Summative evaluation of the National HE STEM Programme

Report to HEFCE and HEFCW by CFE

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1. Executive summary

1.1. The Higher Education Funding Council for England (HEFCE) commissioned CFE in March 2012 to undertake a summative evaluation of the National Higher Education Science, Technology, Engineering and Mathematics (HE STEM) Programme on behalf of both HEFCE and the Higher Education Funding Council for Wales (HEFCW). The National HE STEM Programme ("the Programme") ran from August 2009 to July 2012 with £20 million of funding from HEFCE's Strategic Development Fund (SDF) and a further £1 million investment from HEFCW.

1.2. The purpose of this summative evaluation is to support HEFCE and HEFCW to understand the effectiveness of the Programme and the results of their investment. The evaluation was commissioned to establish:

- The overall effectiveness of the Programme
- The ways in which the Programme has impacted on policy, process and activity within higher education institutions (HEIs) and the broader STEM community
- The sustainability of the Programme outcomes
- The effectiveness of the governance and management of the Programme at local and national levels, including the oversight of the funders.

1.3. The evaluation took a mixed method approach, drawing on interviews with stakeholders, Programme partners and project leads, an online survey and desk research on Programme documentation. HEFCE and HEFCW's requirements for this research were focused on an evaluation of the Programme overall and its higher level outcomes, rather than its constituent projects or activities. Additional evaluative work has also been undertaken by individual projects and by the Programme hub team, which has been drawn on where possible in this report.

Effectiveness of the Programme

1.4. There has been a high level of engagement with the Programme, covering the majority of HEIs with relevant STEM provision in England and Wales. The depth of involvement has varied among institutions, in terms of the number and size of projects engaged with, but overall good coverage has been achieved.

1.5. Collaboration within the Programme has been effective and has established professional relationships between many organisations that would not normally have worked together. As well as universities and professional bodies, collaborators included a range of employers, sector skills councils, sector and representative bodies. Within regions, a positive outcome of collaboration was that a dialogue between regional universities was

opened, and the Programme increased the opportunity for universities to share approaches.

1.6. A total of 149 projects were funded specifically for the purpose of promoting and sharing best practice. Overall the evidence suggests that the Programme was effective at disseminating good practice across the HE STEM sector. Through keeping many of these projects small in value, the Programme has been able to replicate these activities more widely, covering greater numbers of universities.

1.7. The available data on project funding show that the Programme funded a range of different sizes of projects, with funding evenly spread between a large number of smaller projects and decreasing numbers of higher value projects. This mix of smaller and larger projects matches the range of different objectives individual projects wished to achieve. Several stakeholders did suggest that the large number of projects made managing the Programme more challenging.

1.8. The range of funded projects also spanned the objectives of the Programme in terms of widening participation/outreach, curriculum development and workforce development, with a wide range of different project categories underneath these main strands. The range and diversity of activity can be seen as positive, as the Programme had the flexibility to fund different types of projects. This flexibility did come at the price of complexity and by spreading resources across so many activities, the totality of the impact is more dispersed and difficult to assess. However, our online survey of project leads reveals that they felt the projects they had been involved with were highly effective, with nearly three-quarters (73%) of respondents giving high scores for overall effectiveness.

Impact of the Programme on policy, process and activity

1.9. Evidence from our fieldwork is positive on the impacts of the Programme on university activity and practice. Importantly, the project leaders believe their own institutional effectiveness would be lower if they had never participated in the Programme. The Programme does seem to have influenced practice and activity at institutions, although wider cultural change at institutions has been more difficult to evidence.

1.10. Programme partners felt that the ultimate impact of the Programme on wider aims such as widening participation will only emerge as current school-age students apply to university. Even then, it is impossible to systematically ascribe changes in applications to the impact of the Programme, or individual projects, particularly given the changing economic and HE funding environment over the course of the Programme. Nevertheless, the number of applications and graduates in STEM subjects has increased over the course of the Programme, marking a positive development.

1.11. There were also examples of the Programme or its activities having influenced the national debate around HE STEM or policy. Projects funded through the Programme have been

cited by ministers and research commissioned by the Programme has influenced national debates and reviews in both England and Wales.

Sustainability of Programme outcomes

1.12. Sustainability was identified as a key theme at the outset of the Programme and in the selection criteria for funding projects. There is evidence to suggest that proposals for projects or activities were rejected on the basis they offered limited potential for sustainability. Robustly measuring sustainability is though inherently difficult when the Programme was only just drawing to a close. It is only when the external support has been fully removed for six to twelve months (or potentially even longer) that sustainability can be conclusively demonstrated. Therefore additional evaluative activity at a later point in time could be valuable for assessing the Programme's overall impact and sustainability.

1.13. From a policy perspective, increasing participation in HE STEM subjects is still regarded as strategically important and a priority by the UK and Welsh Governments and the HE funding councils, although different approaches are being pursued from when the Programme was established.

1.14. The infrastructure (i.e. the national hub and the regional spokes) is not sustainable without further funding. However, all core Programme partners have committed to building upon the work of the Programme going forward in legacy plans and funded legacy projects. Significant work has also taken place within the Programme's national hub to ensure sustainability. The University of Birmingham has recently established a STEM Education Centre as a direct legacy of the Programme, to create a coordinated range of STEM enhancement and enrichment activities across the university, with a national and externally-facing remit. This has already brought about a number of national collaborations, notably with the National STEM Centre based in York, to build strategic relationships between universities and schools and colleges (facilitated as part of the University of Birmingham's Office for Fair Access (OFFA) access agreement). Discussion has also taken place with the Higher Education Academy (HEA) to inform and ensure legacy support is available to the sector, and a collaborative programme activity agreed for 2012-13 focused upon evidence informed practice and pedagogic research.

1.15. The different strands of the Programme – increasing and widening participation, curriculum enhancement and innovation, and workforce development/employer engagement (in STEM) – all arguably remain integral to a university's core business, particularly given recent changes in the HE policy and funding regime. It is therefore reasonable to assume that there will be a level of ongoing institutional commitment to these strands through embedding, mainstreaming and disseminating, something which the Programme has encouraged. At an activity/practice level, the evidence available to us would suggest that a high proportion will remain embedded within the HE STEM sector beyond the lifetime of the funded Programme; a finding which is further supported by the results from our online survey.

Effectiveness of Programme governance and management

1.16. The Programme opted for a hub and spoke model, with the University of Birmingham hub team coordinating national activity alongside six regional spoke institutions to drive forward regional activity. Each regional spoke was expected to engage with universities and other partners within the region, which was hoped to be more effective than a single national partner coordinating all activity. In addition to the regional spokes, the four professional bodies were also key national partners, instigating and coordinating activity nationally.

1.17. Generally there was a sense that the model of the hub and spoke allowed the learning from the Programme to be spread more widely than otherwise would have been possible, allowing for regional and national differences to be taken into account and "cascading" learning and activities to regional partners beyond the spoke institutions. The model also facilitates both larger, national scale activities, as well as those at regional and local levels. The University of Birmingham and the hub and spoke teams provided effective management to achieve the Programme's objectives. However, the benefits of a model with so many delivery partners (the hub, six spokes and four professional bodies) came at a price of greater staffing and administrative costs than would have been incurred by a purely national infrastructure, or through the funding councils administering funding directly to projects. Added to this, unequal region sizes led to disparity in the funding available per HEI offering STEM courses in each region.

1.18. The complex Programme structure was also reflected in the funding for activities, with the arrangements leading to multiple funding calls from the national hub, spokes and professional bodies. Although these routes provided more opportunities for engagement with the Programme, feedback from spoke institutions was that the different levels were overcomplicated and potentially confusing for institutions wishing to participate in Programme funding calls. However, this did not translate into negative perceptions on the part of project leads.

1.19. We received feedback from spokes and professional bodies that the timescales of the Programme were challenging for a programme of this scale and ambition. Delays at the early stages of the Programme were a running theme in discussions with stakeholders, spokes and professional bodies, partly due to not setting aside a dedicated set up period before the Programme began. Given the scale of the Programme's aims of changing institutional practice and culture, there were arguments made that a longer-term Programme might have been more effective.

1.20. Feedback from interviews has been broadly positive on the role of both the English and Welsh HE funding councils in supporting, overseeing and engaging with the Programme. The councils took a comparatively active approach to overseeing the Programme, in comparison to other similar SDF initiatives, reflecting the Programme's size and strategic importance, and HEFCW in particular worked to engage HEIs in Wales with the Programme.

1.21. Overall, the conclusion of this evaluation is that the National HE STEM Programme was an effective and valuable contribution to the challenges facing the supply and diversity of STEM graduates in England and Wales, and overcame challenges relating to scope and complexity. With hindsight, the effectiveness and impact of the Programme might arguably have been increased by undertaking a more streamlined Programme model. However, the reasons for having a Programme model that was resourced at the national, regional and subject levels were valid and understandable and remain so.

2. Introduction

This evaluation examines the effectiveness, impact, sustainability and governance and management of the National HE STEM Programme, which ran from August 2009 to July 2012, and was funded by the Higher Education Funding Councils for England and Wales.

2.1. The Higher Education Funding Council for England (HEFCE) commissioned CFE in March 2012 to undertake an evaluation of the National Higher Education Science, Technology, Engineering and Mathematics (HE STEM) Programme on behalf of both HEFCE and the Higher Education Funding Council for Wales (HEFCW).

Background

2.2. The National HE STEM Programme ("the Programme") ran from August 2009 to July 2012 with £20 million of funding from HEFCE's Strategic Development Fund (SDF) and a further £1 million investment from HEFCW. The Programme built on four earlier HEFCE and HEFCW funded pilot projects in STEM and sat as part of HEFCE's work to support strategically important and vulnerable subjects (SIVS) and HEFCW's work on subjects of broader importance to Wales (SBIW). The Programme had three core strands of delivery activity based around:

- Activities to widen participation within and across the STEM disciplines at HE level, working with schools and colleges
- HE curriculum developments focusing on course delivery and design, student support and knowledge and skills
- Activities to encourage those currently within the workforce and society without a Level 4 qualification to engage with HE STEM study.

2.3. A key objective for these activities was for them to become embedded in the work of the HE STEM sector and therefore to achieve sustainability for the Programme outcomes.

2.4. The Programme was hosted at the University of Birmingham and operated a "hub and spoke" model, with regional spokes at the Universities of Bath, Birmingham, Bradford, Manchester Metropolitan, Southampton and Swansea. The hub at the University of Birmingham was responsible for the national coordination and coherence of the Programme and for financial management. The four professional bodies involved with the earlier STEM pilot projects (Royal Society of Chemistry (RSC), Institute of Physics (IOP), Royal Academy of Engineering (RAEng) and Institute of Mathematics and its Applications (IMA)) also continued to be involved in the Programme as key partners.

2.5. The purpose of this summative evaluation is to support HEFCE and HEFCW to understand the effectiveness of the Programme and the results of their investment. The evaluation was commissioned to establish:

- The overall effectiveness of the Programme
- The ways in which the Programme has impacted on policy, process and activity within HEIs and the broader STEM community
- The sustainability of the Programme outcomes
- The effectiveness of the governance and management of the Programme at local and national levels, including the oversight of the funders.

2.6. Through evaluating the Programme we have also generated several considerations or lessons learned for the funding councils when considering funding future programmes.

This report

2.7. This report presents conclusions and findings from the summative evaluation conducted by CFE from March to October 2012. After this introduction the rest of the report is structured as follows: Section 3 summarises the approach and method for the summative evaluation; Section 4 gives further details on the context for the Programme and its aims and objectives; Section 5 outlines our findings in relation to Programme effectiveness, while Section 6 addresses its impact; Section 7 considers the sustainability of the Programme outcomes; Section 8 evaluates the effectiveness of the governance and management of the Programme; and finally, Section 9 draws conclusions and lessons learned from the Programme and evaluation.

3. Method

Our evaluation was primarily based on feedback and consultations with Programme partners and project leads, supported by an in-depth analysis of Programme documentation and management information.

3.1. In March 2012, CFE were commissioned by HEFCE to conduct a summative evaluation of the National HE STEM Programme. Our fieldwork, comprising primary and secondary research, took place between March and September 2012, followed by analysis and reporting during September and October 2012.

3.2. HEFCE and HEFCW's requirements for this research were focused on an evaluation of the Programme overall, rather than its constituent projects or activities. This is partly due to the considerable scale and complexity of the Programme, but also because of the substantial amount of evaluation activity already undertaken at an individual project level. Detailed assessments and evaluations of project outputs have been made by each individual project funded through the Programme and are publicly available through the National HE STEM Programme website.[1] Our evaluation framework is therefore primarily concerned with evaluating the higher level outcomes of the Programme, rather than monitoring project outputs, although we do highlight some example projects for illustrative purposes. HEFCW also required developments in Wales to be assessed against the Welsh policy context, where this differs from the wider England and Wales context.

3.3. In summary, the key evaluation questions are closely linked to the evaluation objectives stated in Section2, and relate also to the Programme strategy, discussed in Section4:

- How effective was the Programme overall at delivering its aims and objectives in relation to the delivery activities of widening participation outreach activities, curriculum development and workforce development?
- How has the Programme impacted on policy, process and activity within higher education institutions (HEIs) and the broader STEM community?
- How sustainable are the Programme outcomes and achievements?
- How effective was the governance and management of the Programme at local and national levels, including the oversight of the funders?

3.4. To answer these questions we undertook a mixed methods programme of research, summarised in Table 1 below.

[1] National HE STEM Programme website: www.hestem.ac.uk

Activity	Summary
Literature review and secondary data analysis	> A comprehensive review of existing literature for both England and Wales to understand the context for the National HE STEM Programme, and the challenges in relation to maintaining and increasing student numbers and quality in the HE STEM sector. > An analysis of Destinations of Leavers of Higher Education (DLHE) survey and UCAS data to provide contextual information on how the HE STEM student population has developed over the course of the Programme.
Programme document review	> A review of Programme documentation and management information, to understand how the Programme functioned and what the Programme activities were. This includes analysis of the following: o Programme bid and contract information o Monthly monitoring reports and key minutes from meetings o Key budget and expenditure data o Project case studies and key evaluation reports.
Interviews with Programme leadership and stakeholders	> Nineteen interviews were conducted either face-to-face or via telephone according to preference, and were conducted on either a group or one-to-one basis.
Interviews with Programme partners	> Six visits to regional spoke universities, to conduct a series of face-to-face depth interviews with institutional leaders, regional directors, heads of academic units, regional officers, specific project leads and Programme support staff. > Four visits to the professional body partners engaged in the Programme, to conduct a series of face-to-face depth interviews with key individuals involved in directing, managing and coordinating Programme activity.
Survey of Programme partners and project leads	> An online survey of 248 project leads at universities, professional bodies and other organisations to gather feedback from those who had accessed funding from the Programme.
Interviews with project leads	> Ten telephone depth interviews with individuals involved in leading one or more projects, in order to gain detail and understanding of the effectiveness and impact of both the Programme and their own projects.
Regional Steering Group questionnaire	> Five additional questionnaire templates distributed to members of regional steering groups, to gather additional feedback and ensure that any members of the group that have not been engaged have had the chance to contribute to the evaluation.

Table 1: Summary of evaluation activities

3.5. Given the Programme's scale and complexity, a key challenge has been to ensure the evaluation considers as much relevant information as possible and that the majority of fieldwork was completed before the end of the Programme in July 2012. This evaluation uses the perceptions of Programme partners and stakeholders to inform its assessments, alongside Programme data. The hub team is also producing a final Programme report that will evaluate the achievements of the Programme and should be considered alongside this summative evaluation report.

4. Programme context, aims and objectives

This section briefly describes the policy background to the National HE STEM Programme, and the four pilot projects prior to the Programme, before discussing the establishment of the Programme and its aims and objectives.

3.6.

4.1. The National HE STEM Programme was conceived against a background of a national debate in both England and Wales on the benefits of higher level STEM skills to the economy and concerns about shortages of these skills. Successive reports in England, from the 2002 Roberts report, *SET for Success*[2], highlighted the increasing demand for innovation and skilled graduates (particularly in the more numerate subjects) in contrast to a simultaneous decrease in the supply of maths, engineering and physical science graduates in particular. A review by the Department for Education and Skills in 2004[3] identified a lack of coherence and coordination in initiatives to boost the supply of STEM skills and recommended setting up a cross-cutting review of STEM initiatives to rationalise them and improve efficiency. Other reports, including the Leitch review of skills[4] and Lord Sainsbury's *Race to the Top*[5], also highlighted the importance of higher skills to national prosperity and competitiveness, and the need for a more coherent approach to maintaining STEM skills. These reports and the national debate accompanying them made a political case for the need for intervention and established the STEM disciplines as requiring further focus and funding in order to arrest a slide in demand and supply of STEM higher level skills and in 2004 the Government put forward a long-term commitment through the Science and Innovation Investment Framework 2004-2014.

4.2. Similar issues were identified with the supply of STEM skills in Wales, with challenges from school level to HE. The Royal Society 'state of the nation' report[6] on the transfer of STEM skills from schools and colleges into HE found that Wales and England had similarly low

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[2] G. Roberts, SET for Success: The supply of people with science, technology, engineering and mathematics skills, (2002) HM Treasury. http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/set_for_success.htm, p.19.

[3] Department for Education and Skills, Report on the Science, Technology, Engineering & Maths (STEM) Mapping Review, (2004) DfES, www.nationalstemcentre.org.uk/elibrary/resource/4958/report-on-the-stem-mapping-review-2004, pp.39-40.

[4] S. Leitch, Prosperity for all in the global economy – world class skills. Final report of the Leitch review of skills, (2006) HM Treasury. http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/leitch,.

[5] Sainsbury, The Race to the Top: A Review of the Government's Science and Innovation Policies, (2007) HM Treasury, www.hm-treasury.gov.uk/d/sainsbury_review051007.pdf.

[6] The Royal Society, Preparing for the transfer from school and college science and mathematics education to UK STEM higher education: A state of the nation report,(2011) Royal Society, http://royalsociety.org/uploadedFiles/Royal_Society_Content/education/policy/state-of-nation/2011_02_15-SR4-Fullreport.pdf

proportions of A-level students in the core sciences, in comparison to Scotland and Northern Ireland. A particular focus in Wales was on workforce development and employer engagement, because of the importance of engagement between science and business for the country's economy. There were also similar perceived issues with the quality of STEM supply from HE to employment, with employers claiming many STEM graduates were "not ready for industry" due to a lack of practical skills and lack of training to assess risk.[7] A lack of experience in research and development practices was cited as one of the issues, which was a difficulty in Wales. In response to these concerns, the Welsh Assembly Government published the first science policy for Wales in 2006, offering a strategic vision for sciences, engineering and technology, and emphasising the importance of securing a sufficient supply of higher level skills in these subjects. This was reinforced in the skills and HE strategies of 2008 and 2009, with the HE strategy noting the importance for the Welsh economy of development stronger higher level skills and research in STEM subjects.

Learning from pilot projects

4.3. In 2005 HEFCE established an advisory group on SIVS , of which STEM subjects were an important component. Similarly HEFCW identified STEM subjects as SBIW, which need supportive intervention to address issues of supply and demand. As well as increasing the sheer numbers of people with skills and qualifications in STEM disciplines, both funding councils noted the importance of addressing the under-representation of certain groups in higher level STEM subjects, including women. Although some STEM subjects were seeing steady growth in graduate numbers (for example, clinical medicine, dentistry and veterinary science), both HEFCE and HEFCW identified a need to raise student demand in the subjects of chemistry, physics, mathematics and engineering in particular. This would involve targeting outreach activities at schools to raise the profile and attractiveness of these disciplines, and developing new HE curricula.

4.4. Working with professional bodies representing each of these disciplines, HEFCE, later joined by HEFCW in order to bring a coherent approach across England and Wales, initiated and funded four pilot projects in 2006-07, running until 2009-10. The pilot projects engaged in three strands of activities: interaction with guest speakers and exposure to career models; hands-on experience with the people, practices and places involved in STEM careers; e-mentoring, involving enthusiastic mentors in tandem with vibrant blogs and other web-based resources, and on-site interventions, for example in science laboratories, for both student experience and staff continuing professional development (CPD). Broadly, the pilot projects were intended to test approaches for raising student demand, widening participation, progression and retention in HE STEM subjects, which could then be rolled out more extensively across both countries.

4.5. The four pilot projects are described in brief below.

[7] National Assembly for Wales, *The Science, Technology, Engineering and Mathematics (STEM) Agenda,* (2011) www.assemblywales.org/stem_agenda_report-e.pdf, p. 35.

- London Engineering Project (LEP) (Summer 2005-July 2009, £4.34m investment, led by RAEng). LEP set out to widen participation in engineering HE, focusing on attracting under-represented groups in London: women, students from the lower half of the socio-economic scale, students with no family experience of HE, certain ethnic minorities and adult learners. Activities included the deployment of engineering role models (student ambassadors from London South Bank University, ambassadors from the Science, Technology, Engineering and Mathematics Network (STEMNET), Transport for London, and Tubelines), e-mentoring delivered by the Brightside Trust, STEM days, residential courses, summer schools and after-school clubs. The pilot also supported the development of a range of new HE engineering curricula and was judged in its evaluation report as being successful in delivering these activities and meeting its aims.[8]

- Stimulating Physics (May 2006-July 2009, £3.45m investment, led by the IOP). The programme was split into two strands: "Access", based in HEIs, which included a teacher fellowship scheme to link HEIs to schools and curriculum development to attract a broader range of students to physics, and "Demand" which included piloting activities in three regional clusters of schools and colleges designed to increase students' motivation to continue studying physics at A-level and beyond (e-networking, industrial visits, careers awareness-raising). In 2009 the Department for Education awarded the IOP a contract to build upon the success of the pilot through the establishment of the Stimulating Physics Network, in partnership with the science learning centres. The website continues to provide a range of support for all secondary schools in England, including resources for teachers and pupils.

- Chemistry for Our Future (CFOF) (Sept 2006-July 2009, £4.9m investment, led by the RSC). Employing two cross-cutting themes – Careers and Sharing Good Practice – CFOF included university and industry outreach, including further roll-out of a widening participation project Chemistry: The Next Generation, a teacher fellowship scheme, HE chemistry curriculum development and widening access to university laboratories. The project placed a strong emphasis on increasing exposure for school students to practical chemistry at HE level, through for example portable experimental demonstrations using cutting-edge equipment, known as Spectroscopy in a Suitcase (SIAS).

- More Maths Grads (2007-2010, £3.1m investment, led by the Mathematics, Statistics and Operational Research HEA Subject Centre on behalf of the London Mathematical Society, the IMA, the Royal Statistical Society and Heads of the Departments of Mathematical Sciences). Piloted via lead HEIs in the West Midlands, Yorkshire and Humberside and London, the project addressed four key themes: integration and diversity, employer engagement, HE curriculum innovation, and mathematical sciences support. The project also involved four themed strands of activity: student, teaching, careers, and HE. These four strands included enrichment activities aimed at raising aspiration, support materials for teachers, information about careers options, and a review of the HE curriculum in mathematical sciences. Following the initial successes of

[8] Royal Academy of Engineering, The London Engineering Project: Evaluation Report, (December 2009), p. 3.

the project, in 2008 HEFCW provided funding for a similar but smaller pilot scheme in Wales.

From pilot projects to National HE STEM Programme

4.6. As the pilot projects neared their completion, HEFCE and HEFCW set out plans for a national programme to continue and spread the work of the pilots. It was calculated that replicating the pilot projects nationally in their entirety across both nations could have cost over £60m, so the funding councils looked for economies of scale to spread and embed the institutional practice developed through the pilots. Outreach, widening participation and curriculum development activities were to form the core of the national Programme, but to these the funding councils added workforce development activities, reflecting the priority in both Wales and England of providing higher level skills to those already in the workforce. The Programme was to be led by a university, rather than the professional bodies, and HEFCE released an invitation to tender in early 2009. The decision to award the University of Birmingham the Programme was confirmed in the summer of 2009, with funding granted through HEFCE's SDF and, in Wales, under HEFCW's SBIW initiative.

4.7. The interviews for this evaluation have highlighted that the decision to award the Programme to the University of Birmingham over the other bidders, and the subsequent set up phase, did lead to some sensitivities in relation to the unsuccessful bidders and the professional bodies. Some institutions and professional bodies felt that there was some delay in setting up the Programme, including on appointing spoke institutions. The delays were particularly felt by the professional bodies as they were seeking to transition from the pilot projects, and important continuity in staff expertise and momentum in activities was not maintained as effectively as should have been the case.

4.8. HEFCE appears to have played a positive role in brokering these difficult early discussions between the University of Birmingham, the spokes and the four professional bodies, as well as in promoting the Programme to the wider sector. The responsible Pro Vice-Chancellor at the University of Birmingham also played a crucial role in these early stages. Nevertheless, the delays in the start up period, both in appointing all the spoke institutions and in appointing staff throughout the partners, did have negative impacts on the capacity of the Programme even after it had formally commenced. This can be explained by the short period of time between funding confirmation in June 2009 and commencement of the Programme in August 2009, meaning that recruitment had not been completed when the Programme began. These challenges relating to timeframe are further discussed in Section 8of this report.

4.9. The Programme was to be delivered through a national hub at the University of Birmingham, with six regional spokes based at HEIs in the South West, Wales, the North West, Yorkshire and the North East, the Midlands and East Anglia, and the South East. The effectiveness of this model is evaluated in Section 7 of this report.

Aims and objectives

4.10. The initial invitation to tender and the successful bid document from the University of Birmingham stated that the three overarching aims of the Programme were to create a Programme that:

- Engages collaboratively to increase and widen participation
- Promotes, supports and champions the STEM disciplines
- Is increasingly responsive to the skills needs of both employers and employees.

4.11. While the need for demand-raising activity in the STEM disciplines was evident in the national reports that set the context for the Programme, HEFCE also recognised from the pilot projects a strong widening participation imperative that needed to be addressed, and as a result situated the Programme within the Widening Participation Team at HEFCE. As noted in interviews with Executive Committee members, HE STEM subjects too often suffered from "a stark lack of diversity" that needed to be addressed in tandem with increasing the overall volume of participation.

4.12. There was a recognition too from the funding councils and the University of Birmingham that the STEM landscape – particularly in relation to outreach – was a crowded space, and that a national programme must build on and not duplicate existing work. When the National HE STEM Programme was launched there were a number of other existing STEM organisations including the National STEM Centre and its Science Learning Centres, STEMNET, the UK Resource Centre, the Women In Science and Engineering (WISE) campaign and the HEA subject centres in STEM related subject disciplines which existed until 2011. Individual HEIs also had existing STEM initiatives in relation to outreach, graduate skills and workforce development, which the Programme hoped to build upon.

4.13. To achieve the Programme's aims, the bid document set out six key objectives:

- To develop infrastructures which enable the HE and employment sectors to offer a collaborative and sustainable supply of lifelong learning opportunities to support the UK workforce from school, during university and within the workplace
- To develop innovative and transferable models and programmes of activity across the disciplines of Chemistry, Engineering, Mathematics and Physics relating to access, skills development and employer engagement through the integration and strategic development of existing activities, initiatives and resources, that will offer demonstrable long-term benefit to the HE sector
- To broker and facilitate the community-wide sharing and dissemination of good practice in relation to HE STEM activities, education and employer engagement
- To establish a culture of sustainable collaboration within the national HE STEM sector by working in partnership with HEIs, employers, professional bodies, and existing and future initiatives and organisations

- To act as a catalyst for institutional change so that the National STEM Programme may be embedded within the HE sector to create a long-term and sustainable programme of activity

- To develop an efficient, effective and adaptable programme of national activity that responds to emerging sector needs and national policies and offers a high quality experience to all who engage with it.

4.14. A crucial feature of these objectives is that they relate to developing and influencing institutional practice and culture, which was intended to help the Programme outcomes to be as sustainable as possible. The aims and objectives were to be achieved through three broad strands of activity: outreach activity with schools and colleges, curriculum development, and activity to raise skills of both graduates and people in the workforce.

4.15. The nature of the objectives which consciously acknowledged the need for there to be both structures and a legacy beyond the duration of the Programme meant that sustainability was clearly addressed, and this was echoed by professional bodies, institutions and the funding councils.

> *The primary objective for us was that however, whatever came out of the Programme would be sustained. So, that this was a programme as much about changing HEI practice and approach and possibly culture in some sense as it was about delivering activity. In fact, there was more about changing practice, impacting on practice, enhancing practice. So, that that would then just become part of what the institution does.*
>
> Programme stakeholder

4.16. The extent to which the sustainability was successful will be explored later in the evaluation report, but it was clearly considered and communicated in devising the aims and objectives, and the process of ongoing reporting (including the six monthly reports to the funding councils) clearly monitored sustainability throughout.

4.17. There was feedback from the stakeholders that the aims and objectives of the Programme were both timely and the national structure important.

> *It's been a major national intervention in Wales and in England, in an area where I think the university sector and the professional bodies felt that there was considerable area of risk, and considerable need for intervention. So I think timeliness, for me, has been excellent.*
>
> Programme stakeholder

4.18. Furthermore, there was a strong view from the professional bodies that the chosen aims and objectives were sensibly aligned with their existing objectives and built upon the pilot projects , a view backed up by the RAEng and the Wales Institute of Mathematical and Computational Sciences. Another professional body echoed the view that the aims and

objectives certainly built on and complemented existing activity, although they did seek to place some perspective on the scale of funding that was available in comparison to the substantial activity they were already undertaking in this area.

4.19. This would indicate that there had been careful consideration to ensure that the aims and objectives built on and extended existing priorities within the sector, and given the strong backing for this perspective from the professional bodies, careful alignment with the pilot projects.

4.20. After the Programme had started, the six Programme objectives stated above were subdivided and split into seven new goals. These were used as the basis for monitoring success in the six-monthly reports to the funding council, and were designed to map with the Programme's own evaluation framework. These new goals shared many of the same priorities as the objectives that preceded them, but made more specific reference to activities to be undertaken. For example, specific reference was made to workforce development, which became a key strand of activity within the subsequently developed Programme strategy. The Programme goals were to:

- Engage the HE sector in the activities of the Programme to build capability within HEIs
- Disseminate the activities and learning from the Programme to the HE sector to increase awareness and provide opportunities for HEI engagement and adoption of practices
- Facilitate and enable the sharing and dissemination of best practice across the HE STEM sector
- Enable collaborations between HEIs, and between HEIs and other STEM initiatives and organisations to enable a longer-term way of working
- Transfer and embed the activities and learning from the four Pilot Projects into the HE sector to influence the core practices of universities
- Develop innovative and transferable models and modes of activity in relation to:

  widening participation into HE,

  delivery of the HE curriculum, and

  workforce development and employer engagement
- Impact upon the core practices of universities and enhance the delivery of STEM programmes of study within the HE sector in a sustainable manner.

4.21. In order to ensure each Programme objective and goal would be addressed, the National HE STEM Programme Strategy was formulated to define the Programme's key delivery strands and approach. These strategic aims were wide-ranging and intended to be overlapping.

4.22. The nature of the Programme meant that individual projects could address strands of activity, and transcend subject discipline. At a high level, as summarised in Table 2 below, the activity strands for the Programme covered: HE engagement with schools and colleges, including activities to address outreach and widening participation objectives; curriculum development (including projects to develop teaching and learning, pedagogic research and new STEM programmes of study); and "higher level skills", which focuses on graduate skills development (including employability) and workforce development activities.

Activity strand	Objectives and activities
HE engagement with schools and colleges	To increase the impact of HE STEM sector activity and interventions with schools, colleges and local communities
Curriculum development	To enhance delivery of the HE curriculum to improve the overall learning experience offered to undergraduate students within the STEM disciplines
Higher level skills	Graduate skills development: Activities focused upon ensuring those who graduate from HE STEM Programmes possess the necessary skills and competencies to contribute fully in the global workplace.
	Workforce development: Activities to support HEIs increase the knowledge, understanding, skills and competencies of those currently within the UK workforce who have not previously participated within HE.

Table 2: High level National HE STEM Programme strategic themes and activities

4.23. The strategic themes listed above are multifaceted and each incorporates a number of strategic activities. From a delivery perspective, many projects within the Programme addressed more than one of the activity strands, albeit usually with a primary focus. For example, a given project may have been primarily focused upon graduate skills development, specifically to deliver employability provision to undergraduates, but also involved significant elements of curriculum development, and have an additional objective to foster new links with employers. Of course, there were also many projects that were tightly focused on a particular strand of activity, with isolated outputs that are only intended to impact upon a single objective (for example, to widen participation in a particular subject field or degree). This is by design: the diversity and multi-layered nature of projects in the Programme were part of an overall approach to develop capacity in the HE sector in line with institutional priorities, and where possible, building upon existing activity and expertise.

4.24. The relative importance of each strand of activity shifted throughout the course of the Programme. In particular, workforce development appears to have become a lower priority for some Programme partners in England, reflecting wider changes in the HE policy environment between 2009 and 2012. It should be noted however that workforce development remained of key importance in Wales. Despite a changing policy emphasis, substantial investment did continue in workforce development over the course of the Programme and it was a successful strand of activity in its own right. Since workforce development had not been included in the pilot activities, there was some questioning, from the professional bodies and others, of whether it should sit as part of the Programme. From a professional body perspective, the Programme's activities might have been better

concentrated on school-age students than on the skills needs of the existing workforce. HEFCE's view appears to have been that combining workforce development with outreach and curriculum development would mean that the Programme could complement other SDF initiatives, such as the Transforming Workforce Development Programme, and lead to mutual reinforcements and additional impact in this area. HEFCW also felt it was important to emphasise employer engagement and workforce development, because of the importance of higher level STEM skills and the interaction between HE and employers to the success of the Welsh economy.

4.25. In practice this evaluation has found little evidence that institutions receiving both National HE STEM Programme funding and Transforming Workforce Development funding actually made these kinds of reinforcing links. Instead, it was possible for institutions to undertake STEM-focused workforce development and wider SDF/workforce development activities in isolation. For example, one spoke institution was also a significant and high profile recipient of workforce development funding. From the evidence of our interviews, there did not appear to be links between the two initiatives within the institution. Taking into account the challenges of implementing a programme with such a broad scope and the varied and uneven nature of cross-faculty and cross-department collaboration in universities could be an important lesson for future programmes.

Establishing targets in line with the aims and objectives

4.26. There was wide recognition even as the Programme was being established that its deliberately ambitious aims, particularly those relating to widening participation and changing institutional practice, would be difficult to measure. Attempts by universities and previous national programmes, such as Aimhigher in England or Reaching Wider in Wales, have demonstrated how difficult it is to attribute any improvements in participation or access to a particular intervention, alongside all the other factors influencing STEM provision and student choices. Although the bid document did set out a series of success outcomes and even key performance indicators, the majority of these were framed in terms that would be difficult to assess success or failure in a quantitative sense. There were a number of comments from our interviews suggesting that the objectives were too broad, not sufficiently focused, were not attached to quantitative targets, and did not set a baseline against which to measure progress. Of the 16 measures of success quoted in the bid document, 15 are qualitative, with just one quantitative measure (an increase in absolute number of adult learners studying STEM subjects through flexible learning modes). The baseline for measuring progress was intended to be set in conjunction with independent evaluators appointed for the formative evaluation. However, this evaluation failed as the evaluators ceased trading before submitting any meaningful evaluation design.

4.27. It can be argued, despite these criticisms, that the aims of the Programme were not suited to simplification into an easy to measure quantitative framework. Influencing institutional practice by its nature will vary from situation to situation and cannot necessarily be standardised and measured. Following the Programme's conception, this summative evaluation has primarily focused on qualitative indicators of effectiveness, impact and

sustainability, although where possible we have addressed quantitative measures. A lesson for future programmes is getting the right balance between quantitative and qualitative outcomes for funded activity. Many programmes will have a mix of both types of outcomes, allowing measurable progress against hard targets, while at the same time allowing flexibility to achieve less easily measurable, but important, goals. By focusing so much on qualitative measures, the National HE STEM Programme has had some difficulty clearly demonstrating its impacts and achievements, without resorting to listing a range of diverse outcomes that are specific to one situation and difficult to collate.

5. Effectiveness of the Programme

In this section we examine the overall effectiveness of the Programme, in terms of its key goals of engaging the HE sector, facilitating the dissemination of good practice, and supporting innovative activity in the sector in widening participation, curriculum development and workforce development.

4.28.

5.1. The National HE STEM Programme set out to achieve the range of objectives set out in the previous section, to support and develop the capacity and practice of the HE STEM sector in England and Wales. To reach these goals the Programme has been effective at supporting a large amount of activity that has contributed and will continue to contribute to these goals. All of these projects have been evaluated individually, and this evaluation does not attempt to measure effectiveness at an individual project level, but rather the effectiveness of the Programme overall at achieving its goals through commissioning projects and other activities. In this section we consider the effectiveness of these activities; issues relating to the wider conception of the Programme and governance and management are covered in Section 8.

5.2. This section considers the Programme's effectiveness in relation to:

- Engaging the HE sector and encouraging collaboration
- Dissemination and sharing of good practice
- Supporting innovative activity in relation to:

  Widening participation into HE

  Delivery of the HE curriculum

  Workforce development and employer engagement.

5.3. Related areas covering impact of these activities and embedding within institutions are covered in the Impact and Sustainability sections to avoid duplication across sections. In evaluating effectiveness, we consider both qualitative and where possible quantitative indicators to draw our conclusions.

Engaging the HE sector and encouraging collaboration

5.4. As the Programme was led by a single institution and regionally by just six spoke institutions, it was particularly important that the Programme could engage the whole HE STEM sector in England and Wales. This includes HEIs and other interested organisations, including professional bodies and employers. Over 80 HEIs in England and

Wales have actively engaged in the delivery of Programme activity, demonstrating that the Programme has been effective at engaging with the HE sector. A total of 107 different organisations were responsible for the 593 projects on the Programme, including 81 universities, three general colleges of HE, the four professional bodies and 19 'other' organisations. These organisations included private research organisations, further education (FE) colleges, HE and industry networks and partnerships.

5.5. The fact that 81 different HEIs have led a project and an additional nine have been engaged as a collaborative partner shows a high level of engagement with the Programme, covering the majority of HEIs with relevant STEM provision in England and Wales. Nevertheless, the depth of involvement of HEIs has varied among institutions, with spoke institutions in particular having the highest level of involvement across multiple projects and activities (up to 32 projects in the case of one spoke institution, and a total of 22 universities holding 313 of the Programmes projects (52.8%)). A cohort of institutions had significant involvement across multiple activities, with the universities of Loughborough, Leeds, Sheffield Hallam, Coventry and Liverpool all being engaged with over 15 projects each. However, several institutions were only engaged in a handful of project activities, with 60 HEIs and other institutions involved in fewer than five projects each. The visibility of the National HE STEM Programme has been variable, with some institutions anecdotally not being aware that the activity they were involved with was connected to the Programme. Interviews with key Programme stakeholders reinforced the perception that the coverage of the Programme across the sector has been good, but with more shallow levels of engagement from some institutions.

> *I have never doubted that there's been a strong amount of interaction between the centre and the partners, but what I do think has been challenging has been the different amount of buy-in from different institutions....There seems to be different levels of commitment and I imagine that that's something that the Programme's had to deal with, and a lot of different interested parties.*
>
> Programme stakeholder

5.6. The "HE STEM sector" is not synonymous with the HEIs in England and Wales, owing to the uneven distribution of STEM provision and students in the HE sector, as illustrated in Table 3. STEM students tend to be concentrated in the best-resourced institutions, demanding the highest entry tariffs. This is the consequence of the subjects being resource- and research- intensive and often needing facilities for experimentation and testing, which makes them more difficult for institutions with smaller budgets to offer. For example, in 2010-11, 97% of physics first degree graduates graduated from high entry tariff institutions; chemistry and mathematics are similarly, if not so starkly, skewed towards higher tariff institutions, while only engineering is distributed more evenly among tariff groups.

Subject area	Highest tariff	High tariff	Medium tariff	Lower tariff	Other HEI
Physics	70.8%	26.0%	1.6%	0.3%	1.4%
Chemistry	58.9%	26.6%	11.7%	1.4%	1.4%
Mathematics	52.1%	31.6%	9.7%	3.4%	3.2%
Engineering	32.5%	26.6%	27.1%	11.1%	2.6%
ALL SUBJECTS (STEM and others)	22.0%	23.0%	34.8%	14.0%	6.2%

Table 3: 2010-11 first degree graduates by entry tariff group and subject (DLHE survey)[9]

5.7. Examining the distribution of funded projects by project lead institution shows that they were spread across universities of different entry tariff groups, over-representing medium and lower tariff institutions, in comparison with the distribution of STEM students overall. This is positive, as part of the aims of the Programme was to widen participation and STEM provision beyond the research intensive institutions where most STEM students study.

5.8. Most projects (528 out of 593) were led by universities. Of these, 58% were led by universities in the 'highest' and 'high' entry tariff categories, reflecting the large proportion of HE STEM students at these institutions. Lower entry tariff universities accounted for just 56 projects (12.1%), as shown in Table 4.

Entry tariff	Number of projects awarded (lead institutions)	Amount of funding awarded
Highest tariff universities	153	£3,111,271.55
High tariff	151	£2,389,946.08

[9] This analysis uses a method of categorising universities by the entry tariffs required for their courses. This taxonomy was developed by Elias, Purcell and Atfield of the Institute for Employment Research, for the Futuretrack project and divides institutions into five categories that are not dissimilar to, but differ from, the more commonly-used mission groups. See "Analysing the relationship between higher education participation and educational and career development patterns and outcomes", Futuretrack Stage 3 Working Paper 1, IER, 2009, www.hecsu.ac.uk/assets/assets/documents/futuretrack/Futuretrack_Stage3_WorkingPa1.pdf

universities		
Medium tariff universities	156	£2,943,852.29
Lower tariff universities	68	£1,158,675.65
General HE Colleges	6	£64,155.00
Other non-HEI (including professional bodies)	59	£2,025,518.00

Table 4: Comparison of Programme funding amounts by lead university entry tariff

5.9. The overall volume of activity differed considerably among Programme regions, with London and the South East delivering the highest number of projects and engaging with the most HEIs, followed by the Midlands and East Anglia region, as shown in Table 5 below. This reflects the greater numbers of STEM-focused HEIs based in those regions in comparison to the others (the uneven distribution of HEIs in the Programme regions is discussed in Section 8: Effectiveness of Programme governance and management). However, the funding distributed to the regions was not proportionate to the number of HEIs or the number of projects, meaning that regions with more projects tended to have projects of smaller size. A significant portion of Programme funding was attributed to projects delivered on a UK-wide basis, with a total of 26 projects delivered by professional bodies, HE networks, specialist HE STEM organisations, and a single HEI that do not feature in any of the other Programme regions. As in the English regions, the Programme in Wales was successful at engaging the majority of institutions offering STEM provision.

Programme region	Number of Projects (lead institutions)	Total Project funding assigned	Total no. of different HEIs engaged
London and the South East	132	£2,278,965.00	23
Midlands and East Anglia	136	£2,382,235.86	17
North East	116	£1,768,699.00	13
North West	66	£1,517,040.75	11
South West	57	£1,454,692.00	7
Wales	60	£1,204,661.96	9
UK-Wide	26	£1,087,124.00	1

Table 5: Regional breakdown of project delivery, funding and HEI involvement

5.10. One of the overarching principles of the Programme was to develop collaborative activities, not only between universities, but also between universities and other organisations, including professional bodies and employers. A focus on collaboration was part of the Programme's remit in its first open call for funding, and continued as a theme throughout in funding for projects.

5.11. Analysis of available project data suggests that collaboration within the Programme has been effective, in that it has established professional relationships between many organisations that may not normally have worked together. The majority of projects involved some form of external collaboration or partnership working.

5.12. One hundred and twenty-two projects mention one collaborator, in addition to the lead partner, while 239 projects had between two and five collaborators, in addition to the lead. Fifty-eight projects had between six and ten collaborators, while 69 projects had 11 or more collaborators, up to a maximum of 19 in one project. As well as universities and professional bodies, collaborators included a range of employers, sector skills councils, sector and representative bodies. While 105 projects do not mention external collaboration, many of our interviews with HEI staff and project leads suggest that internal collaboration within and across HEI departments and faculties has taken place.

5.13. Naturally there have been some challenges associated with encouraging collaboration between HEIs on the Programme, including a sense of competition between HEIs. Several interviewees felt that such competition could increase in the new student funding environment, where competition for students is becoming more intense, inhibiting the transfer and adoption of best practices. It is not clear from the project data whether a sense of competition might have affected willingness to collaborate in a meaningful way during the life of the Programme.

> *I think that the collaborative stuff is going to be a bit more challenging because we're probably going to be more ruthless. That's a shame. That's the way that the funding environment is going. So that, I think, is a challenge. We think we can gain a lot and I got the sense, certainly at the event we had, that other institutions felt that we'd done it in a very collegial way. If we could maintain that collegiality, in terms of keeping some of the projects going, then that will benefit everybody.*
>
> Regional spoke representative

5.14. Despite these challenges, the projects that involved collaboration generally felt this was effective. In our online survey, project leads were mostly positive about the Programme's effectiveness at supporting collaboration and sharing of good practice across the HE STEM sector, with three-quarters giving high scores for effectiveness in this area (see Table 6).

	Low effectiveness scores (1-3)	Neutral score (4)	High effectiveness scores (5-7)	Don't know
Supporting collaboration and sharing of good practice across the HE STEM sector (Mean=5.43 , Base=243)	8.2%	6.2%	74.5%	9.9%

Table 6: How effective do you believe the National HE STEM Programme has been at achieving the following aims?

5.15. The project described below gives a good example drawn from interviews and project data of a collaborative project that has expanded to include greater numbers of partners than originally anticipated, bringing together a community of practice to support better writing skills development for STEM students.

> **Writing skills of STEM students:** The project, led by the University of Bath, has two parts: firstly, research conducted via interviews and surveys identified the skills needs of STEM employers and placement providers; secondly, a multi-disciplinary group was established to discuss how to respond to the research findings. The Project Collaboration Group was established in order to provide a forum to work out how to improve STEM students' communication, focusing in particular on writing capability. The Project Collaboration Group has grown from a group of eight core members to its current membership of 51, including STEM subject specialists from seven universities, English language and writing development specialists, learning developers, careers advisers and librarians. Outputs from the project include the publication of research findings, conference presentations, a special edition of the *Journal of Learning Development in Higher Education* (edited by the group's core members), resource lists, workshops, and a special interest group (Writing and Communicating in STEM Disciplines). The project has achieved greater interest and impact than anticipated, and the variety of disseminating activities has enabled the effective sharing of this vital strengthening of STEM students' skills for the contemporary workplace. Project partners: University of Bath, University of Coventry, University of Plymouth, University of Exeter, University of the West of England, University of Limerick.

5.16. Of course more substantial levels of collaboration took place between the Programme partners themselves, that is, the six spoke institutions and four professional bodies. Through coming together to administer the Programme, individuals within these organisations have formed positive working relationships, focused on Programme delivery at various levels within their organisations. (For more on the hub and spoke model, see Section 8 of this report). Within regions, a positive outcome of coordination was that a dialogue between regional universities was opened and the Programme increased the opportunity for universities to share approaches.

> *One value has been talking to people at other universities, and understanding they experience the same problems, and how they've overcome those problems, and just learning from each other. That's not just universities in [our region], that's nationally, through the national meetings, through the regional spoke meetings. That has been useful cross-fertilisation, and we've been able to come back, and we know, once the Programme ends, that practice is embodied within ourselves.*
>
> Regional spoke representative

5.17. One of the regional spokes confirmed the importance of establishing operational partnerships across the region. In this case, a network was created using workshops to

bring people together and develop bids for funding. This resulted in a high number of bids being put forward and being funded.

> *At the end of the day, I don't think this is really about the high level coordination; this is about establishing grassroots partnerships in the region that can be sustained. I think that the continued involvement of those parties is probably an indication that it is working.*
>
> Regional spoke representative

5.18. The South West spoke reported that links developed between people in their region were positive, and was confident that these relationships would not have been developed in the absence of the Programme. A placements programme was viewed as being particularly successful, as were the efficiencies that came about as a result of increased collaboration, for example in using shared templates, processes and standards that are held centrally. These new practices were embedded institutionally and are likely to continue in future. There was evidence of the effectiveness of working relationships in the networks developed in other regions, and of the usefulness of having Programme staff employed in spoke institutions to coordinate and make links across a region. The regional spoke in Wales was positive about the success of developing working relationships and confident that these will be sustained.

> *A major impact has been the transparency of working in Wales and the really clear collaborative working that we have now established. It is so refreshing and needs to be further encouraged.*
>
> Regional spoke representative

Dissemination and sharing of good practice

5.19. Part of the remit of the Programme was to share and disseminate good practice identified through the pilot projects, or through new funded projects, as widely as possible across the HE STEM sector. This involved funded collaboration between institutions to transfer particular project approaches, and also through the distribution of funding for institutions to adopt project models already developed as good practice. A total of 197 projects were funded specifically for the purpose of promoting and sharing best practice. These projects were a comparatively small part of the Programme involving total funding of £1,726,371.35 (14.7% of the overall budget for project funding), but were nevertheless valuable for their ability to replicate practice across the sector.

5.20. Transferring effective practice was a key theme seen in many projects and the Programme hub developed four key mechanisms by which to facilitate the sharing and transfer of good practice. Four separate funding calls were set up during 2010 and 2011, entitled Adoption of Proven Disciplinary Approaches, Collaborative Practice Transfer, Practice Transfer Adopters (PTAs) and Practice Transfer Partnerships (PTPs). These are summarised in more detail below.

Adoption of proven disciplinary approaches

5.21. One of the key ways that the Programme aimed to transfer and embed best practice was through providing £200,000 funding for institutions to participate and add their own value to a range of activities building on the successful activities undertaken during the four disciplinary pilot projects (CFOF, Stimulating Physics, LEP, and More Maths Grads). Each professional body partner provided a 'menu of activities', inviting institutions to express interest in adopting the activities and embed them into their own practices.

5.22. As a result, 85 projects within the Programme focused on the adoption of proven disciplinary interventions and approaches, generally concerned with activities to enhance university-led outreach and widening participation practices, and delivery of the undergraduate curriculum. Projects were varied in size, ranging from micro-initiatives with a value of £150, to a maximum of £10,000 each. The allocation of activities was prioritised towards submissions where it was believed they would add the greatest value based upon the Programme's knowledge of the depth and breadth of activities already taking place across the HE sector. Significant replication of proven approaches to outreach and curriculum development occurred through these projects, enabling universities to benefit from tried and tested resources and activities. For instance, 29 projects across different universities and regions were replicating the Chemistry: The Next Generation outreach package developed in the chemistry pilot project and judged to be effective in its evaluation, each delivering a minimum of three outreach activities to 150 students. The More Maths Grads pilot project found that most students under the age of 16 prefer hands-on activities, rather than lectures, when interacting with HEIs. Through the Programme, six projects were developed, focused on training HEI staff in running maths enrichment activities developed in the pilot project, facilitating the purchase of basic resources and set-up of four different hands-on workshops, reaching at least 100 pupils in each project.

5.23. One of the Programme's most well known individual projects, SIAS, was replicated across at least 20 universities and has been delivered to thousands of school students. The project involved taking spectroscopy kits into schools, to engage students with a series of hands-on demonstrations and exercises. As well as covering the principles of spectroscopic measurement techniques, the activities seek to encourage students at school to consider studying chemistry and the career opportunities available.

5.24. In feedback for this evaluation and in its own project evaluations, SIAS has been judged as highly successful at an institutional level, exceeded its initial targets for engagement, involving many more kits than originally envisaged, far surpassing expectations and receiving highly positive feedback from schools and HEIs. Discussion with SIAS project leads highlighted that the project was in high demand, with reviews of the project travelling by word of mouth, leading to multiple new assignments and a far more expansive project than initially hoped. This has undoubtedly facilitated the transfer of practice within the Programme, and it is likely to continue to be adopted by additional universities, as illustrated by the quotations below and the project description in Table 8 drawn from interviews and Programme data.

It's been very successful. We've exceeded the number of visits, and we've exceeded student numbers as well. Year on year, the demand is just increasing, so not only do we get repeat bookings, we also get word of mouth, and as teachers move around schools, they then want to book it in their new schools. So, year on year, the demand is going up.

Project lead

Having something that's already been tried and tested, that most of the information was there for you, all you had to do was, kind of, collect the bits together. It really made it easy to implement.

Project lead

Collaborative Practice Transfer Fund projects

5.25. In March 2010, the £200,000 Collaborative Practice Transfer Fund was set up to support the transfer of established initiatives that the HEIs had developed and judged to be effective to other HEIs. A total of 78 applications were received, leading to the funding of 20 projects covering a range of outreach and curriculum development activities. The projects varied quite significantly in terms of budget, ranging between £2,300 and £20,000 each, each representing the product of successful collaboration or the adoption of a well established initiative.

5.26. Some examples from Programme data of the projects undertaken include:

- **Maths Busking:** engaging the general public and school groups through the powerful medium of street entertainment: This project enabled the University of Manchester to extend the expanding network of Maths Buskers across the UK, and to increase its own mathematicians, teachers and students with the confidence and communication tools to promote mathematics to wide and diverse audiences. Utilising the concept and materials already developed by the Royal Institution and Queen Mary University, London, and rolled out at the University of Bath and the University of Coventry. Activities in the project focused on engaging the public using the 'sensibilities' of busking, to raise interest and popular understanding in maths subjects, and develop a team of buskers to communicate and share the positives of mathematics.

- **Enhancing the impact of chemistry outreach by use of selected, repeated interventions and collaborative university provision:** This project, led by Kingston University, aimed to bring about sustainable collaboration between university chemistry departments, to deliver follow-on outreach activities for students who have already attended a CFOF outreach activity. The project also sought to gather additional evidence on the value of repeated outreach interventions, and demonstrate to participating universities the value of working together on outreach activities. Collaborating on the project were Imperial College London and the University of Greenwich.

- **Science Van/Gwyddfan:** Physics-based outreach, evaluation and prompt dissemination to HEIs in Wales and border regions. For this project the University of Aberystwyth aimed to adopt expertise from a number of previous projects, including its own initiative, Science

Circuit, the IOP's Lab in a Lorry and Physicists and Primary Schools, and the Chemistry Roadshow in Bangor. The objective was to trial a new set of outreach experiments in primary schools in the Welsh communities, and to evaluate the activities for the purpose of sharing good practice with other HEIs in Wales.

- **Constructing a coherent STEM strategy with schools:** This project involved collaborative between the University of the West of England (UWE), Bristol, and the University of Plymouth. The aim was to embed good practice from Plymouth into UWE regarding a coherent STEM approach to school liaison, by improving the integration of existing outreach activities run separately by UWE that included mathematics, science and engineering events. The model involved a STEM activity day that comprised a set of six activities to enthuse pupils about science in order to attract them to study STEM subjects at GCSE and A-level. The day was arranged as a school visit, which is preferred to schools visiting university because it is less trouble for the schools to organise and presents lower risk for pupils. Two hundred and seventy Year 8 pupils took part, with three groups of 90 rotated around the six activities, each taking around 12 to 15 minutes. External evaluation of the project was conducted via a questionnaire and interviews with pupils, which enabled staff to modify the activities and to assess the effectiveness of the day. Feedback was very positive from both teachers and learners, with the day giving pupils a chance to learn more about subjects and career paths in STEM. There was a positive impact on the pupils' perception of STEM subjects, and the event was also well received by teachers. The day required a lot of organisation and planning, with regular meetings between staff, however, and the event was quite costly. Since the first activity day, the project's impact has been sustained with a further four activity days, reaching around a thousand pupils in total during 2011-12. The team proposes to run four or five STEM activity days per year, and may also be used at open days or other university public engagement days.

Practice Transfer Adopters

5.27. The PTA scheme was an initiative set up in October 2011 to enable individual HEIs to adopt and embed projects developed during the National HE STEM Programme. Participating institutions were invited to submit applications to bid for a portfolio of projects, with a maximum value of £10,000 each. The purpose of the 84 PTAs funded under the Programme was to further transfer the good practice developed under the Programme, focusing on a number of different areas, including the development of the undergraduate curriculum, employability skills, workforce development, and strategic interventions to widen participation in schools and colleges.

5.28. One example of the PTA scheme successfully transferring practice across several institutions is the University of Bristol's project, Enhancing STEM Academics' Public Engagement Skills. The project set out to enable Masters, PhD students and STEM academics in the South West to become more effective STEM Ambassadors, developing their transferable public engagement skills through activities and events that enhance the University of Bristol's high profile work on volcanoes and earthquakes. The project was deemed highly successful in its internal evaluation, and was extended through the PTA initiative to seven universities, including Birmingham, Bradford, Loughborough, Middlesex, Newcastle, Northampton and Wolverhampton. These adoption activities resulted in a

significant array of new outreach activities for schools' audiences, and the up-skilling of academics in schools' outreach.

Practice Transfer Partnerships

5.29. Another mechanism for transferring good practice was created through the establishment of PTPs in Spring 2011. These consisted of funded partnerships between institutions whereby expertise in a particular area directly relevant to the Programme's work could be transferred between HEIs through collaborative working. This was introduced to foster collaborative working across the sector and was intended to extend beyond the lifetime of the funded Programme. The partnerships consisted of a lead organisation working alongside other HEIs by supporting and enabling them to embed the proven practices into their work.

5.30. Nine projects were classed as PTPs. The projects were somewhat higher in value than those under the PTA scheme, ranging between £10,000 and £101,421. The funding was used to enable partners to disseminate their expertise, and collaborate to exchange practice in their chosen area of interest. While some projects involved the production of physical project materials (such as employability resources), the primary purpose of the PTP fund was to focus upon staff training and guidance, to develop the capacity of the beneficiary institution.

5.31. Themes covered by the partnerships included developing approaches to diversity, transition, induction and retention, careers advice and guidance, outreach and widening participation, employer engagement, and workforce development. Examples from Programme data of PTPs covering a range of themes include:

- **Employer engagement in Mathematics:** For this project the University of Salford and the IMA aimed to establish good practice in mathematics-focused employer engagement, in order to help communicate the route from study to employment for maths students. The project aimed to create practical case studies and resources for participating HEIs to develop links with employers.
- **Careers PTP:** This project, led by the University of Southampton, aimed to provide support for STEM departments to embed careers-focused activities into STEM degrees, thereby inspiring students to pursue future employment in STEM industries. The project produced a range of physical materials, including guidance documentation and a self-assessment tool for STEM departments to determine their own careers provision needs.
- **Widening Participation – Strategic regional working with schools and colleges:** Led by First Campus in England, this project focused on creating a cross disciplinary community of practice for engaging with traditionally under-represented groups of learners. Outputs for the project included a framework for engagement, case studies exhibiting best practice, pilot events and a range of support and guidance to enable partners to develop a common and effective approach to engagement with schools and colleges.

5.32. Overall the evidence suggests that the Programme was effective at disseminating good practice across the HE STEM sector, through the different types of projects, as discussed above. Through opting to keep many of these projects small in value, the Programme has been able to replicate these activities more widely, covering greater numbers of universities. The limitation to this is similar to that of collaboration, in that the penetration of the Programme into the HE STEM sector was not complete. Nevertheless, the resources that were used appear to have been used effectively.

5.33. Some key examples of projects not already mentioned that transferred good practice include:

- Context and Problem-Based Learning (implemented by 20 universities)
- New Maths Support Centres (implemented by 22 universities)
- Maths at Work Day (implemented by 7 universities)
- Sigma mathematics support hubs (implemented by 7 universities)
- Virtual Experiments (implemented by 6 universities)
- Engineering Pick 'n' Mix (implemented by 4 universities)
- Planet SciCast (implemented by 4 universities)
- Business Skills for Chemists (implemented by 4 universities)
- Applied Physics degrees (implemented by 3 universities)
- Integrated Sciences Degree (implemented by 3 universities)

Supporting innovative activity in relation to widening participation, curriculum development and workforce development

5.34. As well as disseminating existing good practice, the Programme also supported a wide range of new activities through funding individual projects. Some of these new developments were later also transferred and shared across the sector.

Evaluation of funding approach

5.35. Examination of project funding data (non inclusive of staff costs) shows that the Programme supported a range of differently sized projects with funding evenly spread between a large number of smaller projects and decreasing numbers of higher value projects (see Table 7 below).This mix of smaller and larger projects matches the range of different objectives individual projects wished to achieve.

Project size	Number of projects	Total invested
Up to £9,999	295	£1,468,069
£10,000 - £19,999	149	£1,871,665

£20,000 - £49,999	101	£2,998,978
£50,000 - £99,999	27	£1,762,834
£100,000 - £250,000	19	£2,923,063
Over £250,000	2	£668,810
TOTAL	593	£11,693,419

Table 7: Distribution of funded projects by value

5.36. Despite their size, smaller projects could achieve the Programme objectives where this involved simply disseminating or extending practice that had already been developed (as discussed), or if supporting relatively straightforward activity . Small funds also enabled a larger number of projects and lower levels of risk. Projects with smaller funding amounts often sat within a wider strand of activity that was replicated across several institutions, thus magnifying the impact. A good example of value for money achieved via a small-scale project is the Student Employability Audit Toolkit, costing £10,000, which *"resulted in new modules, complete revamp of some of the evaluation, employability skills embedded into degrees, and it's led to six adopters as well"* (Regional spoke representative).

5.37. Several stakeholders commented that the large number of small projects may have limited overall effectiveness, because it is more difficult to achieve a transformational impact on the practice of a university through a smaller project. There was also concern that maintaining Programme coherence across a large number of small projects is much more challenging than across larger projects. Indeed, the sheer range and variety of projects led to greater complexity within the Programme delivery, which made the Programme more difficult for stakeholders to comprehend as a coherent whole. There was concern that the large number of projects in general may not have achieved intended impact, and a suggestion that fewer, larger projects could have been more effective.

> *I'm very aware that they seem to have an enormous number of mini projects. My concern with that would be that there are just so many of them...To me it came across as scattergun, the effect of lots of little bits rather than if maybe they could have been a bit more strategic with some major initiatives.*
>
> Programme stakeholder

5.38. However, the distribution of projects in the table above shows that a significant percentage of the Programme's project funding was invested in large projects, alongside smaller ones, and it should be recognised that many smaller projects sat within, not necessarily apart from, larger scale activities. One stakeholder emphasised that the Programme deliberately chose a mix of smaller and larger projects to allow support for activity at individual institutional and departmental levels. There are examples of institutions that led a relatively large number of smaller projects, which added up to a significant investment. This could arguably indicate that a critical mass of project activity within a given institution could be achieved through a large number of smaller projects as well as single larger project. Institutions could therefore decide whether to bid for a smaller number of large projects, or a larger number of small projects, depending on their circumstances and needs. Conversely, institutions leading only one project could be involved in larger or smaller scale projects, although in practice these were more often smaller or medium-sized.

5.39. Evidence from project leads and Programme partners on the whole suggests that smaller projects were effective and achieved valuable outcomes, enabling engagement with a wider range of individuals and institutions. However, this came at a cost of greater complexity for the Programme, including greater difficulty in tracking effectiveness and impact. Overall, it is reasonable that the Programme took an approach of funding a range of smaller and larger projects, depending on the requirements of individual institutions and circumstances; however, we would suggest that spending a smaller proportion of the total budget on small projects might have been a more effective approach.

Investment in strands of activity

5.40. The range of funded projects also spanned the objectives of the Programme in terms of widening participation/outreach, curriculum development and workforce development. There is considerable crossover across the different strands of activity with many projects encompassing aspects of more than one strand of activity. However, to give an indication of how funds were distributed, below in Table 8 we present details for the number of projects that contributed to at least one strand strategic objective, and the number of projects that had a *main focus* on this area, as classified by our own analysis. In summary, investment was fairly evenly spread across HE engagement with schools and colleges, curriculum development, graduate skills development and workforce development projects, but with a greater number of projects in HE engagement in schools and colleges and fewer in workforce development. Therefore, outreach projects tended to be smaller in size, while workforce development projects were larger on average.

Strand of activity	Number of projects contributing to at least one strand strategic objective	Amount invested in projects contributing to the strand	Number of projects with a main focus on this strand	Amount invested in projects with a main focus on this strand
HE engagement with schools and colleges	239	£3,799,015	207	£2,611,852
Curriculum development	244	£5,503,771	174	£4,111,895
Graduate skills development	222	£5,115,981	147	£2,668,166
Workforce development	92	£3,040,695	65	£2,301,505
TOTAL	N/A	N/A	593	£11,693,418

Table 8: Breakdown of numbers of projects and funding that contributed to, and focused on, each strand of activity

5.41. Activities in HE engagement with schools and colleges often focus on forging collaborative links with the school and college sectors, and initiating targeted interventions that seek to raise aspirations, increase understanding of STEM disciplines, and encourage learners to

engage in higher study. Other projects in this strand include activities specifically designed to improve the capacity of the sector to design and deliver outreach and widening participation activities, by enabling collaborative links with regional and national HEIs and transferring best practice. In terms of specific project activities, over half (109) of the projects in this strand (£1,118,974) involved strategic targeting of hard to reach groups; examples of these projects included projects to bring science outreach directly to primary schools and projects to support engagement with under-represented groups through third sector organisations. Eleven projects related to community and public engagement (£272,425), including a project providing STEM careers resources for science museums as a way to engage with audiences outside of schools and colleges. Thirty-nine projects related to skills training for outreach, for HEI staff and undergraduates (£447,652), and 11 projects aimed at providing careers awareness and resources (£143,650).

5.42. Two-thirds (106 projects and £1,969,656) of curriculum development projects comprised activities relating to pedagogies and assessment. These included for example large projects on integrated science degrees, problem-based learning and integrating employer engagement into the undergraduate curriculum. HE-led projects on employability skills also contributed to this strand of activity (seven projects, £454,163), such as several projects working to modify STEM degrees to improve graduates' employability by making better links to industry and employment. Projects focusing on supporting student transitions and retention also featured (ten projects, £274,470); examples of these included projects to provide additional mathematics support for non-mathematics STEM undergraduates and a range of school teacher fellow projects to support the transition from school to university.

5.43. Higher level skills were an overarching focus for the Programme, which aimed to match the skills sets of STEM graduates with the needs of UK employers who base their growth on technology and innovation. This strategy was composed of two main strands of activity: graduate skills and workforce development. The majority of graduate skills development projects focused on developing undergraduate employability skills, either through discrete projects or, again, by modifying curricula. These streams of activity included the development of new STEM courses and bolt-on activities for undergraduate provision (provided by the university), and also involved engagement with employers to enhance curricula and improve the employment prospects of STEM graduates. Graduate skills projects were most often delivered by institutions in the medium to highest fee tariff category. The cross-thematic and overlapping nature of the National HE STEM Programme strategy is evident in this strand; many projects considered under the banner of graduate skills development also represent pedagogic or curriculum development or employer engagement activities, including enquiry/problem based learning, and activities to develop careers resources and awareness amongst STEM students.

5.44. Workforce development and lifelong learning projects aimed to support HEIs to increase the knowledge, understanding, skills and competencies of those currently within the UK workforce who have not previously participated in HE. Although there were fewer projects than the other strands of activity, workforce development projects tended to be larger in scale. Activities that focused on workforce development included the development of

employer-focused CPD (18 projects, £1,161,023) and employee focused programmes (eight projects, £248,423), and employer engagement to enhance employer access and input into HE STEM disciplines (ten projects, £480,819). Projects with a workforce development focus were most frequently seen in engineering disciplines (28 projects), but more rarely in Physics or Chemistry. Workforce development projects were predominantly delivered by HEIs in the medium fee tariff category, in which many universities with a strong business engagement focus reside, including universities such as Coventry, Staffordshire, Teesside and Anglia Ruskin. Many of these institutions had also accessed funding through the SDF Transforming Workforce Development Programme.

5.45. It is important to point out the high degree of overlap across strategic themes, as individual projects could focus on several strands of activity and have a range of objectives. Therefore there are projects that hold a significant focus upon workforce development or employability, for example, that have a primary focus elsewhere. Overall, the 593 projects in the Programme were categorised into a number of different activity groups, the full breakdown of which is shown in Table 9 below.

Project category	Number of projects funded	Total funding	Average value
Employability skills - HE led	60	£1,750,977	£29,183
Workforce development - Employer focused CPD	22	£1,385,554	£62,980
Strategic targeting of hard to reach groups	116	£1,145,164	£9,872
Pedagogies and assessment: Enquiry/ Problem based learning	37	£1,029,508	£27,825
Employability skills - Employer led	49	£893,789	£18,241
Pedagogies and assessment: Conceptual understanding	36	£523,541	£14,543
Employer engagement - Enhancing employer access	9	£454,231	£50,470
Employer engagement - Employer input	21	£422,905	£20,138
Skills training in outreach: CPD for HEI staff	30	£376,259	£12,542
Careers - Awareness	18	£360,002	£20,000
Student support in HE STEM: Transition and retention, including mentoring	18	£348,218	£19,345
Pedagogies and assessment: E-learning/ Technology-enhanced learning	32	£329,139	£10,286
Transitions	14	£302,38	£21,59

		7	9
Community/public engagement	13	£289,432	£22,264
Pedagogies and assessment: Inclusive curriculum	14	£279,130	£19,938
Workforce development - Employee focused programmes	9	£278,210	£30,912
Multiple Categories	1	£247,704	£247,704
Pedagogic research methodologies	20	£247,083	£12,354
Careers - Resources	8	£234,106	£29,263
Skills training in outreach: Training for undergraduates	17	£208,844	£12,285
Employability skills - Recognition and articulation	19	£205,340	£10,807
Producing enrichment resources	11	£113,306	£10,301
STEM Clubs	7	£107,400	£15,343
Student support in HE STEM: Peer assisted learning	7	£61,690	£8,813
Pedagogies and assessment: Sustainable development	2	£55,000	£27,500
Pedagogies and assessment: Cross-disciplinary approaches	3	£44,501	£14,834

Table 9: Breakdown of number of projects and funding for different categories of project

5.46. The range and diversity of activity can be seen as positive, as the Programme had the flexibility to fund different types of projects. However, in a similar way to funding smaller projects, this flexibility came at the price of complexity and arguably, in the view of some stakeholders and Programme partners, threatened the coherence of the Programme. By spreading resources across so many activities, the totality of the impact is more dispersed and difficult to assess.

Project effectiveness

5.47. Through the funded projects, the Programme supported a range of new and innovative projects in relation to curriculum development, widening participation and outreach, and workforce development. Results from our online survey of project leads reveals that they felt the projects they had been involved with were highly effective (see Table 10). While a full review of final project reports will be completed as part of the Programme reporting by early 2013, these also support the view that project leads felt their projects were effective.

Effectiveness of projects at...	Mean	Ineffective (1-3 out	Neutral	Effective (5-7	Don't kn	N/A

	core (out of 7)		of 7)	(4 out of 7)		ow
...facilitating engagement between HEIs and schools and colleges (Base 117)						
	6.04	2.6%	6.0%	86.3%	6.7%	8.3%
...bringing about curriculum enhancements and innovative new programmes of study (Base 157)						
	5.76	3.8%	7.6%	77.0%	8.9%	2.5%
...developing the skills of STEM graduates (Base 92)						
	5.88	2.2%	2.2%	77.2%	12.0%	6.5%
...facilitating engagement and workforce development with employers in relation to HE STEM disciplines (Base 60)						
	5.65	8.3%	6.7%	70.0%	1.7%	3.4%

Table 10: Online survey scores given for the effectiveness of funded projects

5.48. HE engagement with schools and colleges projects are given the highest effectiveness scores on average, followed by curriculum development projects and projects to develop the skills of STEM graduates. Workforce development projects have the highest proportion of low and neutral effectiveness scores, but these are still overwhelmed by a majority of high effectiveness scores.

5.49. Interviews with Programme partners confirmed the views that most individual projects were effective. The Programme funding approach was valuable because it offered a direct funding stimulus for HEIs to undertake activities that otherwise they would not have had the capacity or inclination to undertake. To ensure that projects met the Programme objectives, proposals were required to identify strategies for dissemination, sustainability and evaluation, and were encouraged to develop collaborations.

> *People might say, 'Oh, yes, that's a good idea, yes, I'd like that to happen.' But, in reality, it's very, very hard to fit it in around the day job, and the*

research and everything else that you're supposed to be doing as an academic. So, I think the HE STEM funding gives you a bit of time and space. It privileges that development work in a way that it wouldn't be privileged otherwise.

Project lead

5.50. Many projects had set themselves targets, for example, for engagements with numbers of students or schools, training a number of HE or school staff, creating a new piece of curriculum, or engaging with a number of partners. An analysis of whether projects met their objectives is being generated as part of the Programme's final reporting, based on final project reports that are still being submitted. However, through our fieldwork we have found many examples of projects achieving their intended outputs and outcomes, with a willingness to exceed targets where original ambitions had been reached. For example, one project involved developing networks of HE and school staff, training them and then undertaking activities to embed transition support for learners progressing through schools and on to university. In this case the targets were met comfortably.

The training and recruitment activities went smoothly. I did have a few problems trying to get one final university involved, and finding additional student ambassadors, but we got everybody recruited. We engaged the schools that we had promised to in our proposal, (up to ten high schools with up to 60 feeder primaries), and six universities. We delivered all of the training that we had suggested in our proposal and the feedback from that training was really, really good, so that phase of the project went really well.

Project lead

5.51. Close monitoring of such targets by the project lead (such as the number of students or schools engaged) provided measurable and tangible outputs that could be used to judge individual project success. The number of schools or students engaged, the number of events or sessions carried out, the number of curricula modified or created, and the number of partnerships created were targets that were commonly monitored to ensure that the project had effectively delivered in line with contract requirements. There was also consideration of the quality of outputs and outcomes, as well as quantitative measures.

5.52. Certain activities that relied on organisations and individuals that were external to the Programme partners were identified as less effective in the interviews. This illustrates the challenge of building buy-in for the Programme activity beyond those organisations and individuals who have a direct stake in delivery. This applies both to third party involvement outside of the lead institutions, but also to the involvement of other individuals even within the lead institution, such as departmental colleagues or faculties. These difficulties were noted in outreach and widening participation projects where processes depended on third parties, for instance, to recruit undergraduate ambassadors or mentors, or secure classroom time with local schools. One project involved the use of coordinators in partner universities, to arrange ambassador visits to local schools. Overall, the project was

remarkably effective in engaging a large number of schools, but where the activities had not been successful, it was often due to reliance upon third parties to coordinate or deliver activity, combined with the fact that some parties engaged would not adopt activity as easily as others.

> *I had to get somebody senior in each university to recruit and coordinate their ambassadors, and they're not given time off lecturing or anything to do this. It has to be in their own time. They're not paid to do it. They're not funded. They're not, on the whole, supported. So I was reliant upon the person who'd volunteered to coordinate this for me in each university. So I think that was the barrier. Some were keener than others, some had more time than others. Some had made it happen... In this case, it was impossible for me to jump in and organise everything.*
>
> Project lead

5.53. Many curriculum development projects require the involvement of academic staff within the university to contribute, which requires strong communication of the benefits of any proposed change and potentially careful identification of individuals who will engage with the agenda. Feedback from interviews suggests some projects were more difficult to implement because they required changes of institutional culture and could rely on particular individuals, rather than a wider institutional commitment.

5.54. Although the workforce development projects were rated highly in their effectiveness by the majority of project leads, feedback given in interviews highlighted the challenges presented by this activity. Where activity was effective this tended to be in areas that have an existing history of collaboration between HEIs and employers, such as in engineering, and in medium-tariff institutions. Workforce development was particularly challenging in Physics, Chemistry and Mathematics, but where workforce development projects did succeed, such as in Engineering disciplines, it is perceived that there has been significant progress, as evidenced by feedback from employers that have been successfully engaged.

> *I feel that the feedback on the employer engagement and workforce development projects has been extremely positive. People in these projects have been sharing ideas across universities and learning a lot from each other and improving their approaches to HE STEM activities.*
>
> Regional spoke representative

5.55. However, even some institutions that had been involved in the Transforming Workforce Development Programme did not feel this strand was as successful as it could have been and felt that this was a particularly challenging area. The challenges involved in employer engagement are well known and relate to the levels of demand for higher level skills among employers, as well as communication and cultural differences between academia and industry. Supporting the finding that workforce development is particularly difficult in

STEM subjects is another comment from one of the regional spoke universities, who pointed out that they had had more success with non-STEM areas:

> *We've been able to do that, interestingly, in some other areas, non-science areas, say if you look at things like [a supermarket chain], who are one of the biggest local employers, we've been quite successful in foundation degrees and so on, executive education, board training. In the science side...that's been more difficult.*
>
> Regional spoke representative

5.56. Although reasons for this difficulty in STEM subjects were not given in the interview, this may be because of the nature of many science employers and career paths, which can emphasise traditional academic qualifications such as doctorates and Masters' degrees, rather than foundation degrees and work-based learning routes.

5.57. In reviewing the projects funded through the Programme, there are examples of new innovative and transferable models emerging, alongside those that were primarily concerned with transferring existing practice.

- **The Engineering and Physical Sciences Grand Challenge**: This project was developed at the University of Birmingham as a four-week intensive skills course for final year students in several disciplines to tackle an open-ended, unstructured challenge set by employers. Evaluation of the first and second years of the project judged it to be effective at improving graduates' employability and enthusiasm, as well as links with employers. In its second year of operation, students from Aston University also joined in with the Grand Challenge and it is now taking place at Nottingham Trent University.
- **STEM magic show:** A magic show was used to demonstrate the fundamentals of STEM subjects to school-age students. Engaging students in a fun and interesting way, using a combination of problem solving and popular magic tricks helped to get the message across about STEM far more effectively, than if a straightforward presentation about a maths or science subject had been given.

> *The project was essentially a way to excite students about STEM. If you go into a school and say 'We're going to do something on maths', then you'll probably get four students who would normally have turned up to do something about maths anyway. If you go in there and you say 'We're going to do a magic show', then you tend to get entire year groups together.*
>
> Project lead

- **Nuclear Island:** Led by the Sector Skills Council for the nuclear industry, this project is based on collaboration between universities, contractors and consultants to deliver a new learning experience to provide students with skills and experience suited to the needs of industry. Nuclear Island started off as a pilot at Imperial College London, in which students replicated the design process of a major industrial construction project. Students design and construct a scaled-down nuclear power plant, and are assessed in relation to

real-life skills such as radiation protection, site licensing, budgetary control and project management. What started as an engineering project has now been expanded to include other areas of science and technology, and is to be embedded in HEIs as part of course content. Already there has been success with similar projects based on 30 St Mary Axe ('the Gherkin' building) and the London Olympic velodrome, in which students reconstruct these civil engineering projects over a two-week period.

- **Deep Integration in First Year Engineering Programmes:** Several projects were able to modify curricula to be more responsive to the employability needs of industry. One such example is this engineering project that 'inverted' the usual modular system of course delivery by using a series of real-world problems that were developed with the help of industrial partners. This project involved a re-assessment of engineering pedagogy and curriculum, which used problem-based learning to equip engineering students with flexible skills in applying knowledge to practical problems that employers demand. Another project enhanced the employability of mathematics students by improving their communication and presentation skills – an area that employers identified as being necessary to complement the subject-specific knowledge of current job applicants.

- **The Group Industrial Projects**: This scheme, led by the IOP, replicated a scheme that had already been running at Durham University for 20 years previously, in which third year undergraduate Physics students solve real life problems set by industry for their group projects. The project was felt by Durham to be particularly successful because it addressed a relative scarcity of group-based, real-world scenario problems within higher level Physics study. During our interviews, the IOP reported that universities tend to do relatively little employer-led graduate skills development, because of the onerous demand in terms of organisation and resources, including student supervision, and health and safety issues. This project addressed this issue, by placing students into laboratory-based project settings, in which students worked together to solve real-life problems set by students. Activities included industry-type activities (e.g. quality control) in a safe university environment, as a kind of "workplace simulation". The project was identified as particularly transferable and was rolled out across 15 universities.

- **The Hydrographic Academy**: Described by a Programme partner as "a striking success, targeted in a region of considerable deprivation", Plymouth University worked in collaboration with the Royal Navy and with Fugro (a geosciences company) to deliver a course that focused on oceanography and marine surveying, tailored to the specific skills needs of that industry. With this employer engagement, the project offered a distance-learning route for those in the workforce to gain undergraduate and postgraduate qualifications in addition to professional accreditation. Market research by the business partners suggest that the project will be self-sustaining with future numbers of students that match the current high levels of interest.

Overall effectiveness

5.58. It is clear that the National HE STEM Programme commissioned or initiated significant volumes of valuable activities relating to outreach, curriculum development and workforce development, across the HE STEM sector in England and Wales. Our survey of Programme partners and project leads found that the Programme was deemed to be an overall success, with nearly three-quarters (73%) of respondents giving high scores for

overall effectiveness (see Table 11). Survey respondents felt that the Programme was particularly effective at promoting, supporting and championing the STEM disciplines (72%) and supporting collaboration and sharing of best practice across the sector (74%). The extent to which the Programme was successful overall at widening participation in STEM subjects, improving responsiveness of the sector to employers and employees, and informing future policy and practice in the HE STEM community was less clear, with significant minorities selecting 'don't know' for each. As discussed later in the section on the impact of the Programme, for many respondents it was too early to tell the Programme's effectiveness, or they simply did not feel they had a view on the Programme overall, beyond their involvement in their individual project.

Mean score (out of 7)	Low effectiveness scores (1-3)	Neutral score (4)	High effectiveness scores (5-7)	Don't know	
Widening participation in STEM subjects at HE level					
5.01	9.3%	8.9%	49.8%	29.1%	
Promoting, supporting and championing the STEM disciplines					
5.62	6.1%	6.9%	71.7%	13.8%	
Improving the responsiveness of the HE STEM sector to the skills needs of employers and employees					
5.18	9.4%	8.6%	56.3%	23.7%	
Informing future policy and practice in the HE STEM community					
5.09	10.6%	9.8%	51.2%	26.4%	
Supporting collaboration and sharing of good practice across the HE STEM sector					
5.61	8.2%	6.2%	74.5%	9.9%	
How effective has the National HE STEM Programme been overall, considering all of the above elements? (Mean=5 Base=207)					
5.41	7.4%	4.5%	73.0%	15.25	

Table 11: Effectiveness of the Programme overall, online survey scores

5.59. Feedback from interviews broadly reinforces the view of a Programme that has been visible and effective at championing STEM and supporting collaboration, but whose impact on some of its higher level aims is difficult to assess. The sheer number of different projects and activities has effectively raised the profile of HE STEM skills and increasing the visibility of the STEM agenda. Several interviewees mentioned a 'buzz' that had been brought about by the Programme. One interviewee noted:

> *I do think that it's been visible in championing outreach, and I've definitely noticed that's what they do. I'm not sure I could articulate how successful the outreach itself has been, but they definitely participated in the outreach, they've definitely been extremely supportive, and they've definitely been with the right national bodies and partners.*
>
> Programme stakeholder

5.60. It is also clear from interviews that there were important limitations on the Programme's overall effectiveness. Delays in start-up and the perception that three years was too short a duration to achieve lasting impact were issues of concern for some Programme partners (covered in detail in Section 8 of this report). The size and scope of the Programme, together with the number of partners meant that there was also a high degree of complexity, which caused issues with effective communication and documentation, also discussed in Section 8. Added to this, the qualitative and highly distributed nature of many of the Programme's outputs and outcomes make an overarching assessment of achievements difficult to quantify. One Programme stakeholder recognised that any overall assessment "is necessarily predominantly going to be a qualitative judgement". Nevertheless, in the cases where it is possible to report, and with caveats about measurement, positive feedback is abundant.

> *I think on the whole the money has been well used. ...My impressions is there has been quite good leverage, which is a measure of efficiency.*
>
> Professional body representative

5.61. Those involved in the Programme also perceive that it has provided added value:

> *Some of the activities may have made a real impact, but not necessarily been expensive and, you know, something like, where it made up a curriculum change, you know, that can last a long time.*
>
> Programme stakeholder

5.62. As a result of conscientious project funding management by the hub, spokes and professional bodies, the Programme was seen by many partners to have provided good value for money overall:

> *In terms of value for money I think HEFCE/W have got a great return on their spend. The issue is really sustaining this good work. It will be wasted if we cannot find funding to build on this innovative work.*
>
> Regional spoke representative

5.63. Overall the conclusion is that the Programme was effective at using its funding to achieve its goals and supported a wide range of activities across the HE STEM sector. Projects funded through the Programme took place at a range of institutions, involved collaboration and shared good practice across the sector, and were generally rated as highly effective by those involved. Nevertheless the sheer number of projects, their diversity and the small size of many projects may have limited the Programme's overall effectiveness and has made it very difficult to assess. The impact and sustainability of this activity is considered in subsequent sections. There were important additional limitations on the Programme's effectiveness not discussed in this section, which relate to the Programme delivery model, and these are discussed in Section 8 on the effectiveness of governance and management.

6. Impact of the Programme on policy, process and activity

In this section we examine the ways in which the Programme has impacted on policy, process and activity within HEIs and the broader STEM community, including across its different strands of activity.

6.1. Given the volume and diversity of activity in the Programme, the impacts on policy, process and activity are diverse. In this summative evaluation we consider impact primarily in terms of the impact on the HE STEM sector, rather than impact on, for example, students or employers. We consider the different types of impact relevant to the different activity strands of the Programme, including those relating to outreach, curriculum development and workforce development. Evidence is gathered from project leads, Programme partners and stakeholders, and Programme documentation. An analysis of impacts recorded in individual project final reports is also being undertaken by the Programme itself.

Impact on institutions

6.2. Evidence from our fieldwork is positive on the impacts of the Programme on university activity and practice. In the online survey we asked project leads to rate the extent to which they felt their projects had impacted on a range of areas relating to institutional practice. The results are overwhelmingly positive, showing that, in the view of the project leads, significant impacts were achieved. However these impact ratings are in general lower than the ratings given for project effectiveness quoted in the previous section.

6.3. Impacts of projects relating to outreach and HE engagement with schools and colleges are generally rated as highly positive by project leads. Results from our survey in Table 12 below show that four-fifths of project leads in this strand felt that their projects had high impacts on increasing the quality of their outreach activities and developing new outreach interventions, while two-thirds felt their projects had a high impact on increasing engagement between their institution and traditionally under-represented groups.

Impact of projects on...	Mean score (out of 7)	Proportion of low impact (1-3 out of 7)	Proportion of neutral (4 out of 7)	Proportion of high impact (5-7 out of 7)	Don't know	N/A
Enabling you to develop new interventions to engage with schools, college and FE providers (Base 117)						
	5.79	7.7%	6.0%	79.5%	1.7%	7.6%
Increasing the quality of your approaches to university-led outreach, enhancement and enrichment activities, and interventions with schools and colleges (Base 118)						
	5.71	5.9%	9.3%	79.7%	0	5.1%
Encouraging greater collaboration and sharing of information between your institution and local schools and colleges (Base 118)						
	5.55	6.8%	11.0%	72.9%	1.7%	7.6%
Increasing engagement between your institution and traditionally under-represented groups (Base 118)						
	5.16	12.7%	9.3%	66.9%	4.2%	6.8%
Encouraging greater collaboration and sharing of information between your institution and other universities (Base 118)						
	5.12	21.2%	8.5%	63.6%	1.7%	5.1%

Table 12: How would you rate the impact of the project(s) on each of the following?

6.4. Similarly, project leads involved in curriculum development projects also rated these as having had a highly positive impact on institutions (see Table 13). The highest impact rating of all came for the impact on supporting curriculum development to enhance the

undergraduate learning experience, with 85% of respondents giving high impact scores. There are slightly lower mean scores for aligning curricula to local needs and priorities, collaborating over curriculum development and enabling cross-discipline approaches to curriculum development, partly because of greater numbers of “not applicable” responses, but overall these are still largely positive responses.

Impact of projects on...	Mean score (out of 7)	Proportion of low impact (1-3 out of 7)	Proportion of neutral (4 out of 7)	Proportion of high impact (5-7 out of 7)	Don't Know	N/A
Supporting curriculum development, including learning, teaching, assessment and support practices to enhance the undergraduate learning experience (Base 157)						
	5.94	0.6%	7.6%	84.7%	3.8%	3.2%
Supporting you to develop and align your undergraduate curricula in response to local and regional needs/priorities (Base 157)						
	5.34	7.0%	13.4%	58.6%	3.8%	17.2%
Supporting collaboration and engagement with external partners to develop new curriculum (Base 156)						
	5.33	14.7%	9.0%	60.9%	2.6%	12.8%
Enabling a pan-STEM, cross-discipline approach to the implementation of HE curriculum development and practice in your institution (Base 156)						
	4.56	19.2%	12.8%	47.4%	7.1%	13.5%

Table 13: How would you rate the impact of the project(s) on each of the following?

6.5. Scores for impact in relation to graduate skills development are slightly lower than for the other activity strands, but still largely positive for embedding experiential learning into

STEM courses, and enabling employers to contribute to undergraduate learning and course design (see Table 14). Accreditation of STEM degrees by professional bodies is noticeably lower, with similar proportions of low impact and high impact scores given, suggesting mixed views from project leads on the level of impact here.

Impact of projects on...	Mean score (out of 7)	Proportion of low impact (1-3 out of 7)	Proportion of neutral (4 out of 7)	Proportion of high impact (5-7 out of 7)	Don't Know	N/A
Embedding experiential learning into your STEM undergraduate programmes to provide students with real world industrial and occupational experience (Base 92)						
	5.23	14.1%	6.5%	54.3%	4.3%	20.7%
Enabling opportunities for employers to contribute to undergraduate teaching, learning, or project work (Base 91)						
	5.03	18.7%	6.6%	53.8%	2.2%	18.7%
Helping you to involve employers in course design, development and delivery (Base 90)						
	5.01	17.8%	5.6%	53.3%	1.1%	22.2%
Encouraging professional body accreditation of undergraduate programmes of study (Base 92)						
	4.08	22.8%	7.6%	26.1%	5.4%	38.0%

Table 14: How would you rate the impact of the project(s) on each of the following?

6.6. Project leads also judged the impact of workforce development projects as being highly positive, particularly on increasing demand and raising awareness among employers and

employees of HEIs' offers, identifying new modes of delivery and working collaboratively (see Table 15).

Impact of projects on...	Mean score (out of 7)	Proportion of low impact (1-3 out of 7)	Proportion of neutral (4 out of 7)	Proportion of high impact (5-7 out of 7)	Don't know	N/A
Increasing demand and raising awareness among employers and employees, and those within wider society, to engage with you at a local level (Base 60)						
	5.62	5.0%	8.3%	70.0%	6.7%	10.0%
Helping you identify new modes of delivery and assessment for HE provision, relevant to workforce needs (Base 60)						
	5.55	8.3%	11.7%	65.0%	5.0%	10.0%
Enabling you to work collaboratively with local regional and national organisations to apply and develop workforce related practices within STEM disciplines (Base 60)						
	5.54	8.3%	6.7%	65.0%	10.0%	10.0%
Bringing about the development of flexible and responsive HE provision at your institution, which responds to identified employer skills shortages (Base 59)						
	5.21	13.6%	8.5%	59.3%	5.1%	13.6%
Stimulating an increased uptake of HE STEM curricula within both the workforce and society (Base 59)						
	5.02	11.9%	10.2%	52.5%	13.6	11.9

						%	%

Table 15: How would you rate the impact of the project(s) on the following?

6.7. These positive views of institutional impact are in general supported by evidence from interviews. Project funding and the presence of the Programme as a driving force were felt to have led to better practices and increased activity in relation to HE STEM within institutions. The sheer number of projects supported is another indication of the impact of the Programme.

6.8. With these positive assessments, it is also important to consider the counterfactual situation, had the Programme not existed. As we do not have access to a control group in this case, we asked project leads in the survey to rate their institution's effectiveness at certain key areas now, having participated in the Programme, and how effective they believe their institution would have been had they not participated in the Programme at all (see Table 16).

	Overall effectiveness of the institution at...	Base	Near score (count of 7)	Low impact (1-3 out of 7)	Neutral (4 out of 7)	High impact (5-7 out of 7)	Don't know	N/A
	Engaging with schools and colleges for STEM outreach							
	Actual	118	59.5%	17.7%	4.2%	85.6%	5.1%	3.4%
	Counter-factual	117	52.9%	7.7%	12.8%	63.2%	7.7%	8.5%
	HE STEM curriculum development							
	Act		5	1	2	6	2	7

ual	1 5 5	. 9 1	. 3 %	. 6 %	6 . 5 %	2 . 6 %	. 1 %
Co unt er- fact ual	1 5 1	5 . 1 0	8 . 6 %	8 . 6 %	5 0 . 3 %	2 0 . 5 %	1 1 . 9 %
Developing the skills of STEM graduates to prepare them for the workplace							
Act ual	9 2	5 . 8 6	1 . 1 %	2 . 2 %	7 6 . 1 %	8 . 7 %	1 2 . 0 %
Co unt er- fact ual	9 1	5 . 0 1	8 . 8 %	1 5 . 4 %	4 9 . 5 %	9 . 9 %	1 6 . 5 %
Undertaking STEM-related employer engagement and workforce development							
Act ual	6 0	5 . 2 8	3 . 3 %	1 1 . 7 %	6 1 . 7 %	1 5 . 0 %	8 . 3 %
Co unt er- fact ual	6 0	4 . 3 3	1 5 . 0 %	2 3 . 3 %	3 1 . 7 %	1 3 . 3 %	1 6 . 7 %

Table 16: Overall, please rate how effective you believe your institution is now, and how effective you believe your organisation would be in the absence of the National HE STEM Programme

6.9. The survey results show that project leads in general believe their institutions are highly effective in the key areas relating to the Programme, particularly at engaging with schools and colleges for STEM outreach and at developing the skills of STEM graduates to prepare them for the workplace.

6.10. Importantly, across all four areas discussed, the project leads believe this effectiveness would be lower if they had never participated in the Programme. The difference in mean scores is statistically significant in each case. This is particularly stark in the case of undertaking STEM-related employer engagement and workforce development activities. Looking at the difference between the actual and counterfactual effectiveness scores shows that the average increase in scores due to the Programme is estimated as: 0.90 out of 7 for workforce development, 0.82 for graduate skills development, 0.75 for curriculum development and 0.67 for outreach with schools and colleges. The majority of respondents either gave the same score or gave a 1 point lower score for the counterfactual scenario. However, a small number of respondents indicated steeper differences between their current effectiveness and the counterfactual scenario, with the lowest counterfactual scores at 4 points out of 7 lower than the current rating for both engaging with schools and colleges and developing the skills of graduates, and 3 points out of 7 for curriculum

development and workforce development. Interestingly, these lower counterfactual scores were found across a range of different project sizes.

6.11. The fact that the counterfactual scores are lower is important because institutions and professional bodies would have undertaken some level of activity contributing towards the achievement of the Programme's goals, regardless of whether the Programme took place. Although perceptions of additionality of the Programme are generally positive, professional bodies in particular emphasised that the influence of the Programme on their activities was somewhat limited, given that the areas under discussion were already priorities before the Programme.

> *We already spend two to three times the money that we get from Birmingham ... on similar activities anyway. I think the importance of saying that is to put it into perspective, because actually the project that HEFCE funded is not such a large amount of money for trying to do what it was trying to do across four subject areas. ... you only have, really, rather limited outcomes from that amount of money. If £14 million could fix the problem in all of these subjects we would have done it ages ago.*
>
> Professional body representative

6.12. Although the Programme does seem to have influenced practice and activity at institutions, we have found less evidence of wider cultural change at institutions. The sphere of influence of many projects was restricted to the activities or individuals closest to the project, rather than influencing wider institutional culture. The hub and spoke institutions did of course have more in-depth involvement, with the potential for wider cultural change, as did a number of other HEIs that were involved in large numbers of projects, or in particularly large projects. In broad terms the HE STEM agenda was already a high priority for many of these institutions before the Programme, so the Programme was building on existing commitments.

6.13. Moving beyond the impact on individual institutions to that on the whole sector, our survey also asked project leads to rate their perceptions of the impact the National HE STEM Programme on key aspects of the sector overall (see Table 17). For this question we received a large proportion of "don't know" responses, reflecting the suggestion also made in interviews that many respondents feel it is too soon to determine the impact of the Programme, or that they simply cannot judge the impact across the sector.

Impact of Programme on ,,,	Mean score (out of 7)	Low impact (1-3 out of 7)	Neutral (4 out of 7)	High impact (5-7 out of 7)	Don't know
Increasing interaction between HEIs and existing STEM initiatives and organisations, such as professional bodies/le societies					
	5.34	8.9%	9.3%	64.4%	17%
Supporting the development and delivery of new curriculum to contribute directly to the learning experience of STEM undergraduate students					
	5.30	7.7%	7.7%	58.9%	23.8%
Increasing and enhancing opportunities for undergraduate skills development and exposure to the workplace					
	5.17	7.7%	9.7%	54.0%	26.6%
Bringing about a culture of sustainable collaboration and partnership between HE, employers, professional bodies a STEM-related initiatives and organisations					
	5.10	11.3%	9.3%	59.3%	19.4%
Developing and embedding discipline-based widening participation interventions into the core practice of HEIs					
	4.79	11.3%	14.5%	43.1%	28.6%

Table 17: Overall, how would you rate the impact of the Programme on the following? (Base=248)

6.14. Survey respondents were generally positive on average for all of the statements. Respondents were most positive about the impact of the Programme on increasing interaction between HEIs and existing STEM initiatives and organisations, and the impact of the Programme on the development and delivery of the STEM curriculum. Also positive within these results is the extent to which the Programme brought about sustainable collaboration between its partners. Programme partners felt that this in particular should be celebrated, for bringing about many extraordinary, inventive collaborations, that would not have occurred otherwise.

> *I think it gave the sector an opportunity for cross-institutional working, an incentive that wasn't there before. I say that, because I think what one has to bear in mind when you talk to heads of department in STEM disciplines, they don't always talk to each other as some disciplines do, in fact they are ferociously competitive with one another, you know, in a way that shocked me when I first came into the job. Cross-discipline working, even within STEM is difficult to get, and I think the Programme has been a big catalyst for that.*
>
> Programme stakeholder

Selected examples of impact

6.15. Examples of impact include changed outreach practices, such as those institutions that have taken up the SIAS or Maths Challenge Competition. Feedback in interviews highlighted several examples of institutions that thanks to the Programme's influence were now engaging with schools and students whom they otherwise would not have engaged

with. The sustainability of different types of impacts is considered in Section 7 of this report.

> *What the Programme did was it enabled us to pilot the project, and see if it would work. It enabled us to try a new sort of engagement that had been implemented by two other universities already. Both STEM, and outreach is a large part of what we do and although we are already "good at it", it is always an advantage to try new things without risk.*
>
> Project lead

6.16. As well as impacting on institutions, outreach activities also benefited the undergraduate students who were involved in visiting schools and colleges. SIAS for example provided invaluable experiences not only for the A-level students, but also for the undergraduates and postgraduate students who helped to deliver the activities, sometimes influencing their later careers.

> *One of the things they've seen as an output is a lot of the postgraduate students that have loved being involved in Spectroscopy in a Suitcase so much have then gone into teaching careers, or into outreach things, which for us is fantastic.*
>
> Professional body representative

6.17. The Programme has also seen impacts with new curriculum developments that improve or expand the offer available to students. For example, the Programme has supported the development of new, integrated science degrees covering aspects across several science disciplines. For example, in the context of a course with a broader scope, such as Biosciences, elements of Biology, Mathematics and Physics are taught in a way that meshes the knowledge together. Integrated science degrees were adopted by universities that recognised their value to employers. New, integrated Physics degree courses have been established at a number of universities, including Portsmouth, St Mary's, Bradford and Salford. This less traditional model of Physics was seen to be highly relevant to careers in industries based on energy or the environment. Another beneficial aspect of the integrated approach to curriculum in Physics was that it offered a wider range of entry routes into the discipline by virtue of the fact that integrated courses tend to have more flexible entry criteria.

6.18. A further impact on the STEM curriculum by the Programme is evidenced by an increased number of Applied Physics courses, widening the availability of degrees in places where Physics has suffered as a discipline as departments have been reduced or closed.

> *It is involving a broader spectrum of institutions in Physics, and...I think that's an important impact... [The Programme] has facilitated that and maybe accelerated the development.*

Professional body representative

6.19. Another example of impact includes the 22 new Maths Support Centres set up at HEIs, which will continue to help students after the end of the National HE STEM Programme. These centres, with support from the Sigma collaborative Centre for Excellence in Teaching and Learning Mathematics Support Network, provide additional support to students on a range of degree programmes that contain Mathematics components. The centres have received good feedback from institutions, including some evidence of their having improved student retention.

> *So, through our Programme there are now 22 new Maths Support Centres at institutions around the country, where there weren't before. I think that's quite a major impact. As far as we know of, of those 22, there's only one that will not be operational next academic year. ... That's overwhelmingly positive, with many students saying, "If it weren't for this centre, I'd have dropped out."*

Professional body representative

6.20. Part of the success of these Maths support centres has been in leveraging HEIs' own commitment and funding to setting up and maintaining a Maths support centre, through asking for institutional matched funding alongside the Programme funding. In addition, the IMA have had success with their other employer-led activities, as evidenced in the high demand for the DVDs they produced in which 15 employers describe the desirable attributes of Maths graduates.

6.21. An example of the impact gained from the workforce development activities of the Programme is the Gearing up for Industrial Growth project at the University of Wolverhampton. The project engaged with local employers in the West Midlands, supporting recruitment and progression to further study relating to the high-value manufacturing area of the aerospace industry. Outputs will include the development of a dual track manufacturing programme, as well as a two-year full-time degree in Manufacturing Engineering that combines study time with industrial experience, launching in February 2013. By establishing feeder routes from technology colleges, the project is building sustainable routes to lifelong learning for a STEM career sector that is set to contribute to economic growth.

Impact on wider Programme aims

6.22. The scope of this evaluation is primarily concerned with impacts on HEIs and on the HE STEM sector, rather than with impacts on the Programme's overarching aims of widening participation in HE STEM disciplines, improving STEM graduates' employability, and raising the HE STEM skills of the current workforce. These are by their nature much more difficult to assess than institutional impact, particularly given the brief timescale over which the Programme was active in comparison to the longer timescales needed to measure

changes in student applications or HE STEM skills. Nevertheless we did give these wider impacts consideration in our fieldwork and desk research, as discussed in this sub-section.

6.23. Feedback from interviews emphasised that for many Programme activities, it is currently too early to tell the extent of impacts in any detail, owing to their nature and scope. In the online survey of project leads we therefore asked about the extent to which their institution's involvement with the National HE STEM Programme has had, or will have in the future, an impact on certain key areas, allowing us to compare scores for current impact against future expected impact (see Table 18).

Extent to which your institution's involvement with the National HE STEM Programme has had, or will have in the future an impact on...	Mean score (out of 7)	Proportion of low impact (1-3 out of 7)	Proportion of neutral (4 out of 7)	Proportion of high impact (5-7 out of 7)	Don't know	N/A
Widening participation in STEM subjects at your institution						
Current (Base 100)	4.98	12.8%	7.7%	65.0%	10.3%	4.3%

Future (Base 93)	5.19	14.2%	6.2%	61.9%	13.3%	4.4%
Improving the overall learning experience offered to undergraduate students within the STEM disciplines at your institution						
Current (Base 121)	5.05	9.1%	10.4%	59.1%	14.9%	6.5%
Future (Base 125)	5.81	4.1%	4.8%	76.2%	11.6%	3.4%
Increasing the attractiveness of the HE STEM curriculum and related careers to future generations of students						
Current (Base 123)	5.05	9.7%	10.3%	59.4%	17.4%	3.2%
Future (Base 128)	5.60	6.7%	6.7%	72.0%	13.3%	1.3%
Benefiting your STEM graduates in the workplace or labour market						
Current (Base 92)	5.11	9.8%	9.8%	56.5%	9.8%	14.1%
Future (Base 92)	5.78	4.3%	2.2%	73.9%	9.8%	9.8%
Increasing the STEM-related knowledge, understanding, skills and competencies of those currently within the UK workforce who have not previously participated in HE						
Current (59)	4.71	13.6%	16.9%	45.8%	16.9%	6.8%
Future (59)	5.46	10.2%	3.4%	55.9%	22.0%	8.5%

Table 18: To what extent do you believe your institution's involvement in the National HE STEM Programme has had, or will have in the future, an impact on the following?

6.24. In general the results reinforce the feedback from interviews that the impact of the Programme will increase over time, rather than decrease. Current impact is felt to be high for the majority of project leads in all areas other than for increasing the STEM skills of the

UK workforce. Expectations of future impact have greater proportions of high impact scores given in all areas other than widening participation in STEM subjects. We might speculate that this could be related to changing widening participation policy and context external to the Programme. Several Programme partners felt that some longer-term measurement of impact would be useful, albeit challenging.

> *I feel that it is still too early to evaluate the impact of the Programme or of individual projects from selected spokes. These particular projects need to be measured for impact two to three years post project completion. Of course, the biggest challenge is being able to measure the impact, say, three years down the line.*
>
> Regional spoke representative

6.25. Discussion with Programme partners reinforced the conclusion that the ultimate impact of the Programme on aims such as widening participation will only emerge as current school-age students apply to university. Even then, it is impossible systematically to ascribe any change in applications to the impact of the Programme, or individual projects, particularly given the changing economic and HE funding environment over the course of the Programme.

6.26. Examining data from the DLHE survey shows that over the period of the Programme, the number of graduates in the core STEM disciplines has increased, as shown in the chart below. Programme partners reflected in interviews on this increase and the problem in attributing it to the interventions made under the Programme, but concluded that the Programme was part of a range of influences that have helped to improve the supply and diversity of HE STEM graduates.

> *You can't make a direct connection [between the HE STEM funding and national statistics], but you can look at things like STEM applications, STEM subjects – looking healthy. Now, there's an argument about whether that's the economic environment and because prospective students see the job opportunities in STEM, but we have clearly turned a corner, with good engineering numbers and so on. I would say it's been very positive.*
>
> Regional spoke representative

6.27. It is difficult to quantify at an overall level how far trends in widening participation can be attributed to the impact of the Programme. Nevertheless, the increase in application and participation levels in STEM subjects reinforces the narrative that the Programme has supported such changes. The feeling from many project leads was that widening participation and outreach projects had definitely had a range of positive impacts on the target groups and Programme objectives. Discussion with project leads and Programme partners revealed many qualitative examples of project impact, which while isolated, were tangible successes that would also likely bring impact in future.

In terms of impact I guess would have to say the Discover Science clubs for young girls has had an important impact on 30 girls in Wrexham and 20 plus young girls in Bangor. The Maths Support projects seem to have touched a lot of students and the Teacher Fellows projects have really enabled a few people in school sixth forms to experience science lecturing in universities in Cardiff and Glamorgan universities. Qualitatively these projects will have made a real difference.

Regional spoke representative

6.28. There were also examples of the Programme or its activities having influenced the national debate around HE STEM or policy. Projects funded through the Programme, such as the Maths Support Centres have been cited by ministers. Research commissioned by the Programme has influenced debates and reviews, such as the review by Lord Willis into HE STEM provision. The Programme has also had a positive influence on shaping the policy debate in Wales, particularly around the generation of the Welsh Science Strategy and influencing the Chief Scientist. Despite this, a minority of stakeholders we interviewed felt the Programme might have had the potential to exert a greater influence on policy than it achieved. The question of whether the Programme should have had an additional high profile figurehead to lead such influence was also discussed and is covered in more detail in the governance and management section of this report.

I think they were incredibly successful, as well, in getting a wide range of critical mass of institutions and collaborators, around the country. It seemed to be they didn't really use that, I think they… weren't aspirational enough, in my view...given that they can have this national identity, being able to really use that, to speak as a national voice, or a national lobby...was not really taken up.

Programme stakeholder

6.29. In conclusion, given their largely qualitative nature, it is difficult to quantify the precise impact of the National HE STEM Programme on sector policy, practice and activity. We have found numerous individual examples of impacts on institutional activity and practice, including on improved outreach activities, new and improved curricula and workforce development practices, both in England and Wales. Feedback from project leads is very positive about the impact of their projects on institutional practice and activity, and project leads believe their institutions are more effective at STEM outreach, curriculum development and workforce development than they would have been without the Programme. The extent to which these impacts will be sustainable is discussed in the following section.

7. Sustainability of Programme outcomes

Achieving outcomes that would last beyond the end of the Programme funding was a key objective of the National HE STEM Programme. This section considers the sustainability of the outcomes of the Programme, including at the levels of policy, sector, institution and practice.

6.30.

7.1. Sustainability was identified as a key theme at the outset of the Programme. The importance of ensuring activity and outcomes were sustainable was embedded within the Programme, and indeed was specifically commented on by West Midlands Enterprise as part of their sustainability review:

> *Our judgement is that both in terms of design, and in terms of implementation, sustainability is being taken very seriously across the programme*
>
> National HE STEM programme, internal impact and sustainability review, September 2011

7.2. The final bid document, and the first six monthly progress report to HEFCE and HEFCW, reaffirm its importance and demonstrate how it underpins the adopted delivery model.

> *The task of increasing participation and higher-level skills development in STEM disciplines will not be addressed by a discrete three-year programme of activity, and the focus of the programme is therefore upon the transfer and embedding of activity, rather than upon direct delivery.*
>
> National HE STEM Programme Final Bid Document, p.33

> *The decision for the Programme to not undertake direct delivery is a deliberate one. There have been numerous examples in the past of activities that have had enormous impact, yet when funding ceases, these activities also cease. Instead the Programme will work to enhance and initiate HEI centred activities by encouraging the development and sharing of practices that can become embedded within the HE sector and become a sustainable part of the core practice of HEIs.*
>
> First Six-Monthly Report to HEFCE/HEFCW, April 2010, pp.3-4

7.3. In implementing the Programme delivery model and commissioning projects/activities through the discipline strands, the regional spokes and the national hub, sustainability was a key selection criterion. There is evidence to suggest that projects/activities were rejected on the basis they offered limited potential for sustainability.

7.4. Notwithstanding the fact that sustainability was an inherent element of the delivery model, our interviews suggested that the lack of a clearly articulated sustainability strategy at a Programme level did become an issue in the early stages of the Programme. A lack of any explicit statement about what sustainability meant in practice for the Programme led to strands interpreting it in their own way. The issue was addressed, however, in the later stages of the Programme and appears to have been communicated effectively to relevant partners.

7.5. In determining the extent to which the Programme outcomes are sustainable beyond the initial funding period it is also important to understand what could and should be sustained after the end of the funding. Work undertaken by the National HE STEM Programme has concentrated on the sustainability of the activities and practice initiated. The Internal Impact and Sustainability Review articulated that "sustainability of an activity is deemed to be realised when it will continue in current or modified form, within at least the HEI(s) initially involved in its development and implementation, after National HE STEM support ends".[10] The Review highlights that only those activities which have a perceived benefit to HEIs or other partners are likely to be sustained. This raises a question over whether the Programme, or individual projects, had access to robust evidence of the benefits/impact realised to underpin decisions about whether an activity is sustained. Evaluation was certainly an integral part of project implementation and useful resources and materials were made available to projects via the Programme's website to encourage projects to adopt a structured and systematic approach to collating evidence of impact. The extent to which information collected by projects could be used to judge objective success varies from case to case. However, the commitment of HEIs to building on projects, as evidenced in various Programme related reports, is another indicator that activities are valued and have had impact.

7.6. Our understanding of the Programme's intent and the difference it has made to the HE STEM community and wider stakeholders cited in the section above would suggest that it is important to consider sustainability at a number of interrelated levels, including:

- Policy – to what extent is HE STEM being taken forward as a contemporary and "live" agenda for Government, policy and funding bodies, professional bodies and other key stakeholders?
- Sector – to what extent is the infrastructure (national and regional networks, communities of practice, etc), established through the Programme, sustainable or have alternative mechanisms been established to continuously drive improvements in HE STEM across the sector?
- Institutional – to what extent are the strands of the HE STEM Programme embedded in the strategy, plans and operations of the institutions involved, and to what extent is the capability and capacity in place to support activity well into the future?

[10] National HE STEM Programme, Internal Impact and Sustainability Review, (September 2011).

- Activity/practice – to what extent is HE STEM activity/practice, initiated by/through the Programme, sustainable and are there mechanisms in place to continuously review and improve the activity/practice?

7.7. To a degree the internal work undertaken by the Programme takes into account aspects of the first three levels as 'indicators' of whether or not sustainability can be achieved albeit from an activity/practice perspective. Yet from a Programme perspective one could argue that it is equally important to ensure the environment remains conducive to the HE STEM agenda into the longer term, enabling the true legacy of the Programme to be realised. In this section we therefore strive to provide a holistic picture of sustainability.

7.8. Robustly measuring sustainability is though inherently difficult when a Programme was only just drawing to a close. It is only when the external support has been fully removed for six to twelve months (or potentially even longer) that sustainability can be conclusively demonstrated. At a project level, some had been completed for a period of time when the evaluation fieldwork took place, but the majority were in the process of formally drawing to a close, undertaking summative evaluations and writing final reports. Consequently, like the National HE STEM Programme's Internal Impact and Sustainability Review, we have had to base our assessment of sustainability on a variety of sources of evidence, including the hub, spoke and stakeholder interviews, the online survey and the secondary sources available to us at the time of writing (e.g. a limited number of project final reports). The analysis of this evidence gives an indication of the likelihood that the Programme's outcomes will be sustained, but by no means guarantees that they will be sustained.

Policy level

7.9. From a policy perspective, increasing participation in HE STEM subjects is still regarded as strategically important and a priority by the UK and Welsh Governments and the HE funding councils, although different approaches are being pursued from when the Programme was established. The recent House of Lords select committee report on science and technology is an indicator that the relationship between HE STEM subjects and the economy is still highly important, and thus the policy agenda behind the Programme remains relevant and sustainable.[11] In Wales the Chief Scientific Adviser prepared a "Science for Wales" strategy in 2012 for the Welsh Government, which continued to emphasise STEM education and matching STEM skills supply and demand, as one of a number of key priorities for Wales. The National Science Academy in Wales also provides a vehicle to address STEM outreach, student engagement and workforce development.[12]

7.10. The recent rise in applications to study STEM subjects in HE, alongside providing an expanded 'pipeline' of talented graduates into the workforce, is also helping to counterbalance, at least in the short to medium-term, the vulnerability of these subjects

[11] House of Lords, Science and Technology Select Committee, Report, (2012).

[12] Welsh Government, Science for Wales, A strategic agenda for science and innovation in Wales, (2012).

and secure the immediate future of many STEM schools/departments in universities. Nevertheless, stakeholders are still concerned for the future of some subjects:

> *I think there are worries there about the course mix that might be around, as well as the fact that a lot of kids have been choosing not to study the sciences – so I think that's a continuing problem to keep it attractive and neat.*
>
> Programme stakeholder

7.11. Hence, looking to the longer-term it will be critically important to ensure that progression into and through HE STEM subjects is sustained at a level required to meet economic demand. As such HE STEM needs to remain a contemporary and "live" agenda for Government, policy and funding bodies, professional bodies and other key stakeholders. Maintaining a policy focus on outreach, enhancement and employer engagement will be critical, particularly in what is now a radically different HE policy and funding environment. The Access Agreements have, for example, been highlighted by some of the stakeholders we interviewed as one policy level intervention with potential to sustain a focus on HE STEM from an outreach perspective. Interestingly evidence from the Programme's Internal Impact and Sustainability Review indicates that the Access Agreements have already been identified as one means by which to sustain a strong HE STEM focus in an institution's outreach strategies.

> *Spectroscopy in a Suitcase is now an integral part of the outreach programmes for every HEI involved in the scheme and will enable them to meet the requirements of the access agreements required by OFFA as the new HE funding structure commences.*
>
> Professional body representative

7.12. While it is difficult to directly evidence the extent to which the Programme has contributed to maintaining HE STEM as a policy focus, it would be fair to say that the creation and implementation of the Programme has helped to retain a strong focus nationally on the importance of STEM subjects. Funding council officers, professional body representatives, the national team based at Birmingham, and senior academics in the HEIs involved have all contributed through a wide range of forums and networks to an ongoing dialogue within and across the different stakeholder constituencies as well as with Government advisers and ministers.

I'm delighted a project involving HE, FE, industry and professional bodies has just secured funding from the National STEM HE Programme to embed nuclear power-related skills in degree courses at English and Welsh institutions.

The RT Hon David Willetts, MP – March 2011[13]

7.13. Even though it was never an explicit intention of the Programme to ensure HE STEM remained a policy focus, it can be reasonably assumed that for a while at least the dialogue will be sustained within and across the different stakeholder constituencies and will therefore continue to inform thinking at a policy level.

7.14. In relation to funding HE STEM developments after the end of the Programme in July 2012, when the Programme formally closes, the primary route will be through HEIs determining how best to utilise their mainstream funding allocations. This will especially be the case in England; by contrast in Wales there is a potential for the continued policy focus to lever additional funding to support ongoing activity that has been shown to work, has wide acceptance across the sector and clearly has a role to play in engaging with employers, for example through the Science Strategy and funding for life sciences.

Sector level

7.15. The evidence presented in this evaluation report suggests that the 'hub and spoke' (and sub-spoke) model has been instrumental in engaging a wide cross-section of the HE STEM community in the Programme and in ensuring activities and practices were embedded, as far as possible, from the outset. The stakeholder, hub and spoke interviews recognised the value in the adopted approach which at sector level has enabled good practice to be shared through national and regional networks and events and through communities of practice established as inherent elements of funded projects.

7.16. The infrastructure (i.e. the national 'hub' and the regional 'spokes') created to support these networks is, however, not sustainable without further funding. In many respects the infrastructure was created solely to support the Programme's co-ordination and implementation and the intention was never to sustain it.

The challenge is probably the wider networks and the regional networks, managing those relationships is costly and time-consuming and may not be mission critical...I have a sense that the network that we've got here, has done a lot of good delivery, so it would be a shame if they disappeared. I still think they...sit in a 'nice-to-have', rather than an essential.

Regional spoke representative

[13] National HE STEM Programme, Internal Impact and Sustainability Review, (September 2011).

7.17. Nevertheless given the value of the relationships, networks and communities of practice that have been formed, consideration should be given to how the established infrastructure, either as a whole or in part, could be sustained or more realistically alternative mechanisms identified to continuously drive improvements in HE STEM across the sector beyond the Programme's funding period. As the quote above indicates, maintaining such networks requires ongoing commitment and resource. It is therefore likely that one of the best ways to sustain the networks that add real value to the sector will be through the support of well established organisations, whose missions align with the intent of the Programme, rather than through a dedicated infrastructure. In Wales, stakeholders were discussing the potential to continue to support particularly successful projects, despite budget pressures, given the priority of STEM and workforce development for the economy.

7.18. The professional or scholarly bodies, which were integral to the pilot projects as well as the subsequent Programme, have been identified by many as an appropriate means through which to continue to support HE STEM developments across the sector well into the future. From the professional body perspective, the interviews highlighted that the intent of the Programme was always well aligned to their respective missions, and that HE STEM would continue to be a strategic priority and an element of their future plans and activities. The unknown at the time of our fieldwork was exactly what the nature and level of activity that the professional bodies could realistically support, particularly given other competing priorities for their finite resource. The Programme's Legacy Mapping[14] document outlines legacy activities across the ten core Programme partners and shows all four professional bodies are continuing legacy activities from the Programme, in particular outreach activities. The Legacy Mapping document also shows that the six university spoke partners intend to continue a range of legacy activities.

7.19. The other body, whose mission aligns with elements of the Programme, is the HEA. The HEA has been actively involved in the Programme from its inception - supporting and promoting funding opportunities and dissemination events, amongst other aspects - and STEM continues to be an explicit discipline focus for the Academy. Its structures and resources have been realigned to support STEM and its 2012-13 grant letter from HEFCE also refers to taking forward and sustaining the Programme's outcomes through the Academy's broader engagement in STEM subjects. A Head of STEM and discipline leads are in place to encourage and support the sector to engage in events - such as the "HEA STEM: Annual Learning and Teaching Conference 2013: Where practice and pedagogy meet" - make the most of the funding opportunities such as the Teaching Development Grants and projects such as the Skills in Mathematics and Statistics in the Disciplines, and Tackling Transition. The HEA clearly remains committed to developing and delivering STEM subject-specific services valued by the sector. Discussions have taken place with the Programme's national hub and the HEA to inform and ensure legacy support is available to the sector, including a national series of events to support professional development.

[14] National HE STEM Programme, Legacy Mapping document, (September 2012).

7.20. It is also important to note that in August 2012 the University of Birmingham established a STEM Education Centre that will bring direct benefit to the institution, its staff and students through the transfer and embedding of good practice, and through educational innovation and enhancement across its range of STEM provision. The Centre will also maintain a national, externally facing remit, working in conjunction with existing STEM initiatives and organisations, and will enable a number of the external activities established through the Programme to continue by providing ongoing knowledge transfer and information exchange. The Centre is also intending to link with the National STEM Centre and Science Learning Centre based at the University of York to build strategic relationships between universities and schools and colleges (facilitated through OFFA) and to maintain links with the wider national STEM agenda.

Institutional level

7.21. The different strands of the Programme – increasing and widening participation, curriculum enhancement and innovation, and workforce development/employer engagement (in STEM) – are arguably all integral elements albeit to varying degrees of a university's core business, particularly given recent changes in the HE policy and funding regime. It is therefore reasonable to assume that there will be a level of ongoing institutional commitment to these strands through:

- Embedding within institutional activity
- Mainstreaming changes in working practices
- Disseminating important elements of practice.

7.22. Alternatively institutions may seek to identify and secure alternative sources of funding to support continuance of existing activity. These interrelated approaches to sustainability were adopted by the Programme's South West spoke as a means by which to capture examples of how sustainability was being addressed at a project-level albeit within an institutional/school/ departmental context. The categorisation was subsequently adopted by the hub and the North East spoke.

7.23. Evidence drawn from an independent analysis and presented in the Programme's Internal Impact and Sustainability Review[15] indicates an alignment of the aims and objectives of the Programme with the priorities of HEIs, as exemplified in their respective learning and teaching strategies, and more critically an embedding of outreach activity in OFFA and Welsh Fee Plan agreements. The latter clearly demonstrating that activity is being embedded within institutional strategy, plans and operations. Below are some extracts from OFFA or Welsh Fee Plan agreements which typify how activity is being embedded:

- **Aberystwyth University :** We will support schemes to raise aspirations in STEM subjects from ages 7 to 14 (...HE STEM Maths Challenge activities in 11 schools)

[15] National HE STEM Programme, Internal Impact and Sustainability Review, (September 2011).

- **Imperial College London:** The Reach Out Lab was opened in 2010 to provide additional facilities to deliver practical programmes and an experience of university for pupils aged six to eighteen, specifically from schools without ready access to laboratories.

- **University of Bradford:** We lead the Northern spoke of the HEFCE funded HE STEM programme designed to ensure universities work together regionally and nationally to widen participation in these key subjects. We have built on this role and through working closely with professional bodies we have developed a programme known as 'Building STEM at Bradford'.

7.24. The requirement to demonstrate alignment to institutional (and/or faculty/school/department) strategies and plans alongside a level of institutional commitment, financial and/or in kind support, was an inherent criterion in the commissioning process for funded projects/activity. This indicative commitment has, however, continued well into the implementation phase of the majority of projects and in many instances beyond as part of a continuation strategy. West Midlands Enterprise as part of a sustainability review completed in September 2011, on behalf of the Programme, identified that nearly 90% of projects had received financial and/or in kind support from their HEIs. Whilst not necessarily a surprise given the criteria, it is a positive indication that HEIs may continue to embed and mainstream activity.

7.25. In respect to sensitising more institutional staff to the strands of the HE STEM agenda (capacity building) and developing the skills and expertise of these staff to support activity during and beyond the Programme's timeframe (capability building), the evidence from our evaluation would suggest this has been achieved and provides a real legacy of the Programme. The Royal Academy for Engineering's summative report[16] of the outputs from its disciplinary strand of the Programme provides a further indication that "hearts and minds" have been won and that sustainable capacity and capability has been built in institutions to take forward existing, enhanced and potentially new activity. The report shows that many funded projects involved:

- Departments outside the host department with involvement ranging from awareness raising and building understanding to more active engagement

- Other institutions with, in most cases, one or two institutions actively involved and in some instances much larger numbers

- Most commonly three to five members of staff in an active way, although overall numbers ranged from two to 40 staff.

7.26. The picture described above is replicated across the other core and disciplinary strands of the Programme. Moreover, project related activity has been embedded in institutional policy. For example, the placement evaluation frameworks and guidelines developed as

[16] Royal Academy of Engineering, Enhancing Engineering Higher Education: Outputs of the National HE STEM Programme, (July 2012).

part of the employer-led employability pilot course at the University of Bath have become embedded within institutional quality assurance Code of Practice guidance.

7.27. To gauge the potential impact and sustainability of the Programme's activities upon institutions themselves, we asked project leads in our online survey to consider the extent to which project activities had brought about institutional change and become embedded, to create a long-term and sustainable programme of activity. The results shown in Table 19 suggest moderate agreement that activities under the Programme have been embedded within institutional practice and as such can be judged as sustainable.

	Mean score (out of 7)	Low Extent (1-3 out of 7)	Neutral (4 out of 7)	High extent (5-7 out of 7)	Don't know	N/A
To create a long-term and sustainable programme of activity for graduate skills development? (Base=88)						
	5.36	10.2%	9.1%	64.8%	9.1%	6.8%
To create a long-term and sustainable STEM curriculum? (Base=150)						
	5.17	11.3%	2.7%	67.3%	12.7%	6.0%
To create a long-term and sustainable programme of activity for workforce development? (Base=57)						
	5.05	8.8%	14.0%	54.4%	14.0%	8.8%
To create a long-term and sustainable programme of activity for engaging with schools and colleges? (Base=118)						
	4.91	15.3%	9.3%	59.3%	5.1%	11.0%

Table 19: To what extent have your project activities brought about institutional change and been embedded?

7.28. For each type of Programme activity, over half of respondents indicated that activities had become embedded to a high extent, equating to a score of 5 6 or 7. The scores are highest for graduate skills development and curriculum development, reinforcing the idea that curricula are by their nature sustainable once they are developed, with the lowest scores given for workforce development activities, perhaps reflecting the reduced emphasis on this area in national policy.

Activity/practice level

> *Both reports [i.e. the sustainability review and an early review by West Midlands Enterprise] present evidence that, at the project level, activity is likely to be sustained beyond the HEFCE/HEFCW funding period (quoting HEFCE/HEFCW Executive Committee Paper, September 2011)*
>
> Executive Committee Meeting, Programme Synthesis, May 2012, pp.3

7.29. At an activity/practice level, the evidence available to us would suggest that a high proportion "will remain embedded within the HE STEM sector beyond the lifetime of the

funded Programme"[17]; a finding which is further supported by the results from our online survey.

7.30. Survey respondents were asked to indicate the extent to which their projects and activities undertaken as part of the Programme would be sustained beyond the end of the funding (see Table 20). Our results indicate that the majority of respondents will be continuing STEM-related activities in some form, and in many cases the level of activity undertaken during the Programme will be continued or increased. Almost all (93.6%) involved with curriculum development and enhancement, 88.6% of those involved with HE engagement with schools and colleges, and 87% of those involved in graduate skills development intend to continue their project activities in some way. Two-thirds (65%) of respondents involved in workforce development activities indicated that they would continue their project activities beyond the end of the funding period to the same or an increased extent.

	Increasing this activity in future	Maintaining beyond the current funding period	Continuing but to a lesser extent	Not intending to continue this type of activity	Reviewing activities-pending decision

[17] National HE STEM Programme, Internal Impact and Sustainability Review, (September 2011).

					a c t i v i t y	
	Develop graduate skills to better align with employer need and current and future workforce priorities (Base=92)					
	44.6%	38.0%	4.3%	0.0%	2.2%	
	Engage with employers, employees and wider society to raise HE STEM skills (Base=60)					
	41.7%	23.3%	8.3%	3.3%	8.3%	
	Design and develop curriculum and innovative new models for learning (Base=157)					
	38.9%	45.2%	9.65	0.0%	2.5%	
	Improve HE engagement with schools and colleges (Base=114)					
	27.2%	48.2%	13.2%	0.0%	6.1%	

Table 20: To what extent will you sustain activity undertaken as part of your project(s)?

7.31. Similarly, the Royal Academy of Engineering report[18] indicated that there was high level of confidence in the sustainability of change, with 90% of respondents being mostly or extremely confident. The majority of anticipated changes were to curricula (61%) or pedagogy/delivery (69%), with significant changes also anticipated in employer engagement (44%).

7.32. The evidence available would therefore suggest that projects have in the main been successful in demonstrating the value of their activity and then aligning or embedding the activities with their department/school's or wider institution's mainstream activity (e.g. outreach and student recruitment activities, ongoing delivery of STEM related modules and programmes). Examples of the types of activities/practices likely to be sustained include:

[18] Royal Academy of Engineering, Enhancing Engineering Higher Education: Outputs of the National HE STEM Programme, (July 2012).

- **Greening STEM** – which built on the University of Bradford's Ecoversity Programme by embedding the principles and practices of sustainable development in the curriculum, employer engagement and operational aspects of STEM related areas in the institution; this initiative has since received further strategic support from the University

- **Employer-led employability sessions** – this pilot course at the University of Bath has informed future approaches to engagement with employers at departmental level; placement evaluation frameworks and guidelines have become embedded within institutional quality assurance Code of Practice guidance

- **New STEM Foundation degree and degree courses** – now being offered at a range of universities (e.g. Bradford, Portsmouth, St Mary's) and colleges (Macclesfield College and South Cheshire); these courses incorporate good practice developed through the Programme such as industrial group projects, advisory boards and problem-based learning

- **Mathematics support centres** – established at a number of HEIs and likely to be sustained, with one Deputy Vice-Chancellor acknowledging "the first year [has] been a great success... our University Teaching Committee has recently confirmed that University funding for the project will continue."[19]

> *I think the thing that to me comes across as quite strongly embedded is these maths support centres and I feel that [the Programme has] really facilitated or been part of that agenda. That is to me a very important one that looks to me as though it's embedding into institutions and the institutions are seeing that.*
>
> Programme stakeholder

7.33. The RSC, through its discipline strand, made a decision to focus funds on developing/expanding resources rather than funding activities per se, to increase the likelihood of sustainability after the Programme. The RSC believed that the resources would have a 'shelf life' beyond the end of the funding period. In fact the six-monthly report to the funding councils suggests that the goal of transferring and embedding the activities and learning from the four pilot projects into the HE sector to influence the core practices of universities had been achieved.[20] The RSC's SIAS was one of the pilot projects and is a good example of where resources are likely to be sustained.

> *We're going to talk to the Royal Society of Chemistry about sustaining the 'Spectroscopy in a Suitcase' programme, and so some things which are nicely packaged are probably more sustainable.*
>
> Programme stakeholder

[19] National HE STEM Programme, Fifth Six-Monthly Report to the Funding Councils, (April 2012).

[20] National HE STEM Programme, Fifth Six-Monthly Report to the Funding Councils, (April 2012), p.19.

As I say, I think some of the activities that can be packaged up quite neatly…will continue. Certainly some of the toolkits, I suspect some of the people will want to continue to use…institutions have already engaged with them, the resources are already there.

Programme stakeholder

7.34. The Programme, more broadly, has developed a wealth of resources, many of which have been readily accessible via the National HE STEM Programme as well as professional body websites. As such the longer-term sustainability of these resources, alongside their wider uptake, in part depends on their continuing accessibility to the HE community. With this in mind the national hub has been working with the HEA to create a national bank of resources using the Creative Commons licensing on an open-access basis.

I think that…taking things like problem-based learning and contextual learning into curricula where it hadn't been so visible before is good and I think will last.

Programme stakeholder

7.35. It is perhaps not surprising that such a significant proportion of the activity is likely to be sustained, given the strong emphasis on curriculum and resource development. Evidence from evaluations of previous funded programmes indicates that sustained activities are typically those that become embedded in HEI practice and are thereafter supported through mainstream funding.[21] Furthermore, the Programme encouraged institutions to develop and improve the quality of their practices, arguably a highly visible change where curriculum development is concerned which, if successful, reaps benefits for the institution and results in lasting change. One spoke university staff member based in Wales noted:

I think the project has made HE STEM-focused lecturers in Wales think a bit more reflectively and critically about their own pedagogical practice, and in turn key aspects linked to student recruitment, the transition from school to university, and the necessary skills needed for students to move successfully into work. Better understanding this skills "mismatch" that seems to exist from schools to university then into work is a big issue for lecturers, and I think our projects will have helped in this regard.

Regional spoke representative

7.36. While embedding may require support from senior institutional management, there are positive indications to suggest that this level of commitment is in place (see 'Institutional level' sub-section above). An example of this is the workforce development project, Embedding Resources for Distance Learning, which built on existing part-time STEM provision to develop a distance learning degree designed to meet the needs of employers

[21] SQW, Summative evaluation of the CETL programme, (December 2011).

and the workforce. The project built on previous success by embedding resources developed in the CFOF pilot project, which after a successful trial led to the implementation of a full-scale distance taught course. As long as the course continues to be subscribed and add value to the university's offer, it is likely to be sustained.

Lessons learned on sustainability

7.37. Through the Programme's emphasis on sustainability, ten factors have been identified which contribute to ensuring sustainability, although not all need to be present. The factors are: embedding importance of sustainability at the outset; alignment of activities to wider priorities; institutional commitment; evaluation; dissemination; professional development; developing a community identity; wider value; up-front investment; and, a proven starting point.[22]

> *The three-year delivery timescale, particularly given the requirement for the Programme to change university curricula and practices in a sustainable manner, meant that a series of activities and interventions needed to be quickly established if outcomes were to be realised by the end of the Programme. Enabling practice change within the HE sector at levels beyond that of an individual or single module, for example at course, departmental, faculty or institutional levels is recognised to be a longer-term process and the full success of the Programme will clearly not be evident during its HEFCE and HEFCW funded lifetime.*
>
> Exec Committee Meeting, Programme Synthesis, May 2012, pp.2

7.38. In addition, a key lesson learned about ensuring sustainability by many involved in the Programme, albeit expressed in different ways, is that the commissioning of funded projects/activity needs to allow sufficient time before the end of the Programme is reached to not only deliver, disseminate and evaluate the project outcomes but also to ensure the necessary foundations are in place to secure (and preferably demonstrate) sustainability.

7.39. In conclusion, assessing actual sustainability of Programme outcomes will only be fully possible some time after the end of the Programme. However, early evidence from internal reviews and our own research suggests that many of the Programme outcomes will be sustainable, at least in the immediate future, including at the level of policy, through HE STEM remaining a policy priority, at sector level, through national efforts to maintain some of the developments created by the Programme, and at institutional and practice levels, through continuing activities that were started through funded projects.

[22] National HE STEM Programme, Internal Impact and Sustainability Review, (September 2011).

8. Effectiveness of Programme governance and management

As a large and complex Programme, robust governance and management was crucial to effective practice. In this section we discuss feedback from Programme partners on governance and management, including the Programme delivery model and the oversight of the funding councils.

8.1. The Programme hub and spoke model has been discussed in earlier sections and comprised a central hub team at the University of Birmingham, led by the Programme Director and supported by a Pro Vice-Chancellor, as well as spoke teams at each of the six regional spokes, including a separate spoke team at Birmingham. In addition to the hub and spoke staff, the Programme also had a Programme Board, Executive Group, Advisory Group and individual regions had their own Steering Groups. The funding councils provided an additional level of oversight, as well as attending the Executive Committee, Programme Board and Advisory Group meetings.

The hub team

8.2. The hub team was the central team for financial management and coordination of Programme partners, intended to support and enhance the activities in the spokes and help to share practice across regions. The hub consisted of the Programme Director, a Programme Manager, an Information Officer and an Administrative Assistant and PA to the Director. A Dissemination Officer was appointed for the final year in response to recommendations within the Sustainability Review and Year 3 Business Plan. It is clear from interviews that the hub team hosted at the University of Birmingham were an important asset for the Programme. As a group of dedicated staff, they were responsible for driving forward the national programme of activity, both centrally and through supporting the actions of the spokes and professional bodies.

8.3. The Programme Director played an important role in both raising the profile of the Programme and leading delivery, drafting Programme reports and chairing the Programme Board. The demands on the Director's time were therefore significant. There was some questioning from stakeholders and professional bodies over whether the Director was sufficiently senior within the University of Birmingham to wield the level of influence needed for a Programme of this size. One suggestion made by several stakeholders was that the Programme may have benefited from an additional high profile "Chair" role, alongside the Director, to act as an external figurehead to help raise the Programme's profile across HE. To use an example from another programme, the South East Physics Network (SEPNet) had a former vice-chancellor as its Chair.

Somebody that was very much the figurehead, that went out and about, that did all the political stuff and was well-known, well respected, had gravitas, within that community.

Programme stakeholder

8.4. The hub team and Director were supported by a Pro Vice-Chancellor at the University of Birmingham. Although this was welcome, some stakeholders felt that greater senior level involvement from Birmingham, particularly in the early and mid-stages of the Programme, would have been valuable to provide leadership and raise national profile. Overall though, the hub team were felt to have played an effective and influential role in the success of the Programme.

[The Director] and his team have a strong influence, clearly, and I think that there have been appropriate checks and balances through the governance.

Programme stakeholder

The Executive Committee, Programme Board and Advisory Committee

8.5. The central hub team were supported by several governance bodies associated with the Programme, including an Executive Committee, Programme Board and Advisory Committee. Following feedback from the funding councils during the early stages of the Programme, the Programme's governance and management structures were simplified. Figure 1 below shows the governance structure at a high level, as stated in the Programme hub's first sixth-monthly report to the funding council.

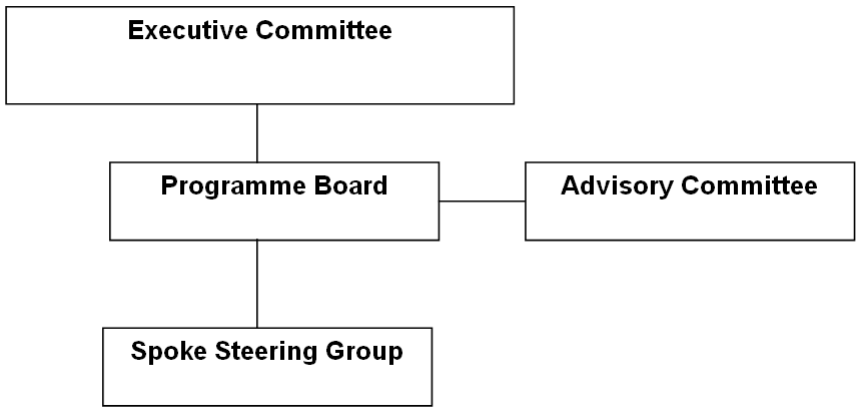

Figure 1: Programme governance and management structure[23]

[23] National HE STEM Programme, First Six Monthly Report, (April 2010).

8.6. The Programme's Executive Committee had ultimate responsibility for delivery of the Programme, including programme management, financial monitoring, resource utilisation, quality assurance and reporting to HEFCE. It focused on ensuring appropriate policies and procedures were in place for delivery, monitored progress and signed off the six-monthly reports from the Programme to HEFCE and HEFCW. The Executive Committee met quarterly from January 2010 onwards and its membership was made up of:

- The Chair (Pro Vice-Chancellor, University of Birmingham)
- The Programme Director
- A representative from each of HEFCE and HEFCW
- One nominated representative chosen from the six spokes (from October 2010 four to five spoke representatives regularly attended)
- One nominated representative chosen from the four current pilot projects (from June 2010, all four professional bodies attended).[24]

8.7. Attendance and senior representation on the Executive Committee was good for the majority of the Programme, although there were some inconsistencies in attendance from 2011 onwards, leading to concerns from the funding councils that institutional commitment to the Programme was weakening as it neared its completion.

> *I think the Executive Group has, up until relatively recently, worked quite well. It managed to secure the senior representation that it needed up until recently. So, you would see, you know, pro V-Cs, deputy V-Cs from the spoke institutions. We were getting the leads from the professional bodies.*
>
> Programme stakeholder

8.8. In general, stakeholder feedback was positive on the effectiveness of the Executive Committee as a forum where issues could be raised, decisions made and actions agreed. The Executive Committee was felt to have been effective at monitoring Programme finances and expenditure, including monitoring invoicing.

8.9. Beneath the Executive Committee, another group, the Programme Board was responsible to the Executive for the operational aspects of the Programme and coordinating Programme activities. The Programme Board was expected to manage and monitor progress, develop operational plans and provide updates to the Executive Committee, advise on finance, HR and legal issues, broker and establish collaborations, and establish and monitor targets and key milestones for the Programme. The Programme Board met six times in 2009-10, five times in 2010-11, and five times in 2011-12, chaired by the Programme Director and included a membership of the spoke Regional Directors,

[24] National HE STEM Programme, First Six Monthly Report, (April 2010), p. 78.

representatives from the four professional bodies, and representatives from HEFCE and HEFCW.[25]

8.10. The Advisory Committee had its first meeting in December 2010, over a year into the Programme's lifetime, on the insistence of the funding councils, in order to provide a level of external, independent scrutiny to the Programme on top of that provided by the funding councils. It also had a remit to use the expertise and experience of its members to ensure the Programme maintained a high profile in the STEM community and achieved the greatest levels of impact. Membership was made up of senior representatives from across the STEM sectors and disciplines, external to the Programme itself.

8.11. The delay in setting up the Advisory Committee was felt by some stakeholders to have had a negative effect, both by making scrutiny of the Programme more difficult for the Committee's members, and by not maximising the levels of external advocacy available to the Programme in its earlier period.

> *I think the project had been running over a year, if I remember correctly, by the time the Advisory Board was in place, and so by the time people got to know what they were doing, they were well into the Programme, and I think that's possibly one of the problems with them missing some opportunities. They would've benefited from having that guidance and oversight earlier on.*
>
> Programme stakeholder

8.12. Although the Advisory Committee did provide input into the development of the Programme, feedback from stakeholder interviews suggests it was felt that the Advisory Committee could have been used more effectively by the Programme and performed more effectively itself, by more actively challenging the Programme. Meeting minutes also suggest that attendance was less consistent that other Programme committees, with 12 of its 20 members only attending three or fewer meetings, out of the total of five that took place.

> *[I didn't have the] impression they really used the Advisory Board as effectively as they might have done. They got a lot of us together, just a couple of times, and didn't really use us between those occasions.*
>
> Programme stakeholder

Views on the Programme model (hub and spokes)

8.13. The Programme established a hub and spoke model, with the University of Birmingham hub team coordinating national activity alongside six regional spoke institutions to drive forward regional activity. Each regional spoke was expected to engage with universities

[25] National HE STEM Programme, First Six Monthly Report, (April 2010), p. 79.

and other partners within the region, which was hoped to be more effective than a single national partner coordinating all activity. In addition to the regional spokes, the four professional bodies were also key national partners, instigating and coordinating activity nationally. Figure 2 summarises the relationship between the national hub, regional spokes and professional bodies.

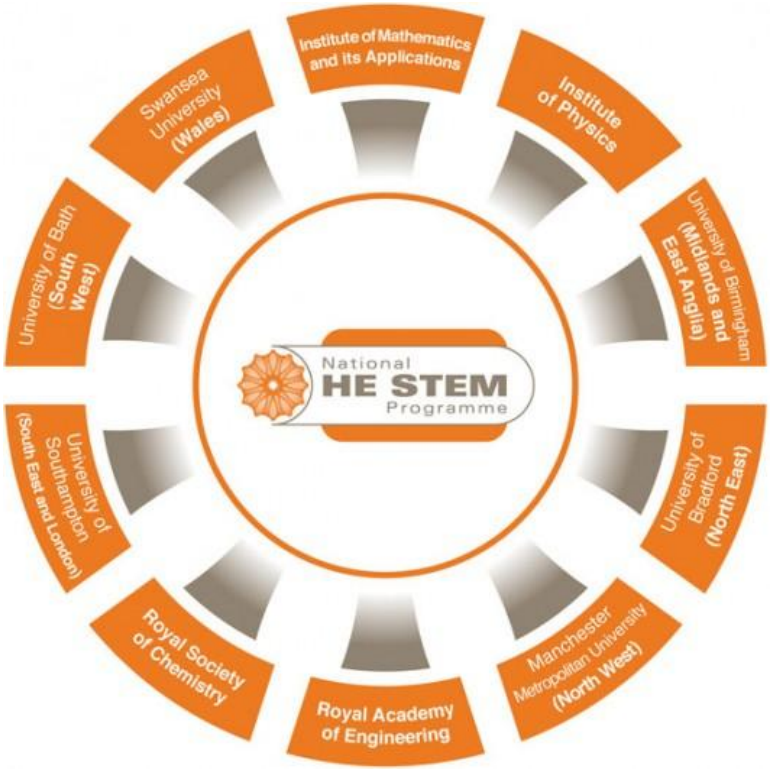

Figure 2: Programme model, National HE STEM Programme

8.14. Programme spokes were based at individual institutions in each Programme region. The standard staffing model for spokes was for a Regional Director, a Regional Officer, a Development Officer and administrative support. The Programme Director was positive about the ways in which the institutional contacts engaged with the structure to ensure more effective performance.

> *Thanks to the regional teams, to the professional body teams, but most importantly to the officers who are working within the institutions, because I think that's a very, very key factor in the successes. The hard work, dedication, and initiative that they've shown.*
>
> Programme stakeholder

8.15. The bulk of the spokes also felt that their management was positive relating to the institutions in their regions, and their engagement with the professional bodies.

> *I think it's gone really well. As a spoke we make sure everyone is informed, so making sure professional bodies are invited to our steering group*

meetings, keeping them up to date, keeping close contact with the people who have, for me, the widening participation responsibilities, and generally keeping a good set of communication going between them.

Regional spoke representative

8.16. Generally there was a sense that the model of the hub and spoke allowed the learning from the Programme to be spread more widely than otherwise would have been possible. The model was deliberately chosen to help smooth the transition from the pilot projects to the national Programme, allowed for regional and national differences to be taken into account and was intended to "cascade" learning and activities to regional partners beyond the spoke institutions. This was intended to facilitate change at individual institutional or departmental level, as well as larger scale national activity. As the Programme developed, the regional spokes were able to take a greater ownership of activities that may have started in other regions or at the professional body pilot stages.

There are different issues that exist in London and the South East. Different employment patterns compared to the North West or the North East. I think what the hub and spoke model has done is give us that flexibility to learn to adapt and to respond, but also to allow some overarching national programmes that, kind of, tie certain things together.

Programme stakeholder

8.17. The hub and spoke model was one way for scale to be reached relatively effectively, through the spoke institutions' engagement with their respective regions. Some project activities lent themselves more naturally to a regional model, while others were more appropriate to manage nationally; the hub and spoke model could accommodate both and regional spokes acted as a focal points to encourage greater activity in regions.

We had a really good relationship with our regional HEIs, so that they did feel comfortable in sending us proposals… We've got about 90 projects in [our] region, and about 60 of those are managed through the spoke. Working with the 60 projects the way we brokered, facilitated, got people, got partnerships together.

Regional spoke representative

8.18. However, the benefits of a model with so many delivery partners (the hub, six spokes and four professional bodies) came at a price of greater staffing and administrative costs than would have been incurred by a purely national infrastructure, or through the funding councils administering funding directly to projects. Funding staff at each Programme partner meant that £6.7m (33%) of the Programme's total funding was spent on staff costs, with only £13.1m (64%) spent on project activities.[26] The Programme's staff levels were

[26] National HE STEM Programme, Financial Report, (April 2012).

set out in the bid and the Programme funding was agreed on this basis. Programme staff at all levels undoubtedly also contributed to the successful project outcomes, but this staff spending is by its nature temporary and unsustainable. Arguably, a streamlined programme model, with less direct expenditure on staff costs, perhaps administered directly by the funding councils or through existing infrastructure, might have left more funding for direct project delivery, but the nature, quality and sustainability of the delivery may not have been as high as the Programme actually achieved.

8.19. Another limitation of the hub and spoke model was that, by selecting particular institutions for hub and spokes in each region, the Programme risked alienating institutions that were not selected. The funding councils and the University of Birmingham set out to ensure that the spoke institutions reflected the diversity of HEIs in England and Wales, with a mixture of research intensive and teaching led institutions, which led to some disagreements over which institutions should be selected. It was also suggested by some professional bodies, that the Programme management and leadership should have resided with them, thus making use of their experience in delivering the pilot projects. Although through the course of the Programme it appears such barriers were overcome, tensions between HEIs in the early part of the Programme, as well as with professional bodies, were mentioned in several interviews. In the event, the funding councils were keen that the Programme should be "sector led" by HEIs. Again, perhaps a simpler programme model, which was administered directly by the funding councils, or by a third party not attached to any single university, might have avoided some of these political tensions between institutions in the early stages of the Programme.

Criticism of unequal regions

8.20. While there was a deliberate move to include a range of institutional types as spokes, the rationale for the choice of region areas themselves seems less clear. With the structure put forward it was necessary to break England and Wales into seven regions, although this later became six as the East of England region was subsumed into the Midlands (see Figure 3 below). Although the same amount of funding was initially allocated to each of the six regions, the number of HEIs within the regions was highly variable. By having five English regions, rather than the standard nine Government Office Regions, the distribution of HEIs and STEM students was highly uneven across Programme regions.

Figure 3: Geographical regions covered by the spokes[27]

8.21. The distribution of regions therefore meant that the level of coordination needed to manage larger regions was greater than for smaller regions, while using the same amount of funding. This was a source of consternation for several regions, particular the larger ones, as well as confusion for other partners. In general larger spokes, such as the South East, were particularly critical of the Programme's structure.

> *It was very unequal. There was a very big burden on the number of institutions, the number of departments, the number of staff STEM departments requiring support being actually quite a bit higher than other parts of the country. I think that this probably had a tougher job than some of the other spokes.*
>
> Regional spoke representative

[27] National HE STEM Programme, First Six Monthly Report, (April 2010), p.6

8.22. Table 21 below shows the breakdown of expenditure between the hub, the professional bodies and the regional spokes, highlighting the variation in expenditure across the regional spokes, despite each originally working from the same budget. Strikingly, regions with fewer institutions, such as the South West and Wales, had higher expenditure than the regions with the most institutions, such as the South East and the Midlands.

Programme partner	Amount of expenditure (staff, project activity and other, reprofiled budget allocations[28])	Approx. number of HEIs with STEM provision
Hub	£3,654,028.80	n/a
RAEng	£1,788,171.00	n/a
IMA	£1,706,350.00	n/a
IOP	£1,840,530.00	n/a
RSC	£1,335,045.00	n/a
Wales spoke	£1,754,501.00	11
South West spoke	£2,009,779.93	7
South East spoke	£1,656,323.00	35
Midlands and East Anglia spoke	£1,488,784.00	17
North West spoke	£1,671,900.00	9
North East spoke	£1,814,275.00	13
TOTAL	£20,719,687.73	n/a

Table 21: Expenditure across the National HE STEM Programme, by Programme body (as reprofiled in the Programme's final year of operation)

8.23. Despite the advantages of having tiers of national, regional and professional body governance, several spokes and professional bodies also acknowledged that the hub and spoke model was rather complex and created challenges for management and relationships. Most felt that on balance, the complexity was a price worth paying for achieving wider involvement, but that relationships between the organisations were inherently complex.

> *I think it's been good to get all those bodies together, but it does make for quite complex organisation. The relationships aren't always clear. I think it's an inherently complex structure, but I certainly think we needed professional bodies, and we needed regional involvement. I think it's too big a problem just to have one central group, so I think in order to get the reach, you had to have some level of regional activity.*
>
> Regional spoke representative

[28] National HE STEM Programme, Financial Report, (April 2012).

This arrangement where we have two clients, working with one lead university, leading with six spokes, working with four learned societies – that is a very complicated communication structure. The danger of having a very complicated structure is that too much of your effort goes into internal communication.

Professional body representative

8.24. The complex Programme structure was also reflected in the funding for activities, with the arrangements leading to multiple funding calls, from the national hub, spokes and professional bodies. This could mean a given HEI might be bidding for project funds from its regional spoke institution, the national hub and up to four professional bodies. Regional spokes supported their regional HEIs to bid for national funds, despite having no control over the national funding call process. Although the different levels of funding calls provided more opportunities for institutions to engage with the Programme, feedback from spoke institutions was that the different levels of funding calls were overcomplicated and potentially confusing for institutions wishing to participate.

As spoke Director, I found numerous funding calls quite demanding on my time, because, as I say, we would get our regional HEIs needing further clarification. …In retrospect, looking at it, I would say they were overly complicated.

Regional spoke representative

8.25. It is also worth noting that there was evidently some level of frustration on the part of spokes and professional bodies with the processes involved in the Programme model. In respect of the regional funding calls, at least three regions felt that they wanted greater autonomy from the hub to select and evaluate bids for funding from their regional HEIs. In some cases regions would approve bids for funding, which would be rejected by the central hub. From a wider perspective, this could be viewed as positive as it demonstrates the tiers of governance acting as checks on each other. However, the spokes felt the funding process was ultimately inefficient.

I felt that it would have been more efficient had the spokes had more autonomy over how we identified our priorities and had the funding to support the delivery on those priorities.

Regional spoke representative

8.26. Similar views were voiced by professional bodies. Particularly in the early part of the Programme, the professional bodies felt that “the administration and bureaucracy that came from the hub was not helping us to move forward.” From the perspective of the professional bodies there were too many and too frequent changes to the funding criteria across the different funding calls.

They give people very steep learning curves so that they bid for one thing, they learnt one set of rules. They [bid for] something else, they've got different rules and that creates an atmosphere of frustration. You're going to get much more of a higher rate of failures on bids because they're struggling with the rules...Our view is that the whole Programme could have been a lot simpler in a strategic view and in its delivery.

Professional body representative

8.27. Requests from the hub for information were initially seen to be both too frequent and too demanding. The professional bodies at times felt overwhelmed by administration, caused by changes or duplication in requests. Several interviewees brought up examples of frustrations with interactions across the Programme structure or difficulties of communication between hub and partners. Feedback from both spokes and professional bodies indicates that the complexity and difficulties with funding calls in particular jeopardised the relationship between the Programme and those bidding for funding.

8.28. These challenges of communication derived in part from working with many different organisations and individuals on projects that were highly dispersed across each region.

Communication has been a real challenge. We do get so many e-mails and newsletters from the hub – but we get very little time to take that information on board.

Regional spoke representative

8.29. At an operational level, one spoke institution said that there had been challenges due to a lack of shared information on the projects across the Programme, which meant that it was difficult to avoid duplication.

Avoiding duplication of effort and project activity never really happened in reality. We never had a single, clear database of projects going on held at the hub. The hub became obsessed with strategic objectives and strategic mapping activity which was not terribly useful in real terms.

Regional spoke representative

8.30. Part of the feedback from Programme partners on the challenges of communication and the complexity of the Programme relates to the clarity of information as it was presented in the Programme's strategic documents, some of which were regarded as being too long and inaccessible. Feedback from partners and stakeholders suggests that there were too many strategic documents and these had a tendency to go into operational detail, rather than maintaining a high-level view. Part of the challenge here relates back to the broad scope of the Programme's original aims and objectives discussed in Section 4, as well as a tension between ensuring appropriate information flow is balanced with accessibility.

8.31. Although the hub and spoke model was challenging, particularly in its first year, the situation was felt to have improved as working relationships and processes became established. Indeed, although challenges with funding call complexity was an important source of frustration for Programme partners, project leads themselves did not identify this as a negative point when consulted through the online survey (see Table 22). Survey respondents rated the overall effectiveness of the bidding process, with the majority (70%) rating this aspect as highly effective, offering a score of 5, 6 or 7 out of 7. Conversely, 10.9% gave low scores for this aspect.

	Mean (out of 7)	Low effectiveness scores (1-3)	Neutral score (4)	High effectiveness scores (5-7)
	5.41	10.9%	7.7%	70.0%

Table 22: How effective was the bidding process for obtaining funding towards your project or projects? Base=247

8.32. Although still present to some degree even after the first year, difficulties in communication and engagement did not present insurmountable barriers for the Programme and it was able to commission the range of activity discussed in the earlier sections of this report. Such problems were regarded as normal for a Programme of this scale, and most partners were able to fulfil their roles effectively. Overall then, the hub and spoke model was seen as effective at engaging institutions at a regional level, but this came with many associated challenges that potentially could have been avoided with a more streamlined Programme model.

Programme timescales

8.33. We received feedback from spokes and professional bodies that the timescales of the Programme were challenging for a programme of this scale and ambition. As had been found on similar SDF funding initiatives, the first year of the three-year activity is often difficult to make successful because of underestimation of set up and partner/staff recruitment timescales. Delays at the early stages of the Programme were a running theme in discussions with stakeholders, spokes and professional bodies. The slow transition from the pilot projects to the national Programme was particularly difficult for the professional bodies, as they lost some continuity in terms of staffing and sector engagement. These issues strained relationships with professional bodies during the start-up period. Delays in appointing staff also affected the capacity of hub and spoke activity in the first year of operation, partly because of the short time period between the funding council's confirmation of funding in June 2009, and the start of the Programme in August 2009. Issues in relation to timescale are certainly understandable, considering that this was a multi-partner, large scale programme, forging collaborative relationships between organisations that had not previously worked together.

8.34. There were some difficulties with the initial recruitment and establishing of the hub and spoke model, and the final spoke institution in the South East was appointed in autumn 2009, some months after the others. Even after the spokes had been agreed, there were delays in establishing contracts and appointing new staff members.

I think it struggled to get moving quickly enough. I think there were delays at the start. They were understandable delays because they were having real problems with contracting with the spokes. There was a lot of time negotiating contracts, etc.

Programme stakeholder

8.35. Another challenge during the early phase of activity was that the hub was not fully staffed and running before the spokes. This was criticised by one region because it meant the regions had to start developing solutions to operational issues independently of each other, without a national lead. This region, as well as one professional body, suggested that there should have been a set up period of, say, six months for the hub to become staffed and develop processes, before the spokes became operational.

8.36. All the spoke institutions noted that part of the first year of operation was lost in set-up time, and the final year was also taken up with activities associated with finishing the project, effectively leaving around two full years for delivery. This was a constraint on both delivery and on learning from the range of activities that were taking place across the Programme. One spoke suggested that any future similar programmes should be five years in duration, rather than three. Given the set up challenges, another spoke felt that the funding councils should have relaxed or extended the final Programme deadline beyond July 2012.

The biggest challenge has been timescale. As a three-year project we were so slow in appointing key staff and did not get fully staffed until we were a year into the project. We effectively were left delivering a three-year project in two years.

Regional spoke representative

8.37. Given the scale of the Programme's aims of changing institutional practice and culture, there were arguments made that a longer-term Programme might have been more effective, or alternatively setting aside a dedicated set-up period for making preparations and appointments before delivery needs to begin.

I think the three years has been fine, but you really are, with a lot of things, only just getting things off the ground within a three year cycle. So, putting on a new degree, radically overhauling the way a particular degree is taught, graduating a cohort of students, that's on a longer cycle than the funding.

Programme stakeholder

Oversight of the funding councils

8.38. The Programme was managed through the Widening Participation Team at HEFCE (later the Student Opportunity Team). There has been continuity within the HEFCE management structure with at least one senior member of staff having been involved in the management

of the Programme since the pilot projects. Feedback from interviews has been broadly positive on the role of both the English and Welsh funding councils in supporting, overseeing and engaging with the Programme.

8.39. The funding councils took a comparatively active approach to overseeing the Programme, in comparison to other similar SDF-funded initiatives, reflecting the Programme's size and strategic importance, as well as the risk to the funding councils should the Programme have failed. The active scrutiny of the funding councils was also necessary because of a failure of the formative evaluation due to the consultants' insolvency. The formative evaluation has been intended to provide ongoing feedback as the Programme developed, as well as advice and suggestions to improve the overall evaluation strategy of the Programme. The failure of this process meant that the overall evaluation plan for the Programme needed to be revised away from external consultants providing evaluation, and consequently both the funding councils and the hub team needed to spend more of their time on evaluative activities and were not receiving external updates on progress as had originally been intended. The councils noted that having robust evaluation mechanisms in place from the start of a programme is an important lesson of this Programme. This active approach on the part of the funding councils involved regular communication with the hub, attendance at Executive Committee and Programme Board meetings, and scrutiny of approach and financial decisions, with HEFCE's assurance consultants working with accountants at the University of Birmingham.

> *The funding councils have certainly supported the Programme…they recognise this is very, very strategically pointed to them.*
>
> Programme stakeholder

8.40. Where the funding councils identified issues with the Programme, such as a large underspend in the first year, or the lack of an external Advisory Committee, they were active in working with the University of Birmingham to address these.

8.41. The fact that there were two funding bodies, HEFCE and HEFCW, does not appear to have had a negative effect on the clarity of the Programme's governance, with positive comments about the consistency and relationships across the Welsh and English funding bodies in relation to Programme management. HEFCW played a particularly active role in engaging with Welsh HEIs to promote the Programme.

> *The funding councils have worked well together as well. I think that's the other thing to say. England and Wales, we never get mixed messages from them and ...there's a joined up message.*
>
> Programme stakeholder

8.42. Although there were some criticisms that the funding councils should have played a more active role in tackling some of the Programme's strategic challenges, there were also

various positive comments about the nature of the questions and scrutiny that the funding councils showed, in terms of reporting and attendance at meetings.

> *They've been pretty assiduous actually, I must say. They have asked searching questions when I've been at the Executive Committee meetings. Quite rightly so.*
>
> Regional spoke representative

8.43. One mechanism through which the Executive Committee and funding councils were able to monitor progress was through the series of six-monthly reports produced by the Programme. Although these were a useful resource, they tended to take the form of a list of positive actions that the Programme had achieved, which left at least one funding council representative wondering how to take a more overarching assessment of progress.

> *The six-monthly reports became directories of everything that was going on. It wasn't a narrative and…it basically said 'look at all this that's going on here left right and centre' and you were almost washed away with the detail of it. But it was hard to pick your way through that detail to actually come to conclusions on how well the project overall and the individual elements were fairing. With hindsight, we need to have stricter guidelines.*
>
> Programme stakeholder

8.44. The six-monthly reports were also by their nature often retrospective, which led to the same funding council representative suggesting that, as well as stricter guidance on reporting, a monthly monitoring process focusing on budget and expenditure could have been useful. For example, the identification of underspend in the early part of the Programme could have happened sooner had this type of reporting been used. The Programme did move to quarterly reporting of finances in its early stages in response to a request from the funding councils.

8.45. To conclude this section on effectiveness of the Programme's governance and management, challenges in this area do not appear to have impacted negatively on project leads, according to our online survey. In response to a question on the overall effectiveness of the Programme's governance and management, almost two-thirds of respondents gave highly positive scores, only 13.8% gave a score of 3 or lower, with a mean score of 5.28 (see Table 23).

	Mean (out of 7)	Low effectiveness scores (1-3)	Neutral score (4)	High effectiver scores (5
	5.28	13.8%	8.9%	64.2%

Table 23: Overall, how effective do you believe the Programme's governance and management has been? Base 246

8.46. The results from the survey and the comments from the interviews broadly support the view that the perceptions of the Programme management were overall positive, but with some important reservations. Despite a complex structure, there was effective management which focused on delivering the Programme's aims and objectives. There were a number of specific and sometimes strongly held criticisms of aspects of the Programme. These included the delay in getting the Programme up and running, and the overall complexity of the Programme's structure, activities and processes. In particular, it is clear from our fieldwork that the hub and spoke model in particular brought significant challenges of coordination and communication between the ten partners concerned. It is also striking that over one-third of the Programme's funding was spent on staff and other unsustainable costs associated with the hub and spoke model. There is potentially a strong argument that a more streamlined Programme model might have been more effective, avoided some of the manifest challenges and reserved a greater proportion of funding for direct and lasting interventions. This potential lesson from the Programme, with others, is considered in the final section of this report.

9. Conclusions and lessons learned

This final section outlines the overall conclusions of this summative evaluation of the National HE STEM Programme, including discussing lessons learned for any future funded programmes of this type.

9.1. As an investment of £21m over three years, the National HE STEM Programme was one of the largest of the SDF programmes. This summative evaluation set out to assess how effective the Programme had been overall, its impact on policy, process and activity in HEIs, the sustainability of the Programme outcomes, and the effectiveness of its governance and management. Evaluating the Programme has been a complex task, reflecting the huge size and complexity of the Programme itself. Nevertheless, through consulting with Programme partners, stakeholders and project leads, as well as examining Programme documentation, some overall conclusions do present themselves.

9.2. Our findings for effectiveness and impact suggest that the Programme supported an extensive range of effective and impactful activities. The majority of institutions offering HE STEM subjects in England and Wales were involved to at least some degree in Programme-funded activities. Although collaboration between HEIs in an increasingly competitive HE environment has been challenging, there are good examples of the Programme supporting and encouraging collaboration and the Programme also fulfilled its aim of disseminating good practice from the pilot projects and other institutions more widely across the sector. The Programme has supported a wide range of new practice development, encompassing outreach, curriculum development and workforce development. Feedback from project leads suggests these activities have been effective at achieving the Programme's goals. Our findings suggest that the activities have had positive impacts on institutions involved and improved their effectiveness at important aspects of their delivery, although the extent to which more significant institutional culture change has been achieved is unclear. We have also found that many of the activities will be sustainable, in large part thanks to a deliberate articulation of the importance of sustainability from the early stages of the Programme, including in the commissioning of projects.

9.3. Despite these successes, in several respects the Programme has faced challenges to its effectiveness by certain aspects of its conception and implementation. The decision that the Programme should be sector-led meant that there were significant challenges appointing the hub, spokes and professional bodies, which were associated with difficult political relationships between organisations at the start of the Programme. The hub and spoke model itself, while useful for engaging at a regional and subject level, came at a high price, both in terms of communication and administration challenges, as well as high staff and infrastructure costs. Even within this model, the tendency of the Programme to fragment funding into numerous and diverse projects had the benefit of allowing local,

smaller scale change, but meant that transformational sector-wide impacts may be lower than might have been the case if resources had been concentrated on fewer, higher value collaborative projects. Finally, the complexity of Programme structure, funding calls and project delivery has meant it has been very difficult for Programme partners and governance bodies to keep a strategic overview even of Programme activities, let alone their impact and effectiveness.

9.4. Overall, the conclusion of this evaluation is that the National HE STEM Programme was an effective and valuable contribution to the challenges facing the supply and diversity of STEM graduates in England and Wales, despite the challenges it faced relating to scope and complexity. With hindsight, the effectiveness and impact of the Programme might arguably have been increased by undertaking a more streamlined Programme model. However, the reasons for having a Programme model that was resourced at the national, regional and subject levels were valid and understandable and remain so. In light of what we now know about the challenges of implementing this model, some different approaches might be taken, should a similar programme be set up in the future. To conclude the report, we reflect on some key lessons learned from this summative evaluation.

> Most of the Programme's success measures were qualitative in nature, making it difficult to quantitatively assess achievements and draw comparisons across projects. One lesson for future Programmes is to have a mix of both quantitative and qualitative outcomes, allowing measurable progress against hard targets, while at the same time allowing flexibility to achieve less easily measurable, but important, goals.

> The large number of small projects did have positive impacts on institutional practice and allowed impact at local levels, especially for institutions that led a large number of small projects. Small projects are also useful for transferring practice that has already been developed, or linking to larger national agendas within individual institutions. However, for institutions involved in a small number of small projects only, the extent of impact on more fundamental institutional change is much more limited. Indeed, even with much larger projects, institutional culture change is very difficult to achieve. A large number of small projects also creates challenges for the coherence of a programme overall, if these projects are different in nature from each other. Any future funded programmes should consider setting limits on the amount of funding that can be spent on smaller projects, or ensuring that smaller projects complement or form part of wider agendas of activity in a straightforward way.

> The range and diversity of activity funded under the Programme can be seen as positive, as it showed flexibility to support different concerns of different institutions. However, this flexibility and diversity made the range of Programme activities extremely complex and somewhat difficult to compare and track outcomes. By spreading resources across so many different activity strands, the totality of the impact is more dispersed and difficult to assess. Future programmes should consider setting clearer frameworks of activity within which projects take place, using common indicators of outputs and outcomes to enable greater comparability and coherence.

> By identifying sustainability of Programme outcomes as a key priority from the outset, the Programme encouraged activities to articulate strategies for sustainability from even

before they were commissioned. This approach seems to have worked well and many of the Programme's achievements will be sustained, at least in the immediate future. Any future programmes should take similar approaches to sustainability, such that it forms an integral part of the planning and commissioning process.

> The failure of the formative evaluation, while not the fault of the Programme, had the effect of reducing the external scrutiny and questioning of the Programme's approach, as well as reducing the amount of information available to Programme's governors. Involving independent evaluators from the early stages of a programme is an important lesson to take for future investments. In general it may be more appropriate for the evaluators to be commissioned by the funding councils, rather than the Programme itself, although both stakeholders should be involved in the process.

> An understandable desire on the part of the funding councils for the Programme to be sector-led lay behind the model of the Programme being led by a single institution, in partnership with spokes and professional bodies. However, this model brought challenges in relation to communication, coordination and political tensions between institutions, notwithstanding the clear commitment of the lead and partner institutions. While being sector led may have advantages for any future programmes, it will be important to consider the best way of achieving an effective programme model. Other possibilities could be direct administration by the funding councils, such as the approach taken by the Transforming Workforce Development Programme, the creation of new organisations to lead activity, or the use of existing sector infrastructure, such as the HEA or existing subject networks.

> The Programme hub and spoke model was useful for embedding Programme activities within regions, but by resourcing several layers of staff, this meant that the Programme's staff costs were high. The unequal distribution of STEM HEIs across region was not matched by adapting the proportions of funding available, effectively meaning that HEIs in crowded regions such as the South East had access to less resource than those in the South West or Wales. The complexity of the bidding process also meant that there was potentially duplication across national and regional partners in terms of staff time to review and coordinate funding calls. If a regional infrastructure is considered for future programmes, it should be more streamlined to reduce expenditure on staff to a minimum and funding should be distributed in proportion to the number of relevant HEIs in a region.

> The timescale of the Programme was challenging and it needed to become operational relatively quickly after receiving confirmation it was to receive funding. This rapid process meant that appointing spoke institutions and staff within them caused some delays which took up time allocated to delivery. Where possible future programmes should consider setting dedicated lead-in or set-up periods to allow for preparations and appointments to be made in advance of the delivery period.

10. List of abbreviations

CFOF	Chemistry for Our Future
CPD	continuing professional development
DLHE	Destinations of Leavers of Higher Education (survey)
FE	further education
GCSE	General Certificate of Secondary Education
HE	higher education
HEA	Higher Education Academy
HEFCE	Higher Education Funding Council for England
HEFCW	Higher Education Funding Council for Wales
HEI(s)	higher education institution(s)
IMA	Institute of Mathematics and its Applications
IOP	Institute of Physics
LEP	London Engineering project
OFFA	Office for Fair Access
PhD	Doctor(ate) of Philosophy
PTA	Practice Transfer Adopters
PTP	Practice Transfer Partnerships
RAEng	Royal Academy of Engineering
RSC	Royal Society of Chemistry
SBIW	Subjects of Broader Importance to Wales
SDF	Strategic Development Fund
SEPNet	South East Physics Network
SET	science, engineering and technology
SIAS	Spectroscopy in a Suitcase
SIVS	strategically important and vulnerable subjects
STEM	science, technology, engineering and mathematics
STEMNET	Science, Technology, Engineering and Mathematics Network
UWE	University of the West of England
WISE	Women In Science and Engineering