DCSF and BIS: Science and Learning consultation

Response by the Wellcome Trust

September 2009

1. The Wellcome Trust is the largest charity in the UK. It funds innovative biomedical research, in the UK and internationally, spending over £600 million each year to support the brightest scientists with the best ideas. The Wellcome Trust supports public debate about biomedical research and its impact on health and wellbeing.
2. The Wellcome Trust is committed to engaging the public with science and research. Our education programme sets out to stimulate interest and excitement in science amongst young people, develop the scientific literacy and ensure the calibre of those who enter biomedical careers and science. Specific activities include: support for continuing professional development, through the National Science Learning Centre, in partnership with the Department for Children, Schools and Families (DSCF); commissioned research to stimulate wider discussion about science education; and the development of resources to help promote contemporary science in the classroom.
3. In addition, the Wellcome Trust has instigated an independent review of 'Science Education for the Future'. The first phase will be to produce a policy 'road map', which aims to address the overarching question: 'What should the future of science education up to the age of 19 years look like in order to inspire young people, ensure they understand the role of science and ensure that science and technology underpin our future prosperity and well-being?'. The road map is expected to be published early in 2010. Phase 2 of the project will be to promote implementation of the recommendations, working in partnership with other stakeholders and encouraging more focused debate and action on specific issues as necessary.
4. We therefore welcome the Government's commitment to science education, signalled by the Science and Learning Expert Group, and are pleased to be able to respond to the consultation. The main messages of our response are:
   - the need to encourage all students to reach their potential, and to recognise and celebrate excellence among the most able students;
   - the need for an innovative curriculum with appropriate assessment to inspire and enthuse all students;
   - the importance of providing students with hands-on practical experience of 'real' science;
   - the need to strengthen links between schools, universities and employers to help deliver this;
   - the role of continuing professional development to ensure science teachers can provide high quality teaching;
   - the need to improve the interface between formal, non-formal and informal learning, to maximise opportunities for engaging students with science; and
   - the need to address the role of science education research to improve the evidence base and its impact on policy and practice.

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?

5. Science education in schools must be dynamic enough to address the continuum between training the next generation of scientists to ensure a pipeline of future researchers with appropriate skills and knowledge; and developing a wider population that is scientifically literate, excited by science, and well informed to be able to engage with scientific debate.

6. Achieving this will require an appropriate and flexible curriculum that can meet the needs of all students and those of different learning abilities. Although there have been some positive developments recently, for example the introduction of the twentyfirstcentury science GCSE, there still needs to be greater flexibility and differentiation. In addition, there remain concerns that the current methods of assessment are not well integrated with the aims of the new curriculum (see paragraphs 14-18 below).

7. We would also encourage the integration of science subjects with other curriculum subjects, to avoid the situation where different disciplines become unhelpfully silo-ed. Cross-curricular approaches can be highly motivational for both teachers and pupils, and allow students to make explicit links between science and everyday issues, for example to improve understanding of ways to tackle climate change or to strengthen thinking and communication skills when debating controversial issues such as stem cell research.

8. It is also crucial to raise the expectations of all students and, in particular, to ensure 'stretch and challenge' for the most promising students. We welcome the recognition by the Expert Group of the need to improve the progression of the most talented students from school to higher education to employment. We suggest that one way to achieve this is to recognise and celebrate excellence in the brightest and most able students. This does not need to be elitist, but should be designed to ensure that the best and brightest children from any background – the science elite – can be given the opportunity to succeed in science.

9. It is worth noting the findings of a recent report by the Sutton Trust1 which analysed the relationship between school, A level results, and progression to academically selective courses in research-intensive institutions. The report found that the "single most important factor determining the probability that students obtained a place on one of the most academically demanding degree courses was the student's own A level (or equivalent) results", and that "it appears that young people with similar attainment who applied to one of the most academically demanding degree courses, were around as likely to get an offer, regardless of the type of school or college they attended." This suggests that the most important thing is to provide the best students with the opportunity of studying science subjects and to encourage them to apply for appropriate courses.

10. In the same way that society appreciates and rewards the most talented sportspeople, musicians and writers, we should not be afraid to celebrate the most talented scientists. In the US for example, the Intel Science Talent Search (formally the Westinghouse awards) is recognised as a prestigious nationwide competition for talented high school students. Students are encouraged to undertake independent scientific research, with mentoring from university academics. The success of this scheme is well-recognised, and 2,600 finalists have received more than $3.8 million in scholarships through the scheme to support college education. Each year there are 40 finalists, and up to 70 per cent of them go on to gain either PhD or MD degrees. Most notably, seven finalists have continued to become Nobel Laureates.

11. While there are a few small-scale examples of science competitions in the UK – for example the Olympiads and the Rolls Royce science prize – these tend to be piecemeal, and there are few incentives for schools to take part. A new national-scale approach, with buy-in from all

[1] http://www.suttontrust.com/reports/BIS_ST_report.pdf

schools across the country, is needed to replicate the same form of success as seen with the US Science Talent Search.

12. Innovative approaches are required to inspire and excite the most able students. The importance of real life exposure to science in the workplace cannot be underestimated, and it may be useful to consider ways to increase the opportunities for students to experience science first-hand (see also paragraphs 24, and 40-41 below). For example, it is now recognised that those children participating in the Avon Longitudinal Study of Parents and Children (ALSPAC) - the Children of the 90s project – have been keen to undertake research projects at A-level and going into universities.

13. Another innovative approach is seen at Simon Langton Grammar school for Boys, where the Trust is funding an innovative project to enable students to undertake real research in a classroom setting. Students from Years 12 and 13 will be given the opportunity to use a range of biochemical and molecular biological techniques as part of research to investigate multiple sclerosis.

31. What are the major barriers to ensuring that young people feel engaged in science/maths?

14. One of the most significant barriers to science learning in schools is testing and assessment. While there have been significant developments in curriculum design, methods of assessment appear to have lagged behind, and often do not effectively test what the curriculum is designed to teach.

15. In 2007 the Trust commissioned research to consider the effects of compulsory national testing on the teaching of science. The Institute of Education conducted research to assess the effects of compulsory national testing on the teaching of science, and teachers, at Year 6 (Y6) in England; and the impact of the abolition of statutory testing in science at Key Stage 2 (KS2) in Wales on Y6 science teaching and teachers.2

16. The report highlighted the following issues:

- teachers consider statutory testing to be leading to a narrowing of the science curriculum and limiting approaches to teaching, with fewer opportunities for pupils to undertake practical activities;
- teachers in England find it difficult to maintain positive attitudes to science among pupils and suggested that abolishing testing would make science more enjoyable;
- teachers in England feel that abolishing statutory testing would enable them to respond more to individual pupils' needs and would allow pupils to develop greater independence in learning;
- test preparation was thought to contribute little to pupils' understanding in science;
- teachers support retaining optional test materials to inform teacher assessment (as they have been in Wales); and
- summative teacher assessment is seen to provide a more accurate assessment of pupils' level of attainment in science than national test results and teachers are concerned about how data from school achievement tables may be used.

17. The report also recommended that there needs to be greater consideration of how to improve progression in learning during KS2 in England and Wales; and that there should be an evaluation of how appropriate it is to use school achievement tables based on KS2 test results for purposes of accountability in England.

[2] The Effect of National Testing on Science at KS2 in England and Wales (2008) http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtd039972.pdf

18. It is likely that many of these findings apply equally at other key stages, particularly the concerns about the narrowing of the curriculum and restrictions on practical work. Assessment methods have a significant impact on curriculum teaching and learning outcomes. It is essential that assessment must be fit for purpose, and well-integrated with the curriculum. Most importantly, any assessment must allow students to demonstrate analytical and thinking skills, rather than simply repeating facts without understanding. We must move away from the situation where teachers feel they have to 'teach to the test'.

19. It will also be important to ensure that the development of qualifications at all levels is robust, with appropriate coordination between the plethora of relevant bodies – including Government, the Qualifications and Curriculum Development Agency, the awarding bodies, and the regulator Ofqual.

20. The transitions between key phases of education (KS2 to KS3, KS4 to KS5, KS5 to University) can also become a barrier that can impact on the quality of engagement and the progression in learning. For example, the repetition of material can be demotivating. The complexity of the issues is highlighted in a series of 'perspectives' commissioned by the Wellcome Trust earlier this year.[3]

21. There are increasing concerns that some schools are not getting adequate laboratory space or levels of equipment as part of their refurbishments under Building Schools for the Future. There is an urgent need to gather further evidence about this and, if necessary, to introduce appropriate safeguards to ensure that specifications are met.

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

22. Results from a recent survey commissioned by the Trust overwhelmingly indicated that students (aged 14-18) found science lessons more interesting at secondary school compared with primary school. Overall 56% said they found science 'a lot more interesting' and a further 28% that they found it 'a little more interesting'. When asked why this was the case, the two most common reasons given were that they studied more interesting topics and because there were more chance to do experiments at secondary school.

23. Statistics continue to show an increasing number of students turning to medicine rather than pure physics or engineering. It would be interesting to explore further what prompts the brightest students to turn to biomedical research rather than physical sciences. As interdisciplinary research becomes ever-more important to answer the challenges society faces today, we need to ensure that students understand the important contributions that all disciplines can make to scientific discovery. It would also be useful to improve our understanding of the gender balance in science, and to understand the underlying factors that drive students to make different subject and career choices.

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

24. One of the most effective ways to improve engagement, participation and progression is to the provide students with hands-on experience of 'real' science. For example, the Nuffield Science Bursaries offer up to 1000 funded places a year for students in their first year of an Advanced or Higher STEM course (KS5) to have the opportunity to experience "real research and development projects, with practising scientists, technologists, engineering and mathematicians". The four to six- week placements have successfully provided students with a real insight into scientific research, and what a research career might involve – and many students have gone onto further science careers as a result. Providing more opportunities of

[3] Perspectives on education: primary-secondary transfer in science (2009) http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtx054697.pdf

this type will require strengthened links between schools, universities and employers, as described below (paragraphs 40-42 below).

25. The changes to the science curriculum in 2006 which, among other things, introduced the twentyfirstcentury science GCSE courses have begun to enable schools to offer a range of different science programmes, but more still needs to be done. Schools must have appropriate incentives to encourage the best and most appropriate teaching for their students. It will also be important to ensure that the new choice of courses provides students with the opportunities to progress to further studies at AS and A-level.

26. It is also important to recognise that not all learning takes place in school lessons. We must acknowledge the interplay between formal, non-formal and informal learning, and improve links between schools, science centres and public engagement activities to begin to inspire students about science through a range of different activities – not just formal teaching. For example, evaluation of the After School Science and Engineering Clubs in the UK has demonstrated the success of the scheme, with pupils who participated in clubs more interested in future science and engineering careers than reference group pupils.

27. It is crucial that evidence-based research should inform policy to help address the barriers to progression and engagement. There is a need for more high quality and robust educational research, and this must be combined with improved mechanisms to translate findings into practice.

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

28. High quality and inspiring teaching from well-trained teachers is vital to ensure effective student engagement. Tailored continuing professional development (CPD) is particularly key in science education: to equip teachers with the necessary skills to deal effectively with changes to the curricula, to remain up-to-date with scientific developments, and to experiment with innovative techniques.

29. The national and regional Science Learning Centres offer the potential to deliver appropriately tailored CPD. Increasing teacher access to these Centres is essential, but the most frequently cited barrier to participation in CPD remains cost. The Wellcome Trust is therefore working in partnership with Government and industry to deliver Project Enthuse, a £30 million collaboration to remove barriers to CPD. Project Enthuse provides bursaries for travel and lesson cover, allowing teachers to attend residential courses at the National Science Learning Centre (NSLC). The scheme also provides a useful opportunity to strengthen links between schools and industry.

30. We note with concern that NSLC is currently experiencing difficulties in relation to VAT recovery on contracts with DCSF. This threatens to cost NSLC more than £1.5 million and undermines its mission. We urge the Government to ensure that it sends a consistent message across all departments.

31. It is also vital to give greater recognition to technicians in schools. Technicians have the skills and experience to design experiments and allow students to gain practical hands-on experience in research. Technicians should therefore be valued as a crucial part of the science teaching team, and must have the resource, investment and training required to continue to deliver high-quality support for science lessons.

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?

32. We welcome the recent initiatives that have been developed to try to improve science careers advice for young people, for example the Science Council's 'Futuremorph' website. It will be important to continue to increase usage of these initiatives and to monitor their impact. Those that are having most effect should be sustained.

33. Careers guidance must provide information about what a research career is, what might be involved, and the breadth of possibilities opened up by a science degree. For example, a recent report by the CBI found that 40 per cent of employers would prefer new employees to have a science degree – a fact that seems to have little recognition when students are making choices.

34. Other initiatives to improve the attractiveness of research careers more widely will also be important. The research Concordat summarises the broader challenges, including issues of recognition, career security, and opportunities for mentoring and personal development. Getting these issues right will be important to help enable students to make an informed choice, and to recognise a career in science as an attractive proposition.

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?

35. Schools and universities, and universities and employers must develop stronger, more effective links to ensure that students are taught the most appropriate skills to enable them to progress. Universities are increasingly expressing concern that students are not adequately prepared when they arrive from school, with an increasing lack of appropriate mathematical skills and practical experience.

36. The Association of the British Pharmaceutical Industry has also expressed concern that there are skills gaps in undergraduate bioscience courses, for example in vivo sciences, including physiology, pharmacology, pathology and toxicology. The Office of Life Sciences has responded to these concerns by proposing the introduction of an accreditation process for undergraduate bioscience degrees, carried out by the Society of Biology. This would be a welcome development, and should help to ensure that biomedical science graduates develop appropriate core mathematical and practical skills.

37. The Office of Life Sciences blueprint also highlighted industry concerns that there is not a co-ordinated mechanism for industry to discuss its needs with HEIs and funders "in a coherent and collective way, and to work with them to bring about the change needed to address the skill gaps that it has identified." The blueprint proposes the establishment of an industry and Higher Education forum to provide a clearer mechanism for coordination, and we welcome this proposal.

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

38. As discussed above, students must have more exposure to practicals and hands-on research as part of their training. There is also a need for generic and analytical skills which are crucial for research and innovation. Many of these skills will also be important for those with a science training who take up employment in a non-science career.

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

39. Many scientists and young people are attracted to study science because it is about asking questions, developing ideas and attempting to understand the world. Science provides analytical skills, hypothesis testing, problem solving, and critical and evaluative thinking which can be applied in many different contexts. It is important to recognise the distinction between the analytical skills developed during scientific training, and the more specific scientific knowledge and facts that a scientist must also master.

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?

40. As discussed already, it will be crucial to strengthen links between schools, universities and employers. This will help to ensure that students are given the opportunity to gain experience of 'real' science, and will also allow improved discussion of skill needs to ensure students are

appropriately trained. The Nuffield school science bursaries, and a similar scheme for university undergraduates, provide a successful example of the importance of such links.

41. Project Enthuse also provides the opportunity to develop a close working relationship between the partner businesses and schools, with teachers nominating 50 high potential A-level science students each year for internships with participating businesses.

42. The interface between schools, universities and employers is currently hampered by different understanding of key phrases such as ‘scientific literacy’ and ‘STEM subjects’. The development of a common language, with clear definitions and shared understanding, would be a significant step forward to foster joint working between these different groups. Improved communication and stronger links between schools, universities and employers will be key to help support student progression and develop the best possible science education in the UK.