House of Lords Science and Technology Committee report into Science Teaching in Schools – a response from the Science Community Partnership Supporting STEM Education (SCORE)

This response has been prepared for the House of Lords Science and Technology Committee by the SCORE partnership and therefore represents the combined views of the following organisations: Association for Science Education, Biosciences Federation, Institute of Biology, Institute of Physics, Royal Society, Royal Society of Chemistry, Science Council. The aim has been to highlight aspects of the Government's response to the Committee's report on Science Teaching in Schools which are to be commended, or those which need further investigation, particularly in the light of change and new evidence since the Committee published their report in November 2006.

The SCORE partnership aims to bring collective action and a strategic approach to strengthening science education, and believes that the key to maximising the impact of its efforts, especially their influence on government, lies in a greater degree of collaboration and in having a sense of common purpose. Through this collective action, the partnership aims to increase its influence over the direction of science education in the years to come, in particular over teacher supply and retention, curriculum development, assessment, delivery of support to teachers and students, and strategies for reaching all young people regardless of age, background, level of ability, gender, ethnic origin and geographical location.

Association for Science Education	www.ase.org.uk
Biosciences Federation	www.bsf.ac.uk
Institute of Biology	www.iob.org
Institute of Physics	www.iop.org
Royal Society	www.royalsoc.ac.uk
Royal Society of Chemistry	www.rsc.org
Science Council	www.sciencecouncil.co.uk

Key points

1. The introduction of new A-levels in 2008 gives an opportunity for inequalities across subjects to be ironed out and we hope that the review of 14-19 education, promised in the 2005 14-19 Education and Skills White Paper and due to take place in 2008, considers whether the current and proposed qualification framework meets the needs of the UK economy and individual learners.

2. We look forward to seeing a much more coordinated and strategic plan for promoting science careers from the Government.

3. We would like to see the Department for Education and Skills (DfES) and the Qualifications and Curriculum Authority (QCA) agree and publicise a best practice model of curriculum development, based on experience with Twenty First Century Science, which could be used as a quality standard for future change.

4. A public consultation on the changes to KS3 is currently underway; the QCA and DfES will need a strong justification for ignoring responses that suggest the development process is too short for successful implementation.

5. We strongly believe that there would be considerable advantages in allowing schools the option of piloting the Key Stage 3 (KS3) changes from 2008 but not insisting that all schools change KS3 until assessment material is available in 2011.

6. If the Research Assessment Exercise (RAE) is not a suitable mechanism by which outreach activities can be recognised, then the Government needs to consider what would be an appropriate mechanism.

7. We feel that the introduction of 'How Science Works' to A levels in the sciences needs to be closely monitored by QCA for impact on practical work.

8. The Government appears to have no reliable mechanism to collect data on how Building Schools for the Future (BSF) money is being spent on school science laboratories, and, just as important, the quality and impact of the work undertaken.

9. We would continue to press the case for an improved career structure for science technicians as a specialist group distinct from Higher Level Teaching Assistants (HLTAs).

10. Continuing Professional Development (CPD) remains essential for science teachers though we doubt that any step change will occur without ring-fenced funding to facilitate teacher release from other duties.

11. We feel that the autonomous nature of the SLCs has acted to reduce their activity as a national network.

Comments on Committee recommendations and Government response

Committee recommendation 6.2

SCORE welcomes the Government's commitments to achieving year on year increases in the number of young people taking A levels in physics, chemistry and mathematics as set out in the *Science and Innovation Investment Framework (2004-2014) Next Steps* document, and recognises that considerable efforts are being made to realise these ambitions.

However, the Government appears to dismiss a significant amount of evidence, some of it commissioned by the Department for Education and Skills, suggesting that student perception of the greater difficulty of the sciences and mathematics is grounded in reality. In the 1996 Dearing Report[1], and in the current work of the University of Durham CEM Centre (widely used by many schools and colleges under the acronym ALIS), a study of matched subject pairs[2] shows that performance in some A-level subjects is lower than others when other factors, such as prior performance, are taken into account. Indeed, on announcing the creation of the STEM Advisory Forum in March 2007 the Minister for Lifelong Learning, Further and Higher Education, Bill Rammell said "Science, Technology, Engineering and Maths are the higher value, more difficult, strategic subjects the Government wants to see maintained and which are crucial to the country's future competitiveness[3]".

We believe the introduction of new A-levels in 2008 gives an opportunity for these inequalities to be ironed out. This does not necessarily mean altering the 'gold standard' of subjects such as mathematics, physics, chemistry and biology, nor altering the content or assessment models of other subjects. It requires the regulator – the Qualifications and Curriculum Authority (QCA) – to ensure that matched subject pair analyses are carried out before awarding grades to ensure subjects are of equal difficulty.

In addition we hope that the review of 14-19 education, promised in the 2005 14-19 Education and Skills White Paper and due to take place in 2008, considers whether the current and proposed qualification framework meets the needs of the UK economy and individual learners. In science there is a particular concern about the status of the applied route and how best to ensure appropriate progression routes to HE and employment.

Committee recommendation 6.3

SCORE welcomes the DfES's development of quality standards for young people's Information, Advice and Guidance (IAG) but would like to see how

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[1] *Report of the National Committee of Inquiry into Higher Education* (1996), chaired by Sir Ron Dearing.

[2] *Report on A-level Subject Difficulties* downloadable from the CEM centre website at http://www.alisproject.org/Documents/Alis/Research/A-Level%20Subject%20Difficulties.pdf

[3] *Press Notice 2007/0043 Forum to boost science, technology, engineering and maths education (*13 March 2007), Department for Education and Skills.

performance will be monitored and evaluated against these standards and a clear statement as to where the responsibility for this lies.

It is still the case that the majority of careers information, advice and guidance practitioners do not have a STEM background and lack experience of the STEM sector. They therefore would particularly benefit from training and support to deliver IAG in this area so they know what is available through science. The Government is not yet addressing this issue. The first priority of science teachers is the teaching of science and providing careers IAG is not perceived as part of their role. However, greater collaboration between science teachers and careers practitioners would enhance opportunities to discuss and promote careers opportunities from science.

We are pleased to see that the Government intends to improve the link between SEMTA's promotion of science careers and the delivery of careers information, advice and guidance. However, SEMTA's footprint does not incorporate all of STEM and we would like to see SEMTA coordinating this work with the other Sector Skills Councils that hold a science remit such as Automotive Skills, Lantra and Skills for Health.

While we welcome the addition of a banner on the homepage of the Connexions Direct website directing people to the science, mathematics and statistics job family as an initial step, we look forward to seeing a much more coordinated and strategic plan for promoting science careers from the Government.

In the Government's response to this recommendation they state that 'It is also important that [students] go on to pursue careers in science to become the teachers and researchers of the future. In doing this it is vital that the education community continues to be really honest with itself about what is working and what isn't'. We are unclear what is meant by this and would appreciate clarification.

Committee recommendation 6.4

SCORE is pleased that the Government has now committed £500,000 towards the funding of the Careers from Science project. We would like to emphasise to the Committee that Careers from Science is not simply a website; it is a wider project that has support across the science community and aims to complement the work of Government and other organisations such as SEMTA. The Science Council is working with the National STEM Director to ensure that the project is central to the STEM community's careers activities and continues to aid greater co-ordination. It is important that the National STEM Director will also be able to assist in linking Careers from Science to the Government's own activities.

Committee recommendation 6.5

The issue of inspection data remains a problem but we would wish to highlight the importance of quality of evidence. We feel that some attention needs to be given to increasing the number of science specialists in inspection teams and to

supporting schools to ensure the quality of their self evaluation in relation to subject-specific (in this case science) aspects of their review.

Committee recommendation 6.6
SCORE is pleased the Government accepts that schools should be given adequate preparation time to plan for any changes when new courses are being piloted and rolled out, and to organise resources prior to implementation. It is important that curriculum development – from initial research and consultation through to implementation and evaluating impact – addresses the needs of a range of stakeholders and produces a coherent and meaningful programme of learning in science. We would like to see the DfES and QCA agree and publicise a best practice model of curriculum development, based on experience with Twenty First Century Science, which could be used as a quality standard for future change.

With specific reference to the Twenty First Century Science GCSE, the Committee will be aware that an independent evaluation of the pilot was published in 2007 and made a number of positive observations as well as noting recommendations that had already been acted on. However it should be stressed that the evaluation concentrated on the Core Science GCSE. As the evaluators note "Perhaps our greatest regret is that resource limitations obliged us to focus so narrowly on one element of the *Twenty First Century Science* pilot – the Core Science course. As a result we have little objective evidence of the outcomes of Core Science plus Additional Science (General) or of Core Science plus Additional Science (Applied)'[4].

Committee recommendation 6.7
SCORE agrees that since Awarding Bodies are currently writing specifications for revised A levels in 2008 it is probably undesirable to delay their introduction. However, it is much less clear that it is too late to delay the introduction of the KS3 changes. A public consultation on the changes to KS3 is currently underway; the QCA and DfES will need a strong justification for ignoring responses that suggest the development process is too short for successful implementation.

In support of our concerns we note that in 2007/8, in addition to preparing for the changes to Key Stage 3, science teachers will be attempting to implement some or all of the following changes:

- teaching the second year of new GCSEs from September 2007;
- preparing to deliver new courses teaching the separate sciences from September 2008 under the entitlement given in the Next Steps document;

[4] *Evaluation of the Twenty First Century Science pilot: a project response* (2007) Jenifer Burden, Peter Campbell, Andrew Hunt and Robin Millar, University of York and Nuffield Curriculum Centre, downloaded from www.21stcenturyscience.org

- preparing for the new A level courses and Extended Projects from September 2008;
- preparing to deliver some science elements in the new specialised 14-19 diplomas, starting in September 2008.

We do not believe that teachers will have sufficient time to deliver the outcomes that these reforms are intended to achieve: planning for cross-curricular links and providing different pathways through the curriculum requires time and coordination. Phased implementation does not really help here as the whole KS3 curriculum will have to be mapped out before it can be taught.

We also believe that publishers and others will not be able to provide high quality resources in the suggested timescale. The only option seems to be to repackage existing resources – again this is hardly like to lead the intended outcomes of the review. We are also concerned about the number of errors that are creeping into resources – the rush to have material available before teaching starts in September 2008 can only exacerbate this situation.

We note that the QCA recently asked science teachers what they would need to support implementation of the new Key Stage 3 Programme of Study (PoS) and found that 'The most useful types of science exemplification for nearly all of the schools in our survey would be comprehensive teacher assessment guidelines and a range of assessment tasks. Also rated as very useful or essential by more than 90 per cent are hard copy, exemplar/guidance materials and web-based exemplar/guidance materials. Almost as many schools feel that continued professional development/INSET would be very useful or essential for supporting teaching and assessment. Exemplar material on CD-ROM is seen as more useful in science than in other subjects'[5]. We therefore hope the promised 'package of training and support for school leaders and subject teachers' is in place before the new curriculum becomes statutory in September 2008.

We note that statutory assessment material for the new KS3 programme of study will not be ready until 2011, so it is not clear how schools that currently teach KS3 in two years will manage the assessment of their students who start their KS3 programme in 2008. We also note that DfES has just announced a pilot to trial changes to assessment, allowing children to take national key stage tests as soon as they are ready, rather than only at the end of a long key stage[6].

Taking all these issues into account we strongly believe that there would be considerable advantages in allowing schools the option of piloting the KS3 changes from 2008 but not insisting that all schools implement the KS3 changes until September 2009 with the first end of key stage assessments available in 2011.

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[5] *Monitoring curriculum and assessment project 2005–2006: Science* (March 2007) Qualifications and Curriculum Authority.
[6] *Making Good Progress* (8 January 2007), Department for Education and Skills consultation document.

It is disappointing that the Government still does not seem to have accepted the fact that proper piloting and evaluation is essential for effective curriculum change, nor that it is in the end more cost efficient and beneficial for teachers and students if sufficient time is allowed. In particular, the radical changes at Key Stage 4 have meant that greater changes are necessary in science than in other subjects, both at Key Stage 3 and A-level, to produce coherence, and these changes do not seem to have been properly co-ordinated within the overall timetable for 11-19 change. We recommend that the Government ensures that the QCA urgently addresses the above issues and makes its recommendations widely known to the profession.

Committee recommendation 6.8

The Government's response avoids the issue. If the Research Assessment Exercise is not a suitable mechanism by which these activities can be recognised, then the Government needs to consider what would be an appropriate mechanism. University academics have over many years become resigned to the fact that outreach work may receive little recognition from their institutions. However, with the current pressures within the university system, some academics are now positively discouraged from engaging with these activities. This is despite the current climate in which the Higher Education Funding Council has provided funding to both the Royal Society of Chemistry and the Institute of Physics to attempt to increase participation in chemistry and physics in Higher Education.

A recent report from the Royal Society[7] (with support from Research Councils UK and the Wellcome Trust) concluded that further research is needed on how the pressure on academics to publish and attract research funding impacts on their involvement in public engagement activities. We are encouraged by the recent 'Beacons of Public Engagement' initiative from HEFCE, RCUK and the Wellcome Trust which is making £8 million available over 5 years to encourage outreach work by universities. However, this initial scheme will be of direct benefit to only a small number of universities and sustained investment will be required to bring about major changes on this issue.

Committee recommendation 6.10

The Committee will be aware that the House of Commons Education and Skills Committee has recently launched an inquiry into Testing and Assessment and we hope that this will encourage debate on a number of serious issues relevant to all subjects. The breadth of this inquiry's remit indicates that the testing and assessment regime continues to have major implications for education, and that to improve this regime we need to take into account the whole educational climate. Recent proposals for 'testing by level on demand' may mean that some pupils could be tested more frequently than they are now, and on the

[7] *Survey of factors affecting science communication by scientists and engineers* (2006) The Royal Society.

assumption that school performance tables will continue there could be further pressures to 'push' pupils through the tests.

At Key Stage 3, unlike at Key Stage 4 and A-level, there are no subject criteria nor Awarding Body specifications to clarify what teachers teach and what students learn and are assessed on. This exacerbates the concerns of teachers as how best to reflect the new, much more general programme of study proposed for 2008. A major concern is that teachers will respond by teaching to the test, to the detriment of pupils' enjoyment and enthusiasm.

Committee recommendation 6.11

The importance of practical work in school science is widely accepted but it is important we ensure that such practical work genuinely supports learning and teaching, and that flexibility is given to the teacher to do this in relation to their pupils' needs and the courses they are studying. In particular, SCORE feels that the introduction of 'How Science Works' to A levels in the sciences needs to be closely monitored by QCA for impact on practical work, as anecdotal reports suggest inconsistencies of interpretation between Awarding Bodies.

With regard to additional resources, practical work in chemistry and physics is already being supported through two websites (www.practicalchemistry.org and www.practicalphysics.org) funded by the Nuffield Curriculum Centre, Royal Society of Chemistry and Institute of Physics. For most teachers, the main need is to be able to try out practicals and develop their own confidence and skills, together with technician support. We hope this continues to be a priority for the Secondary National Strategy and Science Learning Centres in partnership with CLEAPSS, professional bodies and subject associations.

The Government states it wants to achieve 'a step change in provision' through their strategic investment in school buildings, and promises that the Building Schools for the Future (BSF) programme will fund new and refurbished laboratories, alongside additional funding available for local investment in schools which cannot wait for their relatively late prioritisation in the BSF programme. However, the Government appears to have no reliable mechanism to collect data on how BSF money is indeed being spent on school science laboratories, and, just as important, the quality and impact of the work undertaken.

SCORE is pleased to see the Government agree with the Committee that there is a need to persuade schools and authorities to prioritise school laboratory provision but we are not convinced that Project Faraday will be successful on its own, and would encourage the Government to work with us to come up with additional activities in this area. On a small point of accuracy, ASE has indeed been a member of the Project Faraday Steering Group from the first meeting but this did not take place until August 2006, and ASE did not receive its invitation to join the group until after it had given its written evidence to the Committee. Since then ASE has worked to play its part in the development of the project.

Committee recommendation 6.12
The role of technicians is crucial, as the Committee and the Government acknowledge, but we would continue to press the case for an improved career structure for science technicians as a specialist group distinct from Higher Level Teaching Assistants and as such requiring specialist training. The ASE project in partnership with DATA and funded in its pilot phase by the Gatsby Charitable Foundation has been very successful but to build on this there needs to be very clear information regarding funding for technicians to undertake the necessary assessments leading to qualifications. This still needs addressing with some urgency.

Committee recommendation 6.13
We note the Government states that the Training and Development Agency for Schools will be reporting 'early in the new year (2007)' on the issue of financial support for students on pre-Initial Teacher Training enhancement courses: we hope they are now ready to share their recommendations with the Committee and other interested parties.

Committee recommendation 6.14
On 6 February 2007 the Secretary of State for Education announced proposals for financial incentives for completion of accredited qualifications in priority subjects[8], following advice from the School Teachers' Review Body (STRB). The STRB specifically recommended that[9]:

- teachers receive a financial incentive for completion of accredited qualifications in priority subjects designated by the Department or, for teachers in Wales, the Welsh Assembly Government;
- the Department and the Welsh Assembly Government consider using the golden hello payment as the mechanism for this purpose;
- the effectiveness of this approach be evaluated as part of the pilot for the mathematics, physics and chemistry diplomas.

Questions remain however as to the incentives for schools to release their staff to undertake this diploma, particularly if they are mindful that gaining the additional specialism raises a teacher's market value and therefore may increase the likelihood that they will move schools.

Committee recommendation 6.15 and 6.18
Again we note that the STRB recently concluded that based on their evidence and analysis 'We do not therefore see a case at this stage for national-level action on pay to address continuing issues of recruitment and retention in mathematics, physics and chemistry. A permanent change to the teachers' pay system to provide a salary uplift of any magnitude to all 44,000 secondary

[8] *Press Notice 2007/0019 Alan Johnson announces proposals for changes to pay and conditions for teachers* (6 February 2007) Department for Education and Skills.
[9] *School Teachers Review Body Sixteenth Report Cm 07* (2007) HMSO.

teachers of these subjects would be expensive and indiscriminate in its effects, and would take time to stimulate an additional supply of graduates'[10]. However, the STRB have recommended that:

- the Department [for Education and Skills] undertake a programme of action to secure a significant increase in the use of existing flexibilities in the STPCD [School Teachers' Pay and Conditions Document and Guidance on School Teachers' Pay and Conditions] to address local teacher shortages in priority subjects;
- the Department focus this programme on three areas, namely more effective support for local managers, a sharper framework of accountability, and school budgets.

Committee recommendation 6.16

The Government refers to a scheme to write-off the student loans of new teachers of shortage subjects running from 2002 to 2005, and the evaluation of that scheme. We assume they are referring to an evaluation undertaken by the University of Durham in 2004[11] which does actually claim some success for the 'Repayment of Teachers' Loans Scheme', concluding that 'we estimate that the scheme impacted in some way on 76 of the 246 teachers surveyed' (Executive Summary, point 36). The researchers also highlight that because many of the teachers interviewed had not known about the scheme before entering their initial teacher training, the scheme's impact might actually be greater with a more effective marketing strategy. In 2006 the Government introduced variable tuition fees allowing universities and colleges in England to charge new full time home undergraduates up to £3,000 a year. We believe this change in the financial demands on teacher trainees, which is likely to increase in the future, merits a re-examination of the Repayment of Teachers' Loans Scheme, with particular emphasis on the sciences and mathematics, the impact on recruitment to subject enhancement courses and two-year PGCEs, and the impact on recruitment and retention of subject specialists in London schools.

Committee recommendation 6.19

Continuing Professional Development (CPD) remains essential for science teachers and we welcome the willingness of Government to support and encourage schools to undertake subject-related CPD, though we doubt that any step change will occur without ring-fenced funding to facilitate teacher release from other duties. We agree with members of the Rewards and Incentives Group who are quoted in the Government's response as recognising that 'all teachers should have a professional responsibility and a contractual entitlement to be engaged in effective, sustained and relevant professional development throughout their careers'. We would welcome clarification on the realisation of this expectation; although the performance management arrangements will help, greater emphasis needs to be placed on the need for subject-specific developments/improvements to be included in personal development plans.

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[10] *Ibid.*

[11] Barmby, P. and Coe, R. (2004) *Evaluation of the Repayment of Teachers' Loans scheme*, DfES Research Report RR576.

Committee recommendation 6.21

The entire science education community joins the Government and the Wellcome Trust in wishing to see the Science Learning Centres (SLCs) develop and thrive, and we hope the upcoming Comprehensive Spending Review will make adequate commitments to ensuring their future. However, we feel that the autonomous nature of the SLCs has reduced their activity as a national network, increased the likelihood that science teachers in different regions have markedly different CPD opportunities on offer locally, and placed barriers to national organisations, like the SCORE members, working in partnership with them. We would suggest that when their contracts are renegotiated they are given strong incentives, perhaps even requirements, to work in partnership with each other during their next phase of development.