the interpretation in awarding body specifications of the 'How science works' element of the curriculum. Clarity is required about this. In addition, the science-specific skills of accurately measuring, collecting and analysing data need to be emphasised within their science learning. In order to help develop their generic communication skills, students need to experience a range of pedagogical techniques.

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

Comments:
This is a very broad question, for it seems to relate to employment in general, rather than STEM employment specifically. There are both generic and more specific STEM skills, and it would be wrong to suggest that only some, as opposed to all, of these skills need to be developed further as part of a science education *per se*. Science is a process first, a body of knowledge second. It is predominantly concerned with experimentation and testing of 'fact'. Inherent in the practice of science is the development of investigative (including mathematical skills), creative thinking, critical questioning and thinking and problem-solving skills, and each of these skills is likely to be applicable to the workplace and should be emphasised in science education. But it is important that these skills are developed alongside other more generic skills, such as communication (including usage of English, ICT and presentation skills), teamwork and time-management.

38 What skills do you think society values in science students and graduates?

Comments:
Evidence for this may best be found in the CBI Education and Skills Survey, the latest of which (2008) indicated that particular STEM skills being valued among employers of STEM graduates were their numeracy, analytical and problem-solving skills, though it was recognised that these skills are demanded by every sector of the economy.

39 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?

Comments:

The Royal Society has previously said that any research quality assessment exercise must be able to capture excellence in activities such as public policy involvement or involvement in public engagement and outreach work (*Response to HEFCE's consultation on the* assessment *and funding of higher education research post-2008* (Royal Society 2008)). Researchers who, for example, produce fewer research papers, but who provide excellent evidence and advice to policymakers and/or who take time to discuss their research with the public should not be at a disadvantage in the assessment system. Such scientists need support, reward and recognition.

The Society has also advocated (in *A higher degree of concern* (Royal Society 2008)) that when changes are proposed/made to the secondary science curriculum, the needs of students entering STEM higher education must be taken into account explicitly. In addition we believe that broader courses covering a wider range of science subjects should continue to be developed, as they may prepare people to be scientifically literate citizens.

The Society has well established communication and media training courses that enable scientists to explain their work effectively and memorably to non-specialist audiences and provide them with the skills to handle media situations effectively and with confidence. A total of 77 scientists were trained on the Society media and communication skills courses in the financial year 2007/2008. These courses are offered free to Royal Society Research Fellows and at subsided rates to all postdoctoral scientists. The Society is the preferred communication and media training provider for EPSRC and STFC.

Alongside its media and communication courses, the Royal Society successfully piloted a professional development course on the social and ethical dimensions of science in February 2008. Delivered in partnership with the Open University, the course was well received by participants and received a positive independent review. Following the loss of Government funding for our Science in Society Programme, we are looking at options for continuing this course. In addition, we have piloted an intensive training course for scientists interested in supporting schools and colleges, and look forward to developing this provision in partnership with other organisations.

A possible future work programme might look strategically at the training and development needs of the sector, and concomitant reward and recognition. This could include appraising formal and informal opportunities for science and engineering students in higher education to discuss the wider societal aspects of science. It may also include exploration of mechanisms by which funders, universities and business could include aspects of public engagement,

communication and discussion of ethical issues in the training and professional development of scientists.

Finally, while a variety of linkages (of varying length) exist between the various combinations of schools, colleges, universities and employers, little appears to have been done in terms of evaluating the extent to which these directly impact recruitment to STEM higher education and employment. This should be further investigated.

Thank you for taking the time to let us have your views. We do not intend to acknowledge individual responses unless you place an 'X' in the box below.

Please acknowledge this reply ☑

Here at the Department for Children, Schools and Families we carry out our research on many different topics and consultations. As your views are valuable to us, would it be alright if we were to contact you again from time to time either for research or to send through consultation documents?

☑ Yes ☐ No

All DCSF public consultations are required to conform to the following criteria within the Government Code of Practice on Consultation:

Criterion 1: Formal consultation should take place at a stage when there is scope to influence the policy outcome.

Criterion 2: Consultations should normally last for at least 12 weeks with consideration given to longer timescales where feasible and sensible.

Criterion 3: Consultation documents should be clear about the consultation process, what is being proposed, the scope to influence and the expected costs and benefits of the proposals.

Criterion 4: Consultation exercises should be designed to be accessible to, and clearly targeted at, those people the exercise is intended to reach.

Criterion 5: Keeping the burden of consultation to a minimum is essential if consultations are to be effective and if consultees' buy-in to the process is to be obtained.

Criterion 6: Consultation responses should be analysed carefully and clear feedback should be provided to participants following the consultation.

Criterion 7: Officials running consultations should seek guidance in how to run an effective consultation exercise and share what they have learned from the experience.

If you have any comments on how DCSF consultations are conducted, please contact Phil Turner, DCSF Consultation Co-ordinator, tel: 01928 794304 / email: phil.turner@dcsf.gsi.gov.uk.

Thank you for taking time to respond to this consultation.

Completed questionnaires and other responses should be sent to the address shown below by 18 September 2009

Send by post to: Consultation Unit, Department for Children , Schools and Families, Area GB, Castle View House, East Lane, Runcorn, Cheshire WA7 2GJ.

Send by e-mail to: scienceandlearning.consultation@dcsf.gsi.gov.uk