

# The Science, Technology, Engineering and Mathematics (STEM) Programme Report

## Acknowledgements

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# Foreword

## Science, Technology, Engineering and Mathematics (STEM) Programme Report

It is vital to our economy and to the country's prosperity that we maintain and develop our science base - we are committed to doing this. We need the right people with the right skills to build a strong science base and we are determined to ensure a good supply of scientists, engineers, technologists and mathematicians. That is why two years ago we published our 10 year Science and Innovation Investment Framework 2004-2014 - a strategy for the decade which aims to make Britain the most attractive location in the world for science, research and development, and innovation, with a view to attracting the best scientists to meet this goal. We raised our ambitions even further in our Next Steps document published in March 2006, where we pledged to strengthen the UK science base, setting clear aims for improving the stock and flow of skilled scientists, technologists, engineers and mathematicians and introducing measures across the education system to support this.

However, at the current time we have far too many schemes, each of which has its own overheads. The original STEM Mapping Review in 2004 revealed over 470 STEM initiatives run by DfES, DTI and external agencies and subsequently, the STEM cross cutting programme examined around 200 of these. They are not, therefore, in total either efficient or effective and do not give a complete coverage of all schools. We need, therefore to rationalise those supported by the Government and build on the best ones. By doing so, we believe we can achieve a much better result

for the same amount of money.

Our proposals work towards a vision that aims to ensure that STEM support is delivered in the most effective way to every school, college, learning provider and learner. For the first time we will have:

- One high level STEM Strategy Group that will join up STEM across all phases of education and make recommendations to Ministers about national STEM priorities; and
- A National STEM Director who will drive delivery forward.

We are very pleased that the high level STEM Strategy Group will report progress directly to all three of us. Our two Departments will continue to work closely together.

We could not have got this far without the important contribution from our stakeholders, who have worked hard alongside us. We look forward to their continued work and valuable contribution in the future.

We have a responsibility to capture the imagination of young people who will become the scientists, technologists, engineers and mathematicians of the future, and help them reach their full potential. Through delivery of our proposals we will make this a reality. The future success of the British economy depends on their contribution.

## Executive Summary

The *Science and Innovation Investment Framework 2004-2014* set out a long-term strategy to secure and sustain a supply of scientists, engineers, technologists and mathematicians (STEM) to support the science base. As part of this Framework, the STEM cross-cutting programme, jointly managed by DfES and DTI was set up to examine the range of initiatives that currently support this agenda and to look for ways to enhance the effectiveness of Government funding in two areas:

- the flow of qualified people into the STEM workforce; and
- STEM literacy in the population.

The Programme identified the need to improve the delivery of STEM initiatives - particularly those which fall into the categories of professional development for staff and enhancement activities for learners so that the STEM system could be made more coherent; with better signposting and advice to learning providers; and giving every learning provider access to some STEM help.

The work of the programme has concentrated on where we can make the biggest impact by enhancing delivery at the frontline for learners and learning providers and coordinating STEM through a simple core delivery network. The actions in this report are underpinned by three principles:

- a. STEM support should be available to all learners and learning providers. It will therefore be necessary to build on and co-ordinate existing delivery networks to enable them to support the variety of needs.
- b. There is a need for greater co-ordination and joining-up of the many providers of professional development and enhancement activities to achieve more coherent delivery, but without sacrificing diversity of choice.

- c. There are clear economies of scale in providing many of these resources at a level above that of local authority and local Learning and Skills Council (LSC). Some provision is needed at national, regional and local levels.

We raised our ambitions further for school science, recently published in the *“Science and Innovation Investment Framework 2004-2014: Next Steps”* as part of the Chancellor’s 2006 budget announcement. Delivery of the outcomes of the school science ambitions of our Next Steps document are being fully integrated with the core delivery network and the actions described in this report, and are mutually reinforcing.

The actions put forward in this report will be implemented in line with the agreed timetable and, beyond that, as resources allow. The central thrust of the report – to rationalise and improve the delivery of the current plethora of STEM initiatives – should improve value for money and overall be cost neutral. Some of the ideas in the Report will, however, have cost implications which will need to be considered in the context of the 2007 Comprehensive Spending Review.

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As we work towards a vision that aims to ensure that STEM support is delivered in the most effective way to every school, college, learning provider and learner, we will work with our key partners and stakeholders to deliver a STEM system which brings greater coherence and facilitates a more joined up approach to STEM initiatives across the education system.

**The Government is committed to meeting the challenges raised by the STEM mapping review and analysis through a series of clear and decisive actions. We will work together with partners and stakeholders to achieve the ambition we set out - which is to create an education and training environment that delivers the best in science teaching and learning at every stage.**

We propose to introduce arrangements that will:

- At national level provide a clear steer in the setting of priorities and a mechanism for ensuring coherence across the wide range of STEM initiatives;
- At national, regional and local levels, channel activities through a simpler delivery network to increase effectiveness;
- At the local level, provide a means for each

learning provider to access guidance and information to ensure take-up of STEM support.

## Government priorities - setting the national STEM strategy

By **October 2006** we will put in place a new governance structure for STEM policy and a new delivery network. This will consist of:

### Action 1

- A Ministerial High Level Steering Group to set the direction of the national STEM strategy. This will include the joint chairs of the new high level STEM Strategy Group;

### Action 2

- A new high level STEM Strategy Group (SSG) to join up policy through all phases of STEM education across the DfES, the DTI, other Government Departments and external stakeholders;
- The SSG will offer advice and make recommendations to Ministers on national priorities, and support articulation of a coherent national message about the need to increase the take-up of STEM-related initiatives;
- The SSG will be jointly chaired by the DfES Directors General for Higher Education and Schools Directorates. Members will include DfES, DTI, HMT, the TDA, the Royal Society, the Royal Academy of Engineering, the Association for Science Education, the Wellcome Trust, the Gatsby Charitable Foundation and representatives of business;

### Action 3

- A STEM Advisory Forum to ensure members of the wider STEM community can contribute their views and advice on policy formulation and delivery to the SSG;

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### Action 4

- A newly appointed National STEM Director accountable to the School Science Board for implementation of the STEM programme actions;

### Action 5

- The DfES School Science Board in co-operation with the Mathematics Board, where there are already strong links, will work with key partners to take forward delivery of the STEM programme actions as an integral part of the *Next Steps* commitments.

### Action 6

- By **October 2006** the Skills Working Group of the UK Science Forum will recommend a suitable individual to represent business stakeholders in the STEM Strategy Group.

## Ensuring active involvement of stakeholders

### Action 7

- By **December 2006** we will have agreed whether the principal organisations taking co-ordinating roles (the Royal Society, the Royal Academy of Engineering and SETNET) should have a presence in the National Science Learning Centre and the Regional Science Learning Centres, so as to ensure links are maintained between professional development and enhancement activities.

### Action 8

- By **June 2007**, working in partnership with the Association for Science Education (ASE), we will have explored the potential for developing the National Science Learning Centre as the 'British Library' of STEM professional development and resources, making available in one place as much of the learned society, national academy

and professional institution material as possible, subject to quality assurance and copyright restrictions.

### Action 9

- By **February 2007** we will have agreed with SETNET (the Science, Engineering, Technology and Mathematics Network), working with the RAEng (through Technology and Engineering in Schools Strategy, TESS) and the Royal Society (through **Science Community Partnership Supporting STEM Education, SCORE**) and others, arrangements to improve co-ordination of the work of stakeholders who contribute to the delivery of opportunities for curriculum enhancement and enrichment. This will also include plans to increase the number of schools, colleges and students which benefit from such activities and support.

### Action 10

- By **June 2007** working with the Wellcome Trust, we will agree with the National and Regional Science Learning Centres and other partners, the potential contribution they could make to professional development activities in engineering and technology.

## Creating clearer delivery systems

### Action 11

- By **June 2007** we will have established the potential to develop a national STEM communities portal from the existing Science Learning Centres' web portal and the possibility of providing peer reviews of resources, events, industry contacts, CPD and links and feeds from related sites as well as regional portlets. The Science Learning Centres' web portal is already providing a platform for the National Centre for Excellence in the Teaching of Mathematics.

#### Action 12

- By **February 2007** we will have established arrangements for effective collaboration between the National and the Regional Science Learning Centres and the National Centre for Excellence in the Teaching of Mathematics.

#### Action 13

- By **June 2007** the School Science Board will have explored best practice emerging from the Royal Academy of Engineering's London Engineering Project on increasing diversity and consider whether this can be replicated for other subject areas to widen participation from under-represented groups.

#### Action 14

- By **February 2007** we will have agreed more effective mechanisms for engaging with the science and engineering communities on issues of education policy, working with the Royal Society and the Royal Academy of Engineering to develop these in consultation with other stakeholders in the science and engineering sectors.

#### Action 15

- By **February 2007** working with the National STEM Director, we will explore and agree the role that each of the Regional Science Learning Centres could play, working with other partners, in achieving better co-ordination of professional development for school staff and strategic planning.

#### Action 16

- By **March 2007** we will introduce for future evaluation of STEM initiatives standard evaluation systems across DfES and DTI which incorporate longitudinal evaluation and tracking

- particularly on impact on progression to post-16 STEM study and higher education - and which will support more effective targeting and use of STEM funding.

#### Action 17

- By **July 2007**, reflecting advice from the National STEM Director, DfES and DTI will agree, with other funders, on no more than ten national schemes of STEM support for schools (excluding national teacher supply measures) that should receive national funding and endorsement; and on how particular existing schemes and funding streams should be rationalised to fit within this simpler framework, building on those which can contribute most to achieving our objectives at national level.

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## BACKGROUND

1. The *Science and Innovation Investment Framework 2004-2014*, published in July 2004 by HMT, DTI and DfES, sets out a long-term strategy to secure and sustain a supply of scientists, engineers, technologists and mathematicians (STEM) to support the science base. Increasing the STEM supply is necessary for the UK to meet the skills challenge, and to be globally competitive and a world leader in science-based research and development.
2. The *Framework* identifies the need for step changes in:
  - The quality of science teachers and lecturers;
  - The numbers obtaining good science GCSE results;
  - The numbers choosing science, engineering and technology subjects in post-16 and higher education;
  - The proportion of better qualified students pursuing R&D careers;
  - The proportion of minority ethnic and women participants taking STEM subjects in higher education.
3. As part of the Framework, the STEM cross-cutting programme, jointly managed by the DfES and the DTI, was set up to examine the range of initiatives that currently support this agenda and to look for ways to enhance the effectiveness of Government funding in two areas:
  - The flow of qualified people into the STEM workforce
  - STEM literacy in the population
4. The STEM programme complements the new ambitions for science recently published in the “*Science and Innovation Investment Framework 2004-2014: Next Steps*”, as part of the Chancellor’s budget announcement. These are to increase the number of young people taking physics, chemistry and mathematics A levels; to improve the number getting at least level 6 at the end of Key Stage 3; and to improve the number of pupils getting the top grades in science GCSEs. In addition, to increase the number of teachers with science specialisms so that 25 per cent of science teachers have a physics specialism; 31 per cent of science teachers have a chemistry specialism; and to achieve an increase in the number of mathematics teachers to enable 95 per cent of mathematics lessons in schools to be delivered by a mathematics specialist (compared to 88 per cent currently). The STEM programme is now being fully integrated with the implementation of the School Science Programme.
5. This Report focuses on the support necessary to underpin the flow of individuals with STEM qualifications from school through to post-16 (academic and vocational) and to university.
6. The actions in this report will be taken forward in line with the agreed timetable and as resources allow. It will be important not to be diverted from the objectives of current policies. However, any future developments and costs, including reallocation of budgets and impact of DTI/OSI funding would need to be considered within the context of the Comprehensive Spending Review 2007.

See Annex 1 for further information about the STEM programme, including the STEM Mapping Review published in 2004.



## PRINCIPLES DRAWN FROM INITIAL ANALYSIS

7. The STEM Mapping Review revealed over 470 STEM initiatives run by DfES, DTI and external agencies. Further analysis was therefore focused on ongoing initiatives of significant size run by DfES and DTI, and their associated agencies. Though many activities address several purposes, it became clear that it was possible to categorise the primary purpose of different STEM activities into three broad strands:

- Teacher recruitment and retention
- Teacher professional development
- Enhancement - enrichment and aspiration-raising activities for students, and careers advice

8. Improved teacher recruitment and retention will both be necessary to ensure that we meet our objectives. These are the direct responsibility of the Training and Development Agency for Schools (TDA) and Lifelong Learning UK (LLUK) who are resourced to deliver the improvements set out in Chapter 6 of the document - *Science and Innovation Investment framework 2004-2014: Next Steps* published in March 2006.

9. Both professional development and student enhancement activities will need resources (materials, delivery channels and people) to further support their delivery.

10. The analysis showed that at present, there are many initiatives supporting STEM, mainly directed at school-age students. While many of them are of high quality they are mostly uncoordinated and, since they are relatively new, largely unevaluated. Access to, and information about, initiatives are key factors in their take-up by learning providers and learners. It also shows potential overlaps, with many initiatives providing similar types of support.

11. This preliminary analysis has led to the formulation of three principles that underpin the recommendations in this Report:-

- a. STEM support should be available to all learners and learning providers. It will therefore be necessary to build on and co-ordinate existing delivery networks to enable them to support the variety of needs.
- b. there is a need for greater co-ordination and joining-up of the many providers of professional development and enhancement activities to achieve more coherent delivery, but without sacrificing diversity of choice.
- c. there are clear economies of scale in providing many of these resources at a level above that of local authority and local Learning and Skills Council (LSC). In what follows, it is assumed that we need some provision at national, regional and local levels.

## DELIVERY AT THE FRONT LINE

12. It is important to focus on STEM outcomes at the front line – with learning providers. Strong STEM provision and delivery is essential for learning providers (schools, colleges, work based etc) to be able to (a) ensure that all learners have the opportunity to improve their scientific literacy and (b) provide a foundation for those who will specialise in STEM subjects in the learning and skills and higher education sectors, in research and in employment. Learning providers with staff qualified in the subjects they are teaching are likely to generate more STEM-qualified learners, whether measured in terms of GSCE, A-level or vocational qualifications. In these situations, it is likely that the learners are also directly supported on an extra-curricula basis with activities such as science, maths or engineering clubs.

**13.** In the case of both teacher recruitment and retention, the evidence is that the roles of the TDA, LLUK and the DfES are well-defined and understood. The present package of measures on teacher supply in schools seems to be working. The number of students enrolling on conventional initial teacher training courses is increasing. 3,640 students were recruited to science teacher training in 2004/05, compared with 2,310 in 1998/99. However, since the number of physics and chemistry graduates entering teaching remains a cause for concern, we have made further commitments to step up the recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers by 2014, as set out in Chapter 6 of the *Science and Innovation Investment framework 2004-2014:Next Steps*.

**14.** Through workforce remodelling the number and types of adults working in classrooms are both increasing and changing, including teaching assistants and higher level teaching assistants (HLTAs). Technicians and the wider schools workforce are also an important resource in supporting teachers and learners. In support of the 10 year framework and associated commitments, a pilot, managed by the Training and Development Agency (TDA) is under way to examine issues associated with the Government's commitment to enable every secondary school to recruit a specialist mathematics and science HLTA by 2007/08 to support teachers. Additionally, the Student Associate Scheme and other undergraduate volunteering programmes are designed to attract undergraduates into teaching. In 2006/07 2,500 places on this scheme have been allocated to physics, chemistry and mathematics undergraduates.

**15.** It should be noted that engineering and technology are not typically considered as curriculum subjects in schools - though design

and technology and ICT may count as such - but they are often college subjects. There are however 658 schools with specialisms in engineering or technology, a number which is growing. In addition, Specialised Diplomas are being developed in a range of subjects including ICT, engineering, land-based studies and environment. It will become a national entitlement from September 2013 (subject to the Education and Inspections Bill currently before Parliament) for young people to be able to choose to study a diploma, and it is expected that engineering and technology will increasingly become part of a school's curriculum as the diplomas are rolled out from 2008.

**16.** Taking the strands of teacher professional development and student enhancement activities, learning providers are able to choose from among the variety of initiatives on offer. Where choices are made and the outcomes are good, the system can be said to work well. However, the range of initiatives and the differences in delivery mechanisms in both strands can appear confusing, with the result that some learning providers do not take up the support available.

### RESPONDING TO THE CHALLENGES

The actions in this report will enable us to move towards a system which

- a) at national, regional and local levels, channels activities through a simpler delivery network to make the impact of initiatives and associated materials more effective;
- b) at national level provides a clear steer in the setting of priorities and a mechanism for ensuring coherence across the wide range of STEM initiatives;
- c) at the local level, provides a means for each learning provider to access guidance and information to ensure take-up of STEM support.

## A CORE STEM DELIVERY NETWORK

17. Several DfES and DTI structures that would form an essential part of a core delivery network are already in place. An overview of the existing situation at national, regional and local delivery levels is set out in table 1. (Table 1 includes publicly funded initiatives only. The coverage is further extended by STEM support provided by the charitable and private sectors.)

**Table 1.**

### National

Core deliverers are already in place for maths and science professional development: the National Science Learning Centre (NSLC) (funded by the Wellcome Trust) and the National Centre for Excellence in Teaching Mathematics (NCETM). Strategic development for professional development rests with the TDA and LLUK. There is no similar strategic view for STEM enhancement activities for learners.

The main governmental contributors to STEM initiatives at present are disparate - they include three policy directorates within DfES, the TDA, HEFCE and DTI.

### Regional

Organisations in place such as the Regional Science Learning Centres, the regional directors of the National Strategies and SETNET, the TDA's regional fieldforce, the Regional Development Agencies and Government Offices. In some areas there is already good communication and co-ordination between many of these organisations.

*Success for All*<sup>1</sup> and the Science Learning Centres are already working together. The Science Learning Centres have been contracted to manage *Success for All's* science networks and work with the organisations delivering coaching programmes. This approach brings together the FE and schools sectors.

In a similar way, sectors can be brought closer together and initiatives made more coherent by encouraging them to use existing infrastructure.

Regional Hubs for School Science are also being piloted in two regions by SETNET, working closely with the National SLC and appropriate Regional SLCs, as well as RDAs and other partners.

### Local

A number of field forces are in place that support learning providers in a range of activities. These include those of the DfES National Strategies, the TDA, *Success for All's* Subject Learning Coaches and the Local Authorities.

In addition, there are many groups of teachers operating collaboratively, for example through the Association for Science Education's (ASE's) networks, as part of a specialist school's cluster, or in delivering 14-19 curriculum choices. Centres of Vocational Excellence are required to spread good practice within the FE sector. Much of this work involves shared teaching and resources.

SETNET is also a local delivery mechanism, working through the sub-regional SETPOINTS and the Science and Engineering Ambassadors programme to deliver enhancement activities.

Education Business Partnerships work with schools, providing links with businesses. Some of their focus is on STEM subjects.

The extent of co-ordination and co-operation between this range of local field forces varies widely.

<sup>1</sup> *Success for All* is a programme for improving teaching and learning in the learning and skills sector - e.g. further education colleges and sites of work based learning.

Building on existing strengths, considerations and actions for the way forward are set out at each level in the following paragraphs.

### NATIONAL LEVEL

18. There is already much good work being carried out to raise achievement and awareness of what STEM subjects have to offer. However, it is hard to compare the success of initiatives because evaluations vary in type and depth.

**Action:** The introduction of standard evaluation systems across DfES and DTI for future evaluation of STEM initiatives which incorporate longitudinal evaluation and tracking, particularly on impact on progression to studying STEM at post-16 and in higher education, and which would support the effective use of STEM funding.

**Action:** By July 2007, reflecting advice from the National STEM Director, DfES and DTI will agree, with other funders, on no more than ten national schemes of STEM support for schools (excluding national teacher supply measures) that should receive national funding and endorsement; and on how particular existing schemes and funding streams should be rationalised to fit within this simpler framework, building on those which can contribute most to achieving our objectives at national level.

### Enhancement Activities

19. Enhancement activities are supported by many learned societies and professional associations and institutes. The engineers have been effective in coordinating many of these through the BEST programme, led by the Royal Academy of Engineering and supported by the Gatsby Charitable Foundation, which brings together initiatives for young people into a continuum.

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This ensures greater coverage and awareness of initiatives, and encourages progression from one scheme into the next. The development of the Technology and Engineering in Schools Strategy (TESS) represents another initiative from the engineering community focusing on promotion, activities for students, and advice for students. The TESS mission is to give every primary and secondary school in the UK, regardless of geography or local circumstances, equal access to a good number of quality-approved, high impact, co-ordinated schemes in engineering and technology-related education. TESS is a process through which the engineering community has agreed to work together to provide better coordinated support for the promotion of engineering and technology in schools.

20. The substantial number of activities provided by the science community focus more on supporting science teachers. In recognition of the value of greater co-ordination, the Royal Society has been leading the development of a more formal partnership between key deliverers, namely the Institute of Physics, Royal Society of Chemistry, Institute of Biology, Biosciences Federation, Science Council, Association for Science Education and the Society itself. Currently operating under the name of SCORE - **Science Community Partnership Supporting STEM Education** - this partnership will bring greater cohesion and strategic focus to the range of activities that first and foremost support

science teachers in enhancing the experiences they provide their students.

21. The Science, Engineering, Technology and Mathematics Network (SETNET) is a major deliverer of enhancement activities. Its coordination capacity has been significantly increased over the last year by the introduction of SETNET Regional Directors across England and an equivalent in Scotland. However there remains scope to increase its effectiveness still further.

**Action:** SETNET to work with OSI, DfES, the Royal Academy of Engineering (through TESS), the Royal Society (through SCORE) and others to improve co-ordination of the work of stakeholders who contribute to the delivery of opportunities for curriculum enhancement and enrichment, and to draw up plans to increase the number of schools, colleges and students which benefit from such activities and support.

### *Professional Development activities*

22. At present, the National and Regional Science Learning Centres are commissioned to deliver professional development to teachers who come to them (from the local level). To achieve their missions, they generate professional development activities. These could be deployed more widely through the core network, thus reaching a greater number of teachers and creating a more efficient commissioning and dissemination system which should be able to produce better outcomes at lower cost.

**Action:** DfES will continue to explore with the National and Regional Science Learning Centres and other partners the potential contribution they could make to professional development activities in engineering and technology.

23. While many of the resources may be produced from local initiatives, it is likely that there will be considerable scale economies if these could be produced at a national level. We should also note that there are distinct networks in place to support the various learning providers and there may well be scale economies in bringing elements of these together. ASE already send their published materials to the Science Learning Centres. Links between the key stakeholders producing and co-ordinating STEM enhancement activities and the National and Regional Science Learning Centres will be strengthened through the Governance structure proposed in this report, which will bring key influencers and decision-makers closer together.

**Action:** To ensure links are maintained between professional development and enhancement activities, the organisations taking key co-ordinating roles - the Royal Society, the Royal Academy of Engineering, and SETNET - should explore a presence in the National Science Learning Centre and possibly the regional Science Learning Centres

**Action:** There should be effective collaboration between the National and the Regional Science Learning Centres and the National Centre for Excellence in the Teaching of Mathematics.

**Action:** The National Science Learning Centre could be seen as the 'British Library' of STEM professional development and resources, working in partnership with the Association for Science Education (ASE). This would build upon the large Resource Centre already in place in the National Science Learning Centre. Much of the learned society, national academy and professional institution contributions are relevant, directly or indirectly, to professional development and enhancement activities. It is recommended that as much of this material as possible should be available in one place, subject to quality assurance and copyright restrictions.



### Advice to Government

24. Advice to Government from the mathematics education community flows through the Advisory Committee on Mathematics Education (ACME), an independent committee established by the Royal Society and the Joint Mathematical Council, and operating under the auspices of the Society with current funding from the Gatsby Charitable Foundation and the DfES. The structure of the science and engineering communities is very different, but the need for a more effective mechanism to engage with Government and its agencies is the same, and widely recognised.
25. The SCORE partnership (see paragraph 20 above) will also have a science education policy role, that will enable it to work together to engage with Government on these issues.

**Action:** DfES and OSI will engage with the science and engineering communities on issues of education policy through more effective mechanisms, and will work with the Royal Society and the Royal Academy of Engineering as they develop them in consultation with key stakeholders in the science and engineering sectors.

26. Employers need to be engaged in the STEM agenda in a more systematic way; the UK Science Forum, set up in July 2005 by HM Treasury is currently looking at improving the channels of communication between education and business to make education more responsive to the needs of the business environment, for example by improving the applied, practical aspects of degrees and the quality of teaching.

**Action:** The Skills Working Group of the UK Science Forum to recommend a suitable individual to represent business stakeholders on the STEM Strategy Group (see Action on high level STEM Strategy Group below).

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### Widening Participation

27. We know from previous reviews that some sections of society are under-represented in STEM. For example, only 14% of engineering undergraduates are women; only 3.24% of those studying science, engineering and technology (SET) are black; and 11.11% of those studying SET are Asian, mostly in medicine,<sup>2</sup> and those from less advantaged socio-economic backgrounds are under-represented in all sectors of education beyond age 16.
28. There are a number of initiatives which aim to widen participation from these groups. Computer Clubs for Girls are out-of-school clubs that provide a range of tailored e-learning activities for girls aged 10 - 14 years. STEM Access Grants, a £1.5 million DTI initiative, are provided to schools to engage secondary school students from black and ethnic minority backgrounds, especially Afro-Caribbean boys and Bangladeshi and Pakistani girls, to become more involved in science subjects. The London Engineering Project, a £2.85 million, 2½ year project funded by HEFCE and led by the Royal

<sup>2</sup> Science, Engineering and Technology and the UK's Ethnic Minority Population, a report by Warwick Institute for Employment Research, on behalf of the Royal Society, April 2005, p17

Academy of Engineering, is working with a wide range of commercial, academic and voluntary sector partners, including amongst others the African and Caribbean Network for Science and Technology. The project intends to widen and increase participation in engineering in higher education among minority ethnic students, women and adult learners by engaging with pupils through enrichment projects in schools. Partner organisations are also trained in cultural diversity and gender issues.

**Action:** To explore best practice emerging from the London Engineering Project on increasing diversity and consider whether this can be replicated for other subject areas to widen participation from under-represented groups.

### Web portal

29. A national STEM communities' web portal would underpin the core delivery network and play an essential role in advising and signposting people to the appropriate providers, and could provide access to the professional development and resource library.

**Action:** To investigate the potential to develop a national STEM communities portal from the existing Science Learning Centres' web portal, which is already providing a platform for the National Centre for Excellence in the Teaching of Mathematics. This would underpin the core delivery network and could provide peer reviews of resources, events, industry contacts, CPD and provide links and feeds from related sites. Regional portlets might also be developed.

### Further Research

30. The Economic and Social Research Council (ESRC) has a broad research remit on education policy, and has committed £2.8 million to address key research challenges in science and mathematics

education. There would be value in approaching them to provide research evidence on a number of key STEM issues, including:

- The mechanisms to enable STEM to be delivered into every school and how best to connect at regional and national levels;
- The balance between on and off the job professional development for teachers and the operational need for professional development in relation to the number of training days required.

## REGIONAL LEVEL

31. The Regional Science Learning Centres could also be helpful in rationalising a number of existing regional or sub-regional initiatives into the core network, working with SETNET's Regional Directors and the Regional Hubs currently being piloted, funded by the Regional Development Agencies. ASE field officers could play an important regional role. There is a strong argument for maintaining a regional layer, partly because it will be impossible for a national centre to do everything, and partly in terms of geographical reach to support the local ends of the delivery network.

**Action:** DfES with the National STEM Director, to explore the role that each of the Regional Science Learning Centres could play, working with other partners, in achieving a better co-ordination of professional development for schools through proactive strategic planning.

## LOCAL LEVEL

32. Better co-ordination of STEM support for schools and colleges is needed in every local area. Locally, advisers and learning providers should work together to co-ordinate the STEM elements within each provider's existing plans, making



sure of alignment with the priorities identified by the School Improvement Partner where appropriate.

33. The DfES will work with all the main providers of STEM support, including specialist science and technology colleges, to agree how they will work together regionally and locally in the most effective way to deliver the support needed. It is not about setting up a separate new set of networks or layer of bureaucracy at local level; some authorities may already have mechanisms in place that support organisations in working together, and where it is considered that they work well they should be retained and built upon. It is probable that one model would not fit all local circumstances, *but it is important that all agencies should participate in this support mechanism*. Local delivery is an area that the School Science Board will be considering in more detail.
34. All the agencies operating at a local level should be properly connected to the National and Regional Science Learning Centres. This implies that support for learning providers should be a joint operation at regional and national levels.
35. Specialist subject teachers in an area could be encouraged to join their subject association's local subject group, to learn from each other and disseminate best practice within their own schools. The Institute of Physics has local networks of teachers, organised by a regional co-ordinator, providing support and advice for physics teachers. Subject Learning Coaches, part of the National Teaching and Learning Change Programme, are specially trained to provide peer-to-peer coaching to their colleagues; this is already available to all post-16 providers of the priority subjects, including schools with sixth

forms. Science was one of the first subjects included in the programme to introduce innovative methods of teaching priority subjects launched in 2004.<sup>3</sup> Initial evaluation has shown that there is a 2.8% improvement in exam results for institutions which have adopted the programme. In addition to science, similar support for mathematics (launched in 2005) has been developed and engineering will be one of the subjects covered in phase 3 (September 2006). Consideration should be given to extending peer-to-peer coaching across all learning providers and age ranges.

36. It is necessary to work out alternative models for local delivery teams, led by different agencies in different contexts, such as urban or rural, and taking account of strong existing local partnerships where they exist already. This work should include an examination of budgets and work priorities from possible contributors.
37. Strengthening and streamlining the structures as outlined above will allow a more coherent approach to STEM planning, and make it easier for learning providers to access appropriate resources. Delivery of the outcomes of the school science ambitions of our *Next Steps* document would be fully integrated with the core delivery network and not only support the success of delivering these commitments but will further enhance the core network.

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<sup>3</sup> FE teachers will be required to maintain their professional standing by undertaking an appropriate amount of CPD that covers professional, occupational and industrial knowledge.

## GOVERNANCE

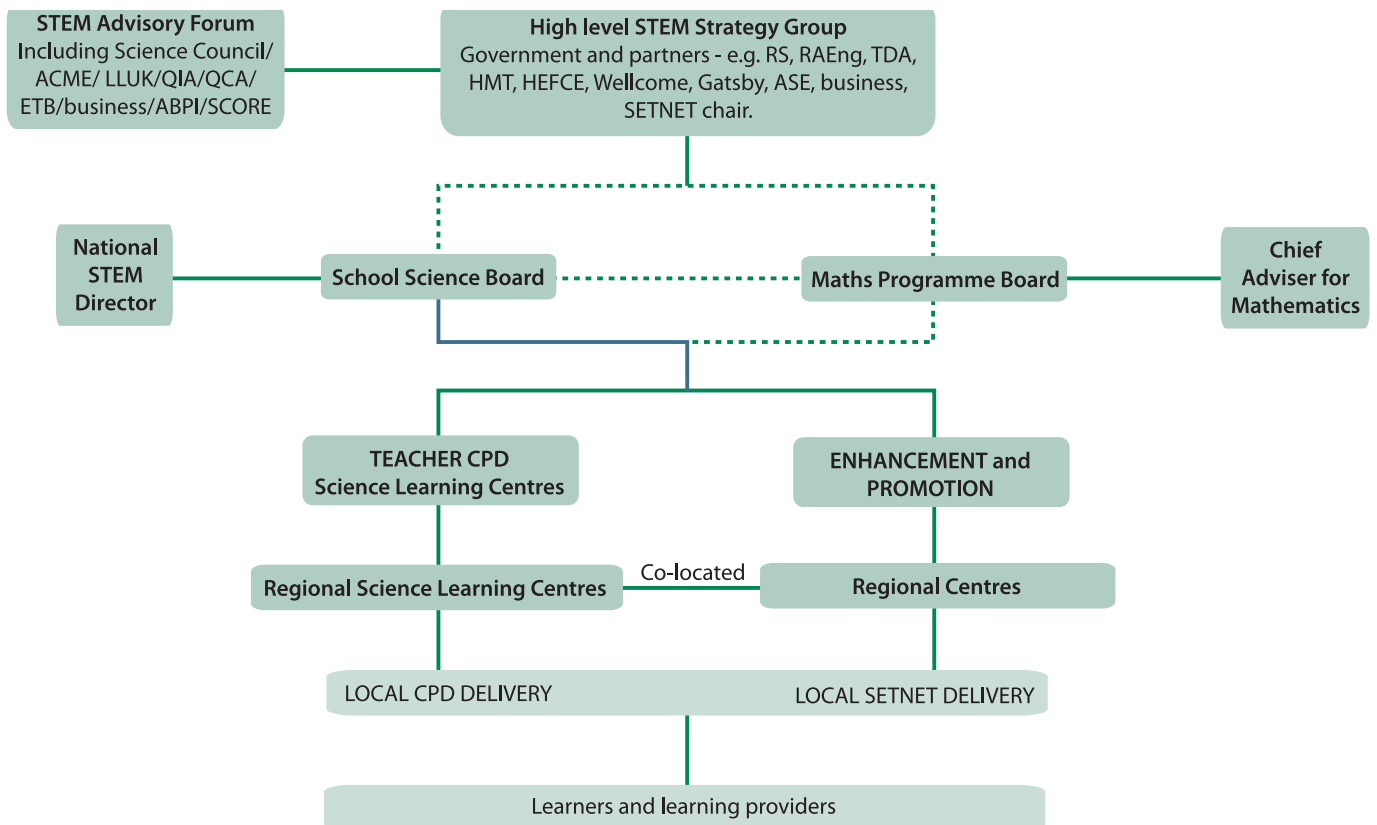
A governance structure for STEM policy and the delivery network will bring together existing and new groups consisting of:

- A Ministerial High Level Steering Group
- A high level STEM Strategy Group
- A STEM Forum (Advisory Body)
- A National STEM Director
- The School Science Board and School Maths Board
- The local delivery mechanisms

39. There is currently a Ministerial High Level Steering Group forming part of the STEM Cross-Cutting Programme, consisting of Ministers from DfES and DTI. This group, with the addition of the chairs of the high level STEM Strategy Group, should set the direction of national STEM strategy.

Figure 1 below shows the structure and interactions between the various parts.

**Figure 1: Governance structure for STEM delivery**



**Action:** The Ministerial High Level Steering Group, with the addition of the joint chairs of the high level STEM Strategy Group, should set the direction of national STEM strategy.

**Action:** There should be a new high level **STEM Strategy Group** to join up STEM policy across the DfES and to encourage a more coherent approach for all STEM across the DTI, other Government Departments and with external stakeholders, across all phases of education. The high level STEM Strategy Group would offer advice and make recommendations to Ministers on national priorities, and support articulation of a coherent national message about the need to increase the take-up of STEM-related initiatives. Group members would include representatives from DTI, HMT, the TDA, the Royal Society, The Royal Academy of Engineering, the Association for Science Education, as well as the Wellcome Trust, the Gatsby Charitable Foundation and business. The Group would be jointly chaired by the Directors General for Higher Education and Schools in DfES.

**Action:** The **School Science Board** with the Mathematics Board, where there are already strong links, will work with key partners to take forward delivery of the STEM programme actions as an integral part of the STEM agenda.

**Action:** A **National STEM Director** should be identified to be accountable for implementation of the agreed STEM programme actions. The Director should be directly accountable to the Chair of the School Science Board.

**Action:** A **STEM Advisory Forum** would be set up to ensure all members of the wider STEM community can contribute their views and advice on policy formulation and delivery to the SSG.

40. The School Science Board is responsible for implementing the ambitions set out in *Next Steps*. Its remit embraces, teacher recruitment, CPD and enrichment - the whole suite of actions required to take forward Ministers' agenda for school science. This Board is already established and in a position of strength to take forward delivery on all fronts - enhancement as well as professional development activities. The School Science Board with the Mathematics Board, where there are already strong links, will work with key partners to take forward delivery of the STEM programme actions as an integral part of the Next Steps commitments.
41. Locally, delivery mechanisms would vary depending on local circumstance<sup>4</sup>. Specialist schools or organisations holding SETPOINT contracts from SETNET, might want to take a leading role in driving local delivery working with other partners. The involvement of all interested agencies is key to success, regardless of which organisation is the lead.

## FUNDING

42. Some actions in this report will require funding if they are to be implemented. Actions can only be taken forward as and when funding allows. The role of the School Science Board and the high level STEM Strategy Group would be to consider any future developments and cost implications, including reallocation of budgets and impact of DTI/OSI funding, within the context of CSR07.
43. DfES will work with partners to explore the greater alignment, and where appropriate convergence, of STEM funds, including from DfES, other Government Departments, HEFCE and external organisations, and will use the high level STEM Strategy Group as a forum for these discussions.

<sup>4</sup> The LSC are currently carrying out a strategic review and are consulting on how the LSC delivers government policy including Education Business Links. This review may also inform current local delivery mechanisms.

44. It will be important not to be diverted from the objectives of current policies underway, such as the National Primary and Secondary strategies and *Success for All*. But there is a need to look well beyond the current Spending Review period and committed funds in moving towards our vision of a much more coherent system. With new funding a certain amount of flexibility would need to be built in to accommodate new strategies coming on board.

## CONCLUSION

45. The actions put forward in this report will be implemented in line with the agreed timetable and as resources allow. Future developments will depend on the outcome of the 2007 Comprehensive Spending Review. The new governance structure will bring a greater coherence to Government initiatives on STEM, and will facilitate closer working and a more joined-up approach across the age ranges. The contribution of our stakeholders is also significant; the proposals developed by the Royal Society, Royal Academy of Engineering and SETNET to improve coherence in their sectors are to be welcomed.

## Annex 1 The STEM Cross-Cutting Programme

### Background: The STEM Mapping Review

1. The STEM Mapping Review was initiated as a result of continued concern over the decline in demand by students for university places in STEM and a perceived lack of supply of graduates and qualified technicians in engineering and related professions. The key findings from the review highlighted the lack of coherence of the plethora of initiatives and identified policy gaps such as initiatives encouraging women, girls and ethnic minorities into STEM; the failure to encourage adults to up-skill or re-skill; and the need for better evaluation of initiatives.

Following the mapping review, Ministers agreed to take forward its recommendations through a cross-cutting STEM programme headed by a High Level Strategy Group under the chairmanship of DfES and DTI Ministers, currently Bill Rammell and Lord Sainsbury, and with representation from key stakeholders.

### 2. Methodology

Around 200 initiatives were examined and over 70 analysed in detail. These were chosen from the larger number identified in the original STEM Mapping Review on the basis that they were government funded, substantial in scale and were continuing. Other new initiatives were identified by policy leads. The networks which deliver STEM initiatives direct to learners and learner providers were also examined.

In addition, initial views were sought from a small sample of science and mathematics teachers and head teachers, some partner organisations, learned societies and professional institutions on the current initiatives and their suggestions for the future.

We found it helpful to classify the initiatives in relation to three broad themes:

- Teacher and teaching assistant supply
- Professional Development for teachers covering formal courses, teaching materials and resources, pedagogy and novel, effective and exciting modes of delivery
- Enhancement Activities for Learners, including areas such as
  - careers advice
  - extra-curricula activities such as clubs, booster classes etc
  - links with employers and work experience
  - campaigns, gender and ethnic minority focused activities
  - direct bursaries and inducements in shortage subject areas.

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## Annex 2 NATIONAL STEM DIRECTOR

### JOB SPECIFICATION

#### Context

1. The STEM mapping review highlighted a plethora of STEM initiatives and a lack of coherence between them. DfES and DTI Ministers have agreed that we need arrangements at the national, regional and local levels that will achieve a better co-ordinated, more accessible and clearer offer of support to staff (CPD) and students (enhancement).
2. Ministers have said that to this end they want to see:
  - Clearer and simplified delivery networks for CPD and enhancement at the regional and local level with providers working together to improve their reach so that all schools and students can benefit;
  - Greater alignment of different providers' activities in support of the priorities set out in the Next Steps document and some rationalisation of funding streams to support fewer higher impact activities and reduce complexity for schools and colleges; and,
  - Agreement on a standard approach to evaluation of STEM initiatives, particularly in terms of their impact on progression to post 16 STEM study.
3. More specifically, Ministers have agreed:
  - That in principle the National and regional Science Learning Centres should play a lead role in monitoring and co-ordinating STEM CPD at the national and regional levels, working with other major players (the TDA, SSAT and National Strategies);
  - That in principle specialist science, maths and technology schools should play a leadership role locally in ensuring other schools can access the CPD support needed, working with the SLC network and other local players;
  - That the SETNET network should play an enhanced role in co-ordinating and rationalising student-focused enhancement activities, in part through a wider stakeholder base; and,
  - That to ensure links are maintained between professional development and enhancement activities, the RAEng, the Royal Society and SETNET should explore a presence in the NSLC and possibly the RSLCs.
4. In terms of governance Ministers have agreed that progress with the STEM agenda will be steered by a high level STEM strategy group representing DfES and DTI and key external partners such as the National SLC, the RAEng, Royal Society and industry. The strategy group will report to a joint DfES/DTI ministerial steering group, and will oversee the work of the school science programme board and the maths programme board which will be held to account for delivery of the *Next Steps* and STEM agendas.

#### The job of the STEM National Director

5. The STEM National Director will have both advisory and executive responsibilities.
6. The Director's core tasks will be to:
  - a) help design and implement arrangements led by the SLCs (National and regional) and specialist science, maths and technology schools (local) to achieve greater coordination of STEM CPD support and reach to all schools and students;

b) building on the success of initiatives like the RAEng-led Technology and Engineering Strategy for Schools, to lead the negotiation of arrangements, led by SETNET, for closer co-ordination of delivery of the principal student-focused enhancement activities;

c) advise on and implement links between the SLC-led CPD delivery networks and the new SETNET-led arrangements for co-ordination of student focused enhancement activities;

d) advise on and implement effective collaboration between the NSLC and RSLCs and the NCETM;

e) discuss with key players and advise DfES and DTI on when existing schemes will come to an end and the options for greater alignment or rationalisation of activities and related funding streams (both for CPD and enhancement); and

f) advise on future spending implications to feed into preparatory work for CSR 07.

7. The first priority for the STEM Director will be to focus on school science activities and funding streams.

### Accountability

8. The National STEM Director will be directly accountable to the Chair of the School Science programme board, and ultimately to the High Level Strategy Group. The STEM Director will help the Chair of the School Science Board set the agenda and direction of work for the Board, of which he/she will be a key member. The National STEM Director will also be a member of the High Level Strategy Group to which he/she will report on a regular basis. He/she will also report in person on progress to the STEM Ministerial steering group.



## Annex 3 Glossary

|              |   |
|--------------|---|
| <b>ACME</b>  | <b>Advisory Committee for Mathematics Education</b><br>Independent committee which acts as a single voice for the mathematical community, seeking to improve the quality of education in schools and colleges   |
| <b>ASE</b>   | <b>Association for Science Education</b><br>Professional association for teachers of science  |
| <b>BEST</b>  | <b>Better Engineering, Science and Technology Programme</b><br>A collaboration of curriculum enrichment initiatives coordinated by The Royal Academy of Engineering   |
| <b>CIHE</b>  | <b>The Council for Industry and Higher Education</b><br>Members drawn from businesses, universities and colleges. It leads in developing an agreed agenda on the learning issues at higher education level that affect our international competitiveness, social cohesion and individual development. |
| <b>CoVEs</b> | <b>Centres of Vocational Excellence</b><br>Colleges in the FE sector developing greater vocational specialisation   |
| <b>CPD</b>   | <b>Continuing Professional Development</b><br>Up-dating and enhancing the skills and knowledge of professionals - e.g. teachers, lecturers, teaching assistants   |
| <b>DfES</b>  | <b>Department for Education and Skills</b><br>Government Department with responsibility for education in England  |
| <b>DTI</b>   | <b>Department of Trade and Industry</b><br>Government Department - within its remit is the Office for Science and Innovation which is responsible for UK Science Policy and for funding basic research allocated via the Research Councils.   |
| <b>EBP</b>   | <b>Education Business Partnership</b><br>Local organisations involving learning providers and businesses; aims include preparing young people for the world of work. Regional presence and a national network   |
| <b>ETB</b>   | <b>Engineering and Technology Board</b><br>etb is a registered charity which exists to promote the collective voice of scientists, engineers and technologists in the UK.   |
| <b>GTC</b>   | <b>General Teaching Council</b><br>Professional body for teachers. Maintains a register of qualified teachers and awards QTS status   |
| <b>HEFCE</b> | <b>Higher Education Funding Council for England</b><br>Responsible for distributing funding for higher education teaching and research to universities and colleges   |

|   |  |
|---|--|
| <b>IfL</b>                              | <b>Institute for Learning</b><br>Professional body for teachers and trainers in adult education, further education and work based learning   |
| <b>IoP</b>                              | <b>Institute of Physics</b><br>Professional body and learned society for the advancement and dissemination of physics  |
| <b>KS</b>                               | <b>Key Stage</b><br>The four stages of compulsory education, by age of child. KS1 5-7 years; KS2 7-11 years; KS3 11-14 years; KS4 14-16 years.   |
| <b>LLUK</b>                             | <b>Lifelong Learning UK</b><br>Responsible for the professional development of those working in higher education, further education, work based learning, and community education  |
| <b>LSC</b>                              | <b>Learning and Skills Council</b><br>Responsible for planning and funding vocational education and training   |
| <b>NCETM</b>                            | <b>National Centre for Excellence in the Teaching of Mathematics</b><br>Operational from June 2006; it has been set up to enhance professional development across mathematics teaching. It is for all teachers and lecturers of mathematics, in all phases of education.   |
| <b>QCA</b>                              | <b>Qualifications and Curriculum Authority</b><br>Maintains the national curriculum and associated assessments; accredits and monitors qualifications in colleges and at work  |
| <b>QIA</b>                              | <b>Quality Improvement Agency:</b><br>Since April 2006, the QIA manages the national teaching and learning change programme for FE. Its work supports the new specialised Diplomas for 14-19 year olds, the Train to Gain programme, National Skills Academies and CoVEs. It will also establish a national network of expert advisers to help advise colleges and providers on raising standards. |
| <b>The Royal Academy of Engineering</b> | The Academy is Britain's national academy for engineering: it provides independent and impartial advice to Government; works to secure the next generation of engineers; and provides a voice for Britain's engineering community.   |
| <b>Research Councils</b>                | The 8 Research Councils for the UK are the main public investors in fundamental research in the UK with interests ranging from bio-medicine and particle physics to the environment, engineering and economic research. The DTI has statutory control of the Councils.   |
| <b>RDA</b>                              | <b>Regional Development Agency</b><br>The 9 RDAs in England aim to strategically drive and co-ordinate regional economic development and regeneration  |
| <b>RS</b>                               | <b>Royal Society</b><br>It is the independent scientific academy of the UK dedicated to promoting excellence in science.   |

- RSC** **Royal Society of Chemistry**  
The Royal Society of Chemistry has dual roles of learned society and professional body.
- SCORE** **Science Community Partnership Supporting STEM Education** is a new partnership founded by the Royal Society along with the Institute of Physics, the Royal Society of Chemistry, the Institute of Biology, the Biosciences Federation, the Science Council and the Association for Science Education. Through collective and collaborative projects and joint studies; and work with others to increase teacher access to their range of resource and support activities.
- SETNET** **Science, Engineering, Technology and Mathematics Network**  
It is a UK-wide charity that provides links between organisations that employ people with Science Technology Engineering and Mathematics (STEM) skills and qualifications, with young people, so that they can see the range, relevance and excitement of STEM Careers.
- SETPOINTS** SETNET's UK-wide network to assist teachers in enhancing and enriching the STEM curriculum
- SSCs** **Sector Skills Councils**  
Sector Skills Councils (SSCs) provide employer leadership for strategic targeted action to meet their sector's skills and business needs. Currently there are 20 SSCs
- STEM** **Science, Technology, Engineering and Mathematics**
- TDA** **Training and Development Agency for Schools (formerly the Teacher Training Agency)**, renamed when its remit was expanded to cover development and training of the whole school team.
- TESS** The mechanism by which the engineering community of The Royal Academy of Engineering, the engineering institutions and others have agreed to promote engineering in schools in a unified way.

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