



**Evidence for
Excellence in
Education**

Final Report

Consultation on Science, Technology, Engineering and Mathematics (STEM) for the Education and Training Foundation

**National Foundation for Educational
Research (NFER)**



Consultation on Science, Technology, Engineering and Mathematics (STEM) for the Education and Training Foundation

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Executive summary

Introduction

The Education and Training Foundation was established on 1st August 2013, with an overarching remit to improve professionalism and standards in the further education and skills sector in England. It was set up during a period of extensive change relating to the funding, structure, content, assessment and accountability of post-16 provision.

The STEM consultation

The National Foundation for Educational Research (NFER) was commissioned by the Education and Training Foundation to undertake a consultation on science, technology, engineering and mathematics (STEM) between January and March 2014. The aim of the consultation was to gain an understanding of the challenges facing the further education and skills sector and what support the Education and Training Foundation should provide.

Thirty-one representatives from 27 organisations were interviewed by telephone and this included consultees from the Department for Business, Innovation and Skills (BIS) and other government bodies, Sector Skills Councils, sector representative bodies (including the Association of Colleges (AoC) and the Association of Employment and Learning Providers (AELP)), colleges, employment and learning providers and other interested bodies (such as the Royal Academy of Engineering (RAEng) and Gatsby). In addition, 105 representatives of colleges and employment and learning providers and other bodies, such as Sector Skills Councils, completed an online consultation document.

NFER staff also attended two conferences. This included a conference convened by Myscience which is currently delivering a STEM Support Programme for the Education and Training Foundation, and an Apprenticeship Debate facilitated by the AELP. Additionally, over 50 policy documents were reviewed, and an Expert Panel was convened to discuss the findings and what should be the next steps for the Education and Training Foundation.

Key findings

Challenges and issues being faced in the delivery of STEM provision

Colleges and employment and learning providers reported that they were facing a range of challenges in the delivery of STEM provision. These included:

- **decreases in funding over recent years and the associated lack of staff time**, for example to engage in continuing professional development (CPD)
- **difficulties in engaging with employers** in terms of the time demand and limited payback
- **reduced demand for STEM vocational courses and Apprenticeships as a result of the lack of quality and impartiality of careers information, advice and guidance (IAG)** being provided by schools with students being steered down the A-level route



- **changes to A-levels and vocational courses** including the heavy factual content and devaluing of practical work within A-levels and the end-of-course synoptic¹ assessment within academic and vocational courses
- **the reform of Apprenticeships** including the lack of small and medium enterprise (SME) involvement in developing the new standards, in addition to concerns about funding being directed through employers and the synoptic assessment
- **the variable mathematical skills and practical abilities of students** coming from schools - even where students had achieved GCSE grade C in mathematics their understanding of algebra was often poor and practical abilities varied and were, in many cases, limited
- **difficulties in linking with secondary schools** to raise awareness of the STEM study opportunities available to young people in post-16 provision.

Challenges and issues being faced relating to the capacity of the STEM education and training workforce

Consultees reported three key issues that they were facing in relation to their workforce:

- **difficulties related to the recruitment and retention of technically skilled staff** including those with engineering, manufacturing, ICT and physics expertise, technicians and science assessors and, more recently, suitably qualified mathematics teachers
- **lack of quality and availability of STEM-related CPD** and a focus on more process-orientated CPD
- **updating the knowledge and skills of staff** - it was an ongoing challenge for staff to keep their knowledge and skills up-to-date due to lack of time and difficulties in engaging employers – particularly SMEs. Staff found it difficult keeping up-to-date with the fast pace of change within industry and with new and emerging technologies. There were also limited opportunities for staff to develop their pedagogical expertise and to share learning, effective practice and resources.

Effective practice in tackling challenges

Consultees gave several examples of effective practice relating to employer engagement, STEM-related CPD, supporting 'lone' teachers of a subject, recruitment of staff and working with schools.

There were a number of **examples of 'two-way' relationships with employers** in which colleges and providers had trained employers' staff or provided SMEs with meeting space and access to equipment in exchange for support to shape the curriculum or the provision of placements or loaning of equipment.

Consultees also gave examples of **effective CPD provision or effective CPD strategies** that had been used. In particular, they had high regard for the Learning and Skills Improvement Service (LSIS) STEM Programme and Excellence Gateway and for the New Engineering Foundation industrial fellowship scheme. They had also found the current

¹ Synoptic assessment assesses the knowledge, understanding and skills developed across the whole course which differs from modular assessment which assesses a particular element of the course.

Education and Training Foundation STEM Support Programme networking and action research elements useful.

In terms of CPD strategies that institutions and organisations had instigated, these included: timetabled weekly CPD slots; pairing of junior with senior staff; peer mentoring; industrial placements; industry experts training staff in colleges and providers; loaning equipment from employers; and making use of university laboratory space.

Consultees also gave examples of: **supporting 'lone' subject teachers** from a number of colleges through the development of a 'virtual department'; staff from industry lecturing for blocks of days agreed with their employer; and STEM careers awareness raising in schools.

What should be the priorities of the Education and Training Foundation?

Consultees recommended a range of shorter-term and longer-term priorities for the Education and Training Foundation in relation to STEM and the most commonly suggested proposals are detailed below. In developing its future STEM Support Programme, it will be important for the Education and Training Foundation to set out a definition of what it means by 'STEM'. In addition, it should collaborate with key partners also involved in providing STEM-related support to the sector. This could include setting up a steering group to support the development and review of its STEM Support Programme.

Short-term priorities (in the next 12 months)

In the shorter-term, the Education and Training Foundation should consider undertaking the activities detailed below.

Support the recruitment and retention of STEM staff

This could, for example, be achieved through national awareness raising and promotion of the careers available within the sector and providing accurate information as to what the jobs involve. There should be a particular focus on hard to fill teaching/training roles in engineering, manufacturing, ICT, physics and mathematics as well as on technicians and science assessors.

Provide STEM-related CPD and opportunities for sharing effective practice

This should include:

- the delivery of STEM-related CPD which supports pedagogical development as well as the acquisition or updating of industrial and technological knowledge
- CPD targeted at STEM leaders and managers to support high-quality leadership and teaching/training as well as providing the opportunity to raise awareness of the importance and benefits of STEM-related CPD
- putting in place mechanisms to facilitate the sharing of learning, effective practice and resources amongst STEM staff.

The Education and Training Foundation may want to consider developing a group of STEM experts or STEM assured institutions to facilitate the delivery of CPD and sharing/networking within their region or locality.



In devising its programme of activities, the Education and Training Foundation should work together with partners who are also involved in the delivery of CPD to the sector.

Gather and disseminate examples of transferable effective practice relating to STEM

This should include examples of transferable effective practice relating to a wide range of areas including:

- the teaching, learning and assessment of STEM subjects
- supporting 'lone' subject teachers
- high-quality training provision (e.g. training provider networks of excellence)
- new models of teaching mathematics at Level 2 leading to continued study
- delivering Level 1 provision to young people who have previously disengaged from education including positive examples of progression
- collaboration and partnerships with employers, particularly SMEs
- Apprenticeship provision
- embedding the development of employability skills in STEM provision
- addressing equality, diversity and inclusion and ensuring representation from under-represented groups
- outreach with schools and supporting transition and careers awareness raising.

Support greater involvement from industry

The Education and Training Foundation should help the sector to develop effective two-way relationships (the 'two way street') with STEM employers. This could include opening up opportunities for work shadowing, industrial visits and placements/secondments, staff exchanges and knowledge transfer. In addition, it could consider supporting the development of a small number of sector partnerships with employers and universities tasked with developing and evaluating models of effective practice.

Robustly evaluate the impacts of the Education and Training Foundation's STEM CPD provision

The Education and Training Foundation will need to assess and share the impacts of the current STEM Support Programme and robustly evaluate future provision so that data on impacts on staff, on the quality of teaching and learning, and on student progress, attainment and engagement can be widely shared. The evaluation should be built in from the beginning of any future programme of STEM support.

Longer-term priorities (over the next 3 years)

Raise awareness of the benefits of STEM-related CPD

Using data collected from the evaluation of its current and future STEM Support Programme activity, the Education and Training Foundation should raise awareness of the benefits of STEM-related CPD amongst staff within the sector, particularly amongst senior leaders

making decisions about what CPD their staff engage in. This will support further engagement in STEM-related CPD.

Explore existing STEM provision and identify gaps

Working with partners, it would be useful for the Education and Training Foundation to map what STEM provision is being delivered, and by whom, within the context of the needs of the labour market. This will identify gaps in provision and expertise which will help to inform its future activities.

Map STEM CPD provision targeted at the sector

In the longer-term, it would be useful for the Education and Training Foundation to put together a 'Directory of National STEM-related CPD' for post-16 provision. This could be web based and, at a later stage, include ratings of the quality of provision drawing on evaluation evidence. Again, this should support further engagement in STEM-related CPD.



1 Introduction and background

1.1 The Education and Training Foundation

The Education and Training Foundation was established on 1st August 2013, with an overarching remit to improve professionalism and standards in the further education and skills sectors within England. The Foundation's central responsibility is to ensure learners benefit from the development of a well-qualified, effective and up-to-date workforce supported by good leadership, management and governance.

One of the outcomes of the national consultation on the development of the Foundation undertaken in spring 2013 was that it should 'foster and promote professionalism to support the development of best practice through research, innovation and excellence in teaching, learning and assessment'.

The government White Paper, 'Rigour and Responsiveness in Skills' (DfE and BIS, 2013b), highlighted the important responsibility the Foundation has 'for professionalism of the sector' in order to 'give the profession itself the power to raise teaching quality' leading to the continuous improvement of standards, reputation and learner outcomes.

The Foundation is sector-led and its key priorities are to:

- improve learner experiences and outcomes
- enhance the reputation of the sector
- develop provider good practice
- make the sector an attractive place to join and work
- promote and champion equality and diversity across the sector.

1.2 The Education and Training Foundation's STEM Support Programme

The Education and Training Foundation funded a STEM Support Programme between October 2013 and March 2014 which was delivered by Myscience. Following the end of the Learning and Skills Improvement Service's (LSIS) Post-16 STEM Support Programme, this new STEM Support Programme was intended as a bridging programme prior to the these consultation findings informing the development of a more substantial programme of work.

A total of £850,000 was allocated to the STEM Support Programme which provided over 900 days of focused support and included five key priorities:

- improving STEM teaching and learning
- the provision of careers education, information, advice and guidance
- employability skills, employer engagement and Apprenticeships

- equality and diversity and STEM subjects
- digital media and mobile technologies.

The programme comprised three key elements as described below.

1.2.1 Network-led support

This included 33 local and national collaborative networks which provided:

- opportunities for practitioners from colleges and employment and learning providers to engage in events and activities which developed collaborative solutions to the challenges they faced
- small amounts of funding (£10,000) which were allocated to support action research projects which addressed one or more of the priority areas detailed above
- mechanisms, through collaborative projects, links to Local Enterprise Partnerships (LEPs) and other fora, to understand the needs of employers in the locality/sector and to support the development of student employability and the delivery of careers information, advice and guidance.

More than 350 staff from across the sector were involved in local networks/action research projects.

1.2.2 Learning visits

The aim of the learning visits was to build capacity by efficiently sharing best practice, including learning from the highest performing employment and learning providers and colleges. The visits included both visits from staff and students. Four hundred participants were engaged in the learning visits.

1.2.3 Continuing professional development (CPD)

The programme included guiding the sector to existing, high-quality CPD. However, it also included the delivery of face-to-face and online provision around aspects of the five themes of the programme. Priorities for CPD were identified by the previous LSIS-supported work and included, amongst other areas: assessment; action research; equality, diversity and inclusion; mathematics in context; digital and multi-media; rapid improvement for providers; and classroom management for motor vehicle and construction. Over 800 delegate days of CPD were delivered.

In addition, some investigative work was undertaken related to the development of a programme of mentoring support in the future with recommendations provided to the Education and Training Foundation. This work built on previous effective mentoring programmes such as 'Starting Out' – a mentoring programme targeted at early career teachers in science and mathematics.

1.3 Structure of report

The remainder of the report includes the following sections:

Section 2: About the STEM consultation

Section 3: Policy background

Section 4: Key challenges and issues faced by colleges and employment and learning providers

Section 5: Examples of effective practice in tackling challenges

Section 6: Views on current STEM-related CPD and gaps in provision

Section 7: Recommendations for the future priorities of the Education and Training Foundation.

2 About the STEM consultation

2.1 Aims of the consultation and key questions

The aim of the consultation was to gain an understanding of the current challenges and issues being faced by the sector and views on what support the Education and Training Foundation should provide.

Through an online consultation document, it explored the following key questions with a wide range of key stakeholders and partners:

- views on the current policies impacting on the delivery of STEM provision and on the capacity and capability of the workforce within the sector
- key challenges and issues in the delivery of STEM provision and relating to the capacity and capability of the sector workforce
- effective practice relating to developing the capacity and capability of the sector workforce
- gaps in the provision of STEM-related CPD
- what should be the priorities of the Education and Training Foundation.

Through a number of in-depth interviews, described below, it also explored views on:

- effectiveness of STEM CPD programmes targeted at the sector, including the STEM Support Programme
- examples of effective practice in the delivery of STEM provision.

2.2 Methodology

The consultation took place between January and March 2014 and 142 people took part. It included five key strands:

- an online consultation
- telephone and face-to-face interviews
- attendance at two conferences
- an Expert Panel meeting
- document review.

In total, representatives from the following number of colleges and employment and learning providers were consulted:

- 53 further education colleges (21 per cent of the population²)
- 17 sixth form colleges (15 per cent of the population³)

² There are 252 further education colleges in England.

³ There are 110 sixth form colleges/sixth form centres in England.

- 23 STEM employment and learning providers.

The total population of STEM employment and learning providers is unknown.

Representatives from a range of other organisations were also involved in the consultation including: government/government quangos, Sector Skills Councils, business, sector representative bodies, CPD providers and other organisations involved in the STEM arena. More details are provided below.

The following sections describe the different strands of the consultation. A full list of the organisations involved can be found in Appendix 1.

2.2.1 Online consultation

Staff within further education and sixth form colleges and employment and learning providers, as well as a number of other key stakeholders such as representatives from Sector Skills Councils, were invited to take part in an online consultation. The consultation was widely publicised by the Association of Employment and Learning Providers (AELP) via its newsletter, LinkedIn and twitter and by the Association of Colleges (AoC) who sent out an e-shot to Associate Principals responsible for the curriculum. NFER also contacted colleges and employment and learning providers directly using contact lists from SEMTA and Myscience as well as using data from its own Register of Schools and Colleges and searches of STEM providers.

The online consultation achieved a good response, with **105 respondents from 92 organisations completing the online proforma**. This included representatives from:

- 46 further education colleges
- 17 sixth form colleges
- 20 employment and learning providers
- 9 organisations which classed themselves as ‘other’.

A small number of organisations put themselves into more than one of the above categories.

Of the organisations classing themselves as ‘other’, this included: a company, a business and education consultancy (formerly a training provider), a local authority, a Science Learning Centre, Sector Skills Councils, a National Skills Academy and organisations which provided training amongst other activities (for example an electronics manufacturing consultancy).

2.2.2 Telephone and face-to-face interviews

In-depth telephone interviews were undertaken with an additional 31 consultees from 27 organisations. This included consultees from:

- **Government/government quangos** including: Department for Business, Innovation and Skills (consultees responsible for further education (FE) and

Apprenticeships), Ofsted, the National Apprenticeship Service, the UK Commission for Employment and Skills

- **Sector Skills Councils and employers** including: SEMTA, Cogent, E-skills, BP, Ford, Begbroke Science Park, Doosan Babcock Ltd, Sevcon Ltd.
- **sector representative bodies** including: the Association of Colleges (AoC), the Association of Employment and Learning Providers (AELP) and the Institute for Learning (IfL)
- **colleges** including City and Islington College, TyneMet College, 157 Group (of colleges), Worcester Technical College
- **employment and learning providers** including: Raytheon, HETA, TDR Training
- **other interested organisations within the STEM arena** including: Myscience, Gatsby, Royal Academy of Engineering, New Engineering Foundation (NEF) and Career Academies UK.

2.2.3 Attendance at conferences

NFER staff also attended two conferences relevant to the consultation. This included the Myscience STEM Network Conference which brought together representatives from colleges, employment and learning providers and other partners involved in running networks as part of the Education and Training Foundation's STEM Support Programme. The conference was attended by 25 representatives including representatives from: 16 colleges, four employment and learning providers, three businesses, one Sector Skills Council and the AoC. During the conference, sessions were facilitated for participants to discuss the broader challenges and workforce challenges that the sector was facing in relation to STEM and the findings were incorporated within the consultation. Participants were encouraged to take part in the consultation and all but three did.

An NFER researcher also attended the AELP Apprenticeship Debate which provided an up-to-date understanding of current developments and views on the reform programme.

2.2.4 Policy review

In excess of 50 policy documents were reviewed to gain an in-depth understanding of the policy context to the study and the changing landscape for colleges and employment and learning providers.

2.2.5 Expert Panel meeting

Towards the end of consultation period, **an Expert Panel meeting was convened which was attended by ten representatives** from: City and Islington College, TDR Training, Sevcon Ltd., the AELP, Gatsby, the Royal Academy of Engineering, Myscience and the Education and Training Foundation. Representatives from SEMTA and Raytheon also intended to attend but train cancellations meant that they

were unable to. The meeting included a discussion of the findings of the consultation and what should be the next steps for the Education and Training Foundation.

3 Policy background

This section summaries the policy context within which the consultation was undertaken. What is important to note is the extent and pace of change within the post-16 education and training arena and the key focus on increasing rigour, quality, accountability and employer engagement. A more detailed policy background is provided in Appendix 2.

3.1 The demand for STEM skills

This consultation needs to be placed within the national context in relation to the demand for STEM skills. The UK engineering and science industries are a vital element of the overall UK economy, with an approximate turnover of £257bn (CBI, 2010). The exact levels of demand for STEM skills are difficult to assess precisely (GB. Parliament, 2013 and Archer *et al.*, 2013). However, skills shortages in STEM sectors are considered to represent a real threat to the UK's capacity for growth and at least one source estimates that around 82,000 engineers and technicians are needed just to deal with retirements up to 2016 and that 830,000 graduate-level science, engineering and technology professionals will be required by 2020 (GB. Parliament. HoC. Select Committee, 2013). Although the past decade has seen significant improvement in the STEM skills supply, demand has risen and businesses continue to report difficulties in recruiting STEM-skilled staff. As the economy continues to improve, these recruitment difficulties are set to escalate (CBI, 2014).

3.2 Changes to the Apprenticeship framework and funding

Following Richard's Review of Apprenticeships (Richard, 2012), the Apprenticeship programme is being reformed with a key focus on improving quality and employer engagement in the design, delivery and assessment of Apprenticeships.

Work has started on the development of a small number of clear standards for each occupation which are being developed by employers or employer-led coalitions. Alongside working towards the standards, there is a requirement for apprentices to work towards English and mathematics at Level 2 if they have not already achieved GCSEs grades A*-C in these subjects. In addition, skills and competencies will be robustly and independently tested and validated. This will include a final, end-point synoptic test which will assess the full breadth of competencies.

The funding of Apprenticeships has also been over-hauled with proposals for the funding to be routed through employers. The exact process for funding has not yet been agreed and a consultation is ongoing until May 2014. Co-investment is at the heart of the proposals with employers expected to contribute to the cost of the Apprenticeship alongside a government contribution.

The first set of Apprenticeship standards are being developed by eight 'Trailblazers'. These are projects led by employers and professional bodies and they include a

number of STEM sectors: aerospace; automotive; digital industries; electro-technical; energy and utilities; financial services; food and drink manufacturing; and life sciences and industrial sciences. Trailblazer activity will continue and grow during 2014/15 and 2015/16.

3.3 The introduction of Traineeships

Traineeships are a new programme for young people, introduced in August 2013 (DfE and BIS, 2013c). They are targeted at young people aged 16-24 who:

- are not currently in a job and have little work experience
- are 16-19 and are qualified below Level 3 or 19-24 and have not yet achieved a full Level 2
- providers and employers believe have a reasonable chance of being ready for employment or an Apprenticeship within six months of engaging in a Traineeship.

The core content of Traineeships is: work preparation training, English and mathematics and, very importantly, high-quality work experience. They last for a maximum of six months.

3.4 The introduction of Study Programmes for 16-19 year olds and associated changes to funding

In response to the Wolf Review (Wolf, 2011), it was announced that, in September 2013, funding for 16-19 year olds would change to a per student basis and students would be offered 16-19 Study Programmes (DfE, 2012). Study Programmes include vocational qualifications, Traineeships and A-levels and they:

- provide progression to a higher level than students' prior attainment
- include qualifications of sufficient size and rigour to stretch students, which are linked to further progression routes
- require students who have not already achieved a GCSE A*-C grade in mathematics and English to study these, or a stepping stone towards these, qualifications
- allow for meaningful work experience related to the vocational area
- include other activities that develop skills, attitudes and confidence to support progression.

There have also been recent changes to funding and weightings for 16-19 provision (Education Funding Agency, 2013). Changes to the funding for 16-19 Study Programmes mean that funding for 18 year olds will be 17.5 per cent below the funding for 16/17 year olds from September 2014.

In addition, programme weightings for provision targeted at 16-19 year olds have changed. The number of programme weighting bands has reduced from seven to four. They now include: base (1.0), medium (1.2), high (1.3) and specialist (1.6). In relation to academic programmes – such as A-levels - they are all weighted 1.0

regardless of content which means that there is no additional funding to cover the practical element of science A-levels.

Within the STEM field, most vocational areas attract a medium or high weighting (e.g. engineering and manufacturing technologies, engineering, manufacturing technologies, construction, planning and the built environment). However, science and other science and health-related courses are set at the base rate.

3.5 Loans for over-24 year olds studying in further education

Further education loans were first mentioned in the New Challenges, New Chances Further Education and Skills System Reform Plan (BIS, 2011a) and introduced from September 2013 for adults aged 24 or older studying at Level 3 and above.

3.6 Changes to the content and assessment of academic and vocational provision

A number of changes have been introduced to the content and assessment of academic and vocational courses. Central to the changes are the reform of A-levels and AS levels. The proposals include:

- AS levels becoming standalone qualifications and not related to A-levels
- a focus on end of course assessment by exam and a reduction in coursework
- proposals for the grade for practical work to be separate from the main grade.

Phase one subjects include the sciences and computing which will be taught from September 2015. Mathematics is in phase two commencing in September 2016. The Perkins Review of Engineering (Perkins, 2013) called on the Royal Academy of Engineering and the Institute of Physics to engage in consultations over revisions to A-level physics.

In relation to GCSEs:

- a new grading system is being introduced including grades from 1 to 9, with 9 being the highest
- they will be linear with terminal assessment - exams will be the default method of assessment except where they cannot provide a valid assessment.

Mathematics will be reformed for teaching in 2015 and science in September 2016.

In relation to vocational courses, the key change has been the introduction of the synoptic assessment and the requirement for a significant amount of content to be subject to external assessment.

3.7 16-19 performance measures and new Ofsted framework

Alongside the introduction of Study Programmes are new accountability arrangements, including reformed 16-19 performance tables and Ofsted framework.

For 16-19 year olds, there are now two ‘types’ of qualifications, in addition to A-levels. These are ‘Tech Level’ (DfE, 2013b) and ‘Applied General’ (DfE, 2013a) qualifications. Tech Level are Level 3 qualifications for students specialising in a technical occupation or occupational group. Applied General are qualifications providing broad study of a vocational area rather than a single occupation, for example applied science.

For a learner’s Level 3 qualification to be recognised, and included, within the 16-19 performance tables, they need to be studying qualifications in the list of approved Tech Level or Applied General qualifications, or be studying A-levels. This affects learners starting two-year courses in September 2014.

In April 2013, the Secretary of State announced the introduction of the Technical Baccalaureate performance table measure (DfE, 2013f). This will be introduced in September 2014 and will mark the performance of 16-19 year olds who have successfully completed:

- a high-quality Level 3 vocational qualification
- a Level 3 core mathematical qualification, including AS level mathematics
- an extended project which develops skills in extended writing, communication, research and self-discipline and self-motivation.

A new Ofsted framework was introduced from September 2012. It includes a continued focus on weaker providers, with greater attention to observing standards of teaching, learning and assessment. From September 2013, there is an emphasis on assessing the quality and coherence of Study Programmes and progression (Ofsted, 2014).

3.8 Enrolment of 14-16 year olds in further education and sixth form colleges

Following the recommendations of the Wolf Review, from September 2013, colleges were able to recruit 14 and 15 year olds into their institutions (DfE, 2013c). Colleges are required to offer a programme of study that delivers the mandatory requirements of the Key Stage 4 national curriculum alongside a technical vocational qualification. Eight institutions have registered to recruit 14-16 year olds in 2013/14.

3.9 Changes to careers information, advice and guidance and work experience in schools

In 2012, the responsibility for providing careers information, advice and guidance (IAG) was transferred to schools and a statutory duty was placed on schools to secure access to independent careers guidance for pupils aged 14-16. From

September 2013, this included pupils from year 8 (aged 12/13) and aged 16 to 18 in schools and colleges (DfE, 2013d).

Recent studies have suggested that the transfer to schools of the statutory duty for providing careers IAG has resulted in a loss of quality and impartiality of advice. This includes a recent report by Ofsted (2013a) and a report focused on the construction industry (CITB, 2014).

In addition, in 2012, the duty on schools to provide year 11 pupils with two weeks of 'work-related learning' was repealed on the advice of the Wolf Report (2011).

3.10 Raising the Participation Age

Alongside all of the other changes, the Government has raised the participation age (DfE, 2013e). From 2013, this requires young people to stay in education and training until they are 17 years and, from 2015, this will increase to 18 years.

3.11 De-regulation of teacher training for colleges

The Draft Deregulation Bill presented to Parliament in July 2013 (GB. Parliament. HoL and HoC, 2013) revoked the power of the Secretary of State to impose qualification requirements in respect of staff and principals at further education institutions in England. This was in line with Lord Lingfield's recommendations (Independent Review Panel, 2012) which questioned the effectiveness of qualification requirements in improving the standards of teaching. In addition, it is no longer a requirement for staff to complete at least 30 hours of CPD each year and provide an annual record to the Institute for Learning (IfL).

So, in summary, this consultation was undertaken at a time when staff within colleges and employment and learning providers were facing a vast amount of change in relation to the funding, structure, content, assessment and accountability of post-16 provision.

4 Key challenges and issues faced by colleges and employment and learning providers

Consultees were asked about the challenges and issues that their institutions and organisations were facing in the delivery of STEM provision. This included broader challenges as well as challenges related to the capacity and capability of their workforce. This section presents the findings from consultees.

4.1 Broader challenges and issues in the delivery of STEM provision

Before discussing the types of challenges and issues that they were facing, consultees reported that the number and extent of the policy changes being implemented was impacting on their ability to prioritise and plan ahead. As one consultee commented:

Managers have an enormous amount of things to think about and prioritising and planning is an issue.

Several challenges and issues were mentioned repeatedly and by the vast majority of consultees. These included:

- funding and time
- employer engagement
- lack of quality and impartiality of careers information, advice and guidance in schools
- changes to A-levels and vocational courses
- reform of Apprenticeships
- variable mathematics and practical ability of students.

In addition, smaller numbers of consultees reported challenges and issues relating to:

- the decrease in young people's engagement in STEM from primary school
- difficulties in developing relationships with secondary schools.

4.1.1 Funding and time

The majority of consultees from colleges commented on the negative impacts of the **decrease in funding** for post-16 provision over the last few years. In addition, they commented on more recent changes to funding which were making planning and delivery difficult. This included the changes relating to the weighting for courses, loans for the over 24s and the reduction in funding for 18 year olds. The reduction in

funding for 18 year olds was of particular concern for some: 'The cut to the 18 year old funding rate is clearly having an impact on being able to offer higher level STEM provision to people who need to take longer than two years'.

In relation to the weightings set for different courses, consultees referred to '**the failure to take account of the demands of individual subjects when establishing funding rates**'. There were particular concerns in relation to science courses – for example funding for A-level sciences is not weighted and setting up a new course is costly. Consultees emphasised the costs of running STEM courses which are much higher than other courses - including the need for sufficient space, equipment and consumables - and it was felt that the funding allocated was insufficient and employers were reluctant to contribute to the cost. There were often insufficient funds to purchase up-to-date equipment that replicated what students would use in the world of work and inadequate space and laboratory facilities to run courses safely or to meet demand. Staff from colleges in London reported that they could not always meet the demand for places on STEM courses due to lack of space for expansion.

Consultees also voiced their **concerns regarding funding for Apprenticeships and Traineeships**. In relation to Apprenticeships, consultees explained the need for at least 10 starts for an Apprenticeship to be financially viable and that this number would not usually be achieved in the early years of delivery. Significant set up time was required and it was difficult to engage employers in an Apprenticeship programme when it did not yet exist. Comments were also made regarding the risk that good providers would withdraw from offering provision as lack of funding would mean that they would not be able train to the quality they aspired to. It was commented that it was challenging for providers to maintain the standards required by Ofsted since funding reductions were resulting in higher class sizes, difficulties in recruiting sufficiently skilled staff, increases in part-time staff and lack of time to update. A small number of consultees made comments about the Higher Apprenticeship programme which they perceived to be bureaucratic with a complex funding model which meant that very few were up and running.

Only a minority of consultees made mention of Traineeships and these consultees did not perceive them to be particularly successful, as yet. Some providers commented on low awareness and poor take-up. Others reported high drop-out rates which were, in many cases, related to young people not being supported to pay their travel and subsistence costs. As one consultee commented:

I'm struggling to get any bursary funding which is ultimately what I need in order to pay learners' travel costs and food ... it's a huge barrier ... You're asking people to work for a loss, people can't do it.

Consultees were also worried about the new proposals for routing the allocation of Apprenticeship funding through employers rather than employment and learning providers and colleges. They felt that the potential complexity of a new system, and the requirement for an employer contribution, could discourage SMEs from engaging in Apprenticeships. As one consultee commented:

The funding is going to be reduced from what it was meaning that employers will have to mandatorily contribute...it's very hard to get funding out of them now. When they've got to manage the bureaucracy as well, I can just see utter chaos which will mean that the number of apprentices going on the programme will diminish.

In addition, concerns were raised about the possibility that employers might pay providers at the last minute causing cash flow issues. Or, alternatively, they might choose a provider based on cost rather than the quality of provision.

Comments were also made about **'inflexible funding regimes'** with qualifications and Apprenticeship frameworks being perceived as too restrictive and not allowing providers to meet the diverse skills needs of industry in terms of both new recruits and upskilling existing staff. It was felt that a more varied range of both short- and long-term provision was needed to attract recruits and the narrowing of the curriculum was a retrograde step. As one consultee commented:

The courses available to address the skills shortages facing the STEM sector are restrictive and overly reliant on inflexible funding regimes.

Another consultee suggested that colleges should be bolder in developing and accrediting their own courses and providing students with college certificates which would both recognise their achievements and provide them with the motivation to continue to higher levels of study.

Closely linked to funding, **time was seen as a key issue**. It was reported that there was insufficient time in the day for teachers to undertake anything more than the core activities of their role. In some cases, the heavy content of subjects was difficult to cover in the time available. This meant that there was insufficient time for practical activities and to support young people with learning and other difficulties.

As a result of the lack of time available to staff, it was felt that there **was insufficient time to invest in engaging with employers**. Engaging with employers was perceived to be very time intensive, particularly when working with small and medium enterprises (SMEs) which often did not have a human resources or training manager and whose staff time was equally stretched. However, it was stressed that links and partnerships were key in terms of provision meeting businesses' needs and linking it to real-world contexts.

4.1.2 Employer engagement

Other challenges were mentioned in relation to engaging with employers. Some consultees commented that they were experiencing **difficulties in securing work experience placements** from employers and this, again, was often more of a challenge when working with SMEs. One consultee gave an example of contacting 270 STEM employers with only 23 agreeing to provide placements.

Also mentioned as a key issue was the **gap between employers' perceptions of what should be taught and the constraints of the syllabus** for particular qualifications. Several consultees also commented on the difficulties they experienced in engaging employers in curriculum development:

[...] *the employer engagement agenda and the struggles we have as a country to encourage employers more in schools and to support the development of the curriculum.*

However, the converse was expressed by one consultee providing the employer angle who commented that there was sometimes a lack of responsiveness from colleges to employers' requirements for provision.

4.1.3 Lack of quality and impartiality of careers information, advice and guidance in schools

The **lack of quality and impartiality of careers information, advice and guidance (IAG)** provided in schools was a key issue raised by the vast majority of consultees. Of particular concern was the fact that schools now had a statutory responsibility for providing pupils with careers advice which was resulting in poor quality and lack of impartiality of advice in many cases. This lack of quality advice was perceived to impact in two ways – on the demand for vocational courses and training (including Apprenticeships and Traineeships) and on students' knowledge of the wide range of STEM careers open to them. A number of consultees commented on schools not raising students' awareness of the range of STEM vocational and training options and, instead, steering them down the A-level route:

There are huge conflicts of interest where schools have a sixth form. This does not support the provision of impartial IAG. This has a big impact for STEM - the engagement is woeful. They would rather have kids going onto A-level programmes.

[...] there are some schools that don't like us coming in because they want to keep their students ... So we feel they are restricting the choices for the students ... students seem amazed at what is available.

I don't believe the information that school children are getting is adequate – it's not giving them the full picture of what opportunities are available to them ... they're being channelled down an academic route.

The talent is there but they're just misguided at the wrong time.

Consultees also made mention of the lack of understanding of school staff of engineering and the resulting lack of awareness, misconceptions and negative attitudes of students. It was felt that the status of engineering amongst young people remained low and that, due to the fast pace of change and emergence of new job opportunities, perceptions of careers were outdated with a lack of understanding of 'modern feats' of engineering. Similarly, it was felt that young people were not aware of the unique opportunities available within computing and opportunities in this sector which allowed you to work in different workplaces – including 'in your own bedroom'. In addition, it was reported that there was a lack of awareness raising of the importance of mathematics to STEM careers:

Teaching staff do not have an understanding of engineering and do not encourage their learners to consider these roles. They also do not help learners to see the value of maths in future careers.

Linked to the lack of careers advice, it was felt that there was still a lack of parity in the vocational and academic routes with a view that the vocational route was of a lower level persisting:

There is still an issue of parity of esteem of the vocational and Apprenticeship routes with academic routes and something needs to be done.

In particular, it was felt that Apprenticeships were undervalued and there was a lack of awareness raising of this route into employment. There was also an issue regarding young people's particular lack of awareness of science Apprenticeships. As two consultees reported:

I don't think they [school staff] realise the way that Apprenticeships have changed and expanded and moved into lots of different areas.

We don't recruit many apprentices based on school careers advice.

Linked to the perceived lack of parity of the vocational and academic routes, it was felt that schools tended to encourage the 'weaker' students onto vocational courses and Apprenticeships which were not always right for them and which could lead to issues in completion.

However, consultees added that there was a similar lack of understanding amongst employers that they could use the Apprenticeship route to recruit young people into science technician roles.

This lack of careers awareness raising meant that some providers were struggling to recruit young people onto STEM vocational courses and Apprenticeships. It was commented that the Local Enterprise Partnerships were encouraging the Apprenticeship route in engineering but that they could increase their focus on raising awareness of opportunities in science, particularly at technician level.

The lack of careers advice exacerbated the chronic shortages STEM employers were already experiencing. Consultees commented that **students were 'hugely ignorant about the variety of roles and careers within the STEM world'** and how STEM subjects relate to potential careers including both technician and professional opportunities. In addition, young people were unaware of the wage premium attached to many STEM jobs.

There was also concern about the **gender and ethnicity divides and stereotypical views of opportunities**, with examples of staff perpetuating these stereotypes. As one consultee commented:

The perception of engineering as a dirty, male-dominated sector with sexist males persists.

With insufficient females opting to study STEM courses and training - particularly engineering, computing, construction and physics - it was commented that more needed to be done to make these subjects appealing to girls. In many cases, it was felt that this lack of awareness was linked to a lack of clear information on the progression routes from STEM education to work:

There is a lack of awareness of the different routes and a gender imbalance. Young people don't have access to the best information in schools.

It was felt that more case studies were needed to promote STEM career opportunities and to tackle the gender divide and that more attention needed to be focused on parents due to their high level of influence on their children.

Consultees felt that the demise of Young Apprenticeships and many schools' reduced focus on offering vocational courses, such as engineering, was also impacting on young people's lack of awareness of, and preparation for, the STEM vocational opportunities available to them post-16 ('Engineering does not exist in schools'). The fact that work experience was no longer compulsory for Year 11 students was also reducing opportunities for young people to gain an understanding of STEM jobs and the routes in.

4.1.4 Changes to A-levels and vocational courses

A number of consultees commented on the **changes to A-levels** and the tight timescale to plan for, and implement, the new curricular. Computing was felt to be a particular challenge due to the complete overhaul of its content and teachers' lack of preparedness to teach coding, as were science A-levels which were in the first tranche. Of particular concern for consultees was the **heavy factual content of A-level courses**, which meant that theory was often not being taught within a real life context. One consultee gave the example of science and commented that it is often not showcased 'as a living thing with an almost infinite range of current frontiers, which give the theory they [pupils] are learning their purpose'. Another commented that 'too much time in the classroom on the theory can dull your skills over time and you can quickly become detached from the needs of let's face it a very fast moving world'. Insufficient funding was also a factor in the reduction in practical work. Practical lessons were more expensive to deliver than theory lessons and also more difficult to deliver with class sizes increasing due to funding reductions. Larger class sizes also limited opportunities for industrial visits.

It was felt that the changes to A-levels, with a separate mark for practical work proposed, would lead to practical work being devalued which would exacerbate the situation further. One consultee commented that this: 'flies in the face of the need for applied skills' and added that the linear assessment model would not mirror what is required in the workplace. It was commented that there needed to be equal significance afforded to theory and practical work. However, the low weighting combined with the change in assessment would make science a more theoretical subject and therefore less attractive. Linked to this, it was reported that some students already rejected STEM subjects as they perceived them to be too difficult, opting instead for other subjects felt to be easier to achieve. With the changes to A-levels, this trend was likely to continue further.

It was commented that 'getting the curriculum right' was important and that a well designed and relevant curriculum was easier to deliver and to involve employers; in addition, it was more engaging to students with a clear progression route into employment. However, the curriculum that was delivered was not always relevant to

today's employers' needs and could be restricted by funding regimes, time, staff skills and experience. Time, in particular, was required to ensure that the curriculum kept pace with changes in the workplace.

Alongside changes to A-levels, consultees expressed **concerns about the changes to assessment for BTEC courses**, although many supported the move towards more rigour and accountability. The introduction of the end-of-course assessment in BTEC courses was a concern in terms of planning and it was felt that the qualification would be more difficult to achieve for those young people who thrive on continuous assessment. In addition, it was felt that end of course assessment did not mirror the requirements of the workplace:

[...] this kind of obsession that we have with synoptic⁴ assessment and testing simply doesn't mirror the reality in the workplace where people are encouraged to work in teams and there is a focus on innovation and creativity.

Regarding the Technical Baccalaureate, institutions were only just 'getting to grips' with this which also applied to changes to the focus of Ofsted inspections.

4.1.5 Reform of Apprenticeships

There was fairly significant concern regarding the current **Apprenticeship reform programme**. This included:

- the lack of significant SME involvement in the development of the new frameworks:

There is a concern that the reform programme is being driven by large organisations and the new frameworks need to be applicable to different sizes of business.

It's going to be governed by the big employers and ninety odd percent of the employers are SMEs and they won't have a look in

- concerns about where the funding would be directed i.e. through employers rather than via employment and learning providers and colleges
- concerns about quality and lack of employer contribution:

They [businesses] say there is a skill shortage but have resolutely under invested in training opportunities and the like for many years.

- the synoptic assessment.

4.1.6 Variable mathematics and practical ability of students

It was commented that the **mathematics ability of young people coming from secondary schools was variable**. Even where students had achieved a C grade or higher in their GCSE as an entry requirement, additional work was often required to get them up to the required level for academic and vocational courses. For example,

⁴ Synoptic assessment assesses the knowledge, understanding and skills developed across the whole course which differs from modular assessment which assesses a particular element of the course.

skills in algebra tended to be weak and students were not adequately prepared for engineering courses and Apprenticeships. As one consultee commented:

Schools are inadvertently preventing them from moving into an Advanced Apprenticeship because their maths is just not good enough. They're not doing the basics.

As a result of variable mathematics ability amongst pupils in the same class, it was reported that differentiating teaching was difficult.

Comments were also made about students' negative attitudes towards mathematics and their lack of awareness of the importance of mathematics for their future study and careers. This was felt to be partly related to mathematics not being taught in context within schools and due to its important relationship with other STEM subjects not being emphasised:

Young people are at a loss as to why they need to study maths at all.

Young people were also felt to lack creative thinking after following directive GCSE courses, which was a barrier when they were undertaking problem solving in post-16 provision.

Several consultees commented that GCSEs in general did not adequately prepare young people for A-levels although this may alter with the current changes to qualifications that are being implemented. They also mentioned the often limited practical abilities of students coming from GCSE or A-level courses at school. As one consultee commented:

The varied or non-existent practical skills of the learners and their ability to formulate hypotheses and understand and evaluate data effectively [is a challenge].

4.1.7 Decrease in young people's engagement in STEM from primary school

A number of consultees commented on the **decrease in students' engagement in STEM subjects from the end of primary and into Key Stage 3** which ultimately impacted on numbers progressing into post-16 provision. It was felt that this was linked to the way courses were taught, the perceived challenges associated with STEM A-levels and young people feeling that they were too difficult to tackle, and a lack of awareness of the vocational routes and the good prospects that arose from STEM courses, as mentioned above. Some felt that it was too late to try to tackle this negative trend within post-16 provision and that action needed to be taken much earlier.

4.1.8 Difficulties in developing relationships with secondary schools

Several consultees mentioned the difficulties that they had faced in developing relationships with local secondary schools with the aim of raising young people's awareness of the STEM options available to them post-16. A number reported that

schools would not let them in and, as a result, young people were not aware of the full range of options open to them and demand for courses and training was negatively impacted. Others commented that links were important to improve students' transition between the phases, in addition to increasing the awareness of staff in the post-16 sector of the school curriculum, particularly GCSEs. However, it was felt that there was a general lack of clarity regarding what was being taught in schools and that the academic and vocational routes were becoming more distinct which would limit movement between them.

4.2 Challenges and issues related to the capacity and capability of the STEM education and training workforce

There were a number of key challenges and issues raised in relation to the capacity and capability of the STEM workforce within colleges and employment and learning providers which are discussed below. They fell within two key themes:

- recruitment and retention of staff
- updating the knowledge and skills of staff.

4.2.1 Recruitment and retention of staff

In terms of the **recruitment and retention of teachers, technicians, instructors, assessors and verifiers**, the majority of consultees reported challenges, with particular issues being faced in recruiting and retaining technically skilled staff, including those with engineering (where there was an acute shortage, particularly in electronics), manufacturing, ICT and physics expertise. The situation tended to be more severe where there was a demand for the same skills and expertise from industry within the local labour market and when the economy was on an upward trend. In this situation, those who might enter STEM teaching would be more attracted by industry opportunities and the higher wages they offered. Although technical expertise and the ability to teach within the real-world context was 'imperative for a good learner experience' and to 'inspire the next generation', staff with appropriate expertise within industry could be reluctant to convert to, or remain in, teaching. As two consultees commented:

Skilled STEM professionals who want to move into education are becoming rare.

We carry a lot of vacancies. It's very difficult and a lot of staff are teaching way over their hours.

Staff who were recruited needed two different sets of skills – technical and teaching skills – and this made recruitment difficult although many institutions supported technical staff to gain teaching skills and qualifications on-the-job. The flat career structure and limited opportunities for progression, as well as the heavy demand of assessment, were also seen to be key reasons for staff leaving the profession.

Several consultees highlighted the difficulty in attracting good technicians due to the low pay, poor conditions and the lack of career structure and opportunities for

progression. In particular, technicians with physics expertise were in short supply. Mention was also made of a lack of qualified science assessors and the need to train them up.

It was also reported that it was more difficult to recruit suitably qualified staff in areas where there was lower educational attainment and where providers had poor facilities and resources and a lack of up-to-date equipment. As one consultee commented:

Excellent staff are only interested in working in excellent working environments.

There was also a gender recruitment issue with it being difficult to recruit female engineering, construction and computing lecturers who would serve as role models for young women interested in STEM. In addition, some consultees commented on their ageing workforce (the ‘retirement time bomb’) and reported that a shortage of staff would become critical in coming years if wages in the sector did not more closely match those of industry.

A smaller number of consultees felt that the **de-regulation of teacher training for post-16 education was a retrograde step**. However, many institutions were ensuring that staff they recruited, who were not already qualified teachers, undertook a teaching qualification on-the-job and this was often a requirement of the job offer. There was also a recognition that applicants coming from different routes required different types of training – for example people from an industrial background required different training to those coming straight from a degree and teaching qualification.

4.2.2 Updating the knowledge and skills of staff

It was emphasised that there was an ongoing challenge in terms of staff keeping their knowledge and skills up-to-date. Due to fewer staff having to work harder, it was reported that many staff did not have the time to regularly engage in subject-specific CPD which would improve the quality of delivery. In addition, they lacked the time to undertake industry visits and secondments. As several consultees commented:

There is an ongoing issue in keeping industrial knowledge updated ... it's a real struggle. Teachers are really busy and it's a real tension to get them out into industry.

There is a general issue of people having time for professional learning and development. They are all struggling with funding; often the first thing to go is time for teachers and trainers together to share good practice. So we are quite concerned about the provision for CPD and the time to do it.

Actually getting a lecturer out and giving them a week to see what is going on in the workplace or a manufacturing facility they just can't find the time.

CPD is a biggie, a lot of staff are out-of-date and therefore compromised in their role.

In addition, organising for staff to spend time in industry was difficult due to employers, particularly SMEs, also being stretched for time:

It is difficult to find employers with the time and willingness to take staff in for placements.

Where colleges and providers relied on large numbers of part-time staff, CPD was even less likely to happen: 'We are back to hourly paid lecturers and they aren't paid for CPD'.

Teachers within colleges, in particular, found it challenging to keep up-to-date with the fast pace of change both within industry and in the potential uses of technology within their teaching:

Also trying to learn new technology without getting in expertise, that is really a big issue.

It was felt that more could be done – if funding and time was available – to transfer knowledge from industry to the classroom, particularly in the use of new technologies and equipment. Where staff were not able to keep up-to-date, this was leading to courses not meeting industry's needs. Instructors and assessors within employment and learning providers tended to have more regular contact with the world of work so this was less of an issue for them:

Our assessors are in companies every few weeks so they are up-to-date with industrial standards and have ideas for contextualising learning.

One consultee summed up the current position:

The lack of industry experience in FE is a growing problem – programmes are not focused on what industry needs, are not up-to-date and are not taught in context. There is also a lack of knowledge of the career options. Training providers have expertise but there are not enough of them. Staff need to re-engage with industry regularly.

It was hoped that the requirement for the greater involvement of employers in Apprenticeships would help institutions to develop closer working relationships with employers and to better meet their needs.

Several consultees stressed the need to improve the quality of teaching and for **more focus on pedagogical advancements**. One consultee commented that there was too much satisfactory provision⁵ and 'dull theory teaching', including a lack of animation and discussion. There was a need for staff to make the teaching of STEM subjects more engaging, for example by increasing the focus on context-based learning. There was also a need to improve differentiation both within the teaching of vocational courses and Apprenticeships. It was noted that learners and trainees were often undertaking the same task with little distinction made between different levels of ability and needs. One consultee commented that staff were 'worn out' which impacted on their enthusiasm for teaching and another commented on the lack of

⁵ Across the FE and skills sector, around a quarter of providers were judged as 'satisfactory' or 'requires improvement' in August 2013, with 41 judged to be 'inadequate' (an increase from 34 the previous year) (Ofsted, 2013b).

time for teachers to reflect on their teaching and how they might make improvements. There were limited opportunities for sharing of learning and effective practice but, where this did occur, staff found sharing ideas for contextualising teaching and learning about resources and equipment particularly beneficial. There was also a tendency for subjects to be taught and assessed separately and a lack of time for collaboration. However, where cross-subject or department collaboration was undertaken, this often led to more engaging teaching, better linkages being made between the STEM subjects, and students' increased understanding of the need for certain subjects such as mathematics.

A number of consultees commented that, although Ofsted's increased focus on the quality of teaching and learning had 'concentrated minds', there was a lack of awareness as to what outstanding looks like:

The increased emphasis from Ofsted on teaching and learning quality but what does outstanding look like? There is a lack of understanding of how to do this and what it looks like.

It was noted that **it was particularly difficult for staff working in college departments where they were the sole teacher of a subject to keep up-to-date** and to undertake CPD. They were stretched running the course and undertaking assessment and did not have time for CPD. In addition, they lacked opportunities for sharing resources and effective practice and were often not adequately supported by senior management. It was usually teachers of science, for example physics, who were in this position. As one consultee commented:

They ['lone' teachers] do not often get the sensitive and thoughtful management that a small and lonely department needs. They do the VLE, ordering and assessment ... they need more nurturing. There is a link between achievement and the size of department.

Several consultees reported a challenge around the **teaching of mathematics** which was even more evident now that students who had not achieved GCSE mathematics grade A*-C at school were required to achieve a Level 2 in post-16 provision. One consultee referred to the national shortage of mathematics teachers and asked: 'Where are all the mathematics teachers coming from? We have a crisis in FE'. There was a recognition of the importance of mathematical skills for young people but an issue in terms of colleges and providers having sufficient suitably qualified staff to teach mathematics. It was also commented that, in some cases, students were taught mathematics outside of the vocational context and that more could be done to support staff to develop their skills in context-based teaching. However, it was commented that the future requirement for students to achieve GCSE mathematics would make this more difficult as some of the GCSE topics did not easily lend themselves to being taught within a real-world context.

Comments were also made about **the need to train up science assessors** for science Apprenticeships. This was problematic as there was not the same history of assessing in science as there was in engineering. This meant that providers had to 'grow their own' and finding staff who were interested in undertaking this role was a

challenge. An issue in recruiting Level 3 and 4 assessors for engineering Apprenticeships was also reported.

A small number of consultees commented that some staff **lacked confidence and expertise in engaging with employers** and this was felt to be more of a pressing training need now that training was becoming more employer-led.

5 Examples of effective practice in tackling challenges

Consultees were asked what effective practice they were aware of in relation to building the capacity and capability of STEM staff within colleges and employment and learning providers. The findings are discussed in the sections below.

The majority of examples of best practice fell within the following two categories:

- collaboration with employers
- delivery of STEM-related CPD.

In addition, a small number of examples were provided relating to:

- supporting 'lone' teachers
- recruitment of staff
- working with schools.

Some of the examples provided in the sub-sections below have been funded through the current Education and Training Foundation STEM Support Programme.

It is also worth noting that Ofsted, the Education and Training Foundation and CAVTL have worked together to identify and disseminate a selection of good practice case studies which are available at <http://www.ofsted.gov.uk/resources/education-and-training-foundation-good-practice-case-studies-for-vocational-education-and-training>. Consultees also referred to grade 1 providers as examples for others to follow and mentioned the work of CAVTL in exploring the features of good and outstanding vocational provision.

5.1.1 Effective collaboration with employers

A number of examples of effective practice were provided in relation to the development of effective relationships with employers. Of particular note were examples of relationships which benefited both the college/employment and learning provider and the employer - the 'two way street' referred to in the McLoughlan report (LSIS, 2013).

One consultee referred to a meeting space for employers which had been set up within his college which included a 3D printer. Businesses were using the meeting space and equipment whilst also helping to shape the STEM curriculum which resulted in benefits for both parties. Another consultee gave a similar example in which a college provided training on-site to businesses in exchange for support with developing the curriculum and providing teacher visits to industry and work experience. An example was also provided of a college marine department working closely with local employers to review and re-develop the curriculum resulting in a significantly improved alignment between college provision and the needs of local

industries. A further example was given of college staff spending a month in industry and the college reciprocating by hosting industrial staff within the college.

Other examples were given of colleges and employment and learning providers developing two-way relationships with local businesses which had led to:

- the development of high-quality Apprenticeships
- opportunities to loan equipment from businesses
- industrial work shadowing and placements
- businesses demonstrating the use of equipment
- college staff delivering elements of provision on employers' sites using state of the art equipment
- employers supporting the development of students' employability skills
- industry experts supporting the development of staff within colleges and employment and learning providers
- Apprenticeship and work-based learning providers training college staff and offering work experience.

Examples were also given of the high-quality Apprenticeship provision of the big motor manufacturers which could offer useful learning for colleges and providers, particularly those new to Apprenticeship provision.

It was commented that the development of effective relationships with employers was often related to the size of the college and its resources as well as to what industry was located in its immediate environs. In addition, it was commented that 'where colleges build on local relationships with industry they are more successful'.

5.1.2 Delivery of STEM-related CPD

A small number of **consultees identified specific courses, or providers of CPD, that they regarded as effective** in helping to build the capacity and capability of STEM staff in the sector. These included:

- the Learning and Skills Improvement Service (LSIS) STEM Programme and Excellence Gateway
- support provided by the New Engineering Foundation (NEF) for staff to engage with industry including the Industrial Fellowship Scheme and Master Classes
- CPD provided by the national network of Science Learning Centres, including the computing network
- the National Centre for Excellence in the Teaching of Mathematics (NCETM) GCSE Mathematics Enhancement Programme
- CPD and resources provided by the Royal Academy of Engineering
- the work of the AoC in facilitating collaborations between institutions
- the work of the Group Training Associations (GTA) network.

The **LSIS STEM Programme was highly regarded** by consultees and mention was made of the effectiveness of its networks, CPD and small-scale action research projects and the wealth of examples of effective practice that the programme had gathered. Action research funding through the programme had provided staff with the time to explore, and apply, new pedagogical approaches which was particularly helpful in the context of a move towards staff undertaking more process-orientated CPD. However, one consultee emphasised that any future activities similar to those funded by LSIS would need to ensure that learning was easily transferable between institutions and providers as this was not always the case with the LSIS programme.

In relation to the current **Education and Training Foundation STEM Support Programme**, consultees who knew about the programme, and/or had been directly involved, were **positive about what had been delivered**. However, there was generally a low awareness of the programme amongst consultees. In terms of what had worked well, the networking and action research elements were perceived to have been particularly useful and the conference was reported to have been valuable for sharing experiences. It was felt that there were many examples of effective practice emerging through the programme. Consultees were also positive about the lack of bureaucracy, the realistic expectations and the straight forward reporting process. As one consultee commented:

It's this sort of project and this sort of funding that we very much need nationally going forward to try to improve our position.

However, it was felt that the programme had been rushed and that a longer delivery timetable was needed. In addition, it was felt that it was not a cohesive, coordinated programme but more a collection of individual action research projects which may not be generalisable to other institutions, or contexts. It was suggested that it would be useful for future programmes to disseminate learning more widely, and for there to be more collaboration across institutions in different geographical areas.

As well as specific CPD programmes, **consultees mentioned a range of effective strategies and approaches that they, or other colleges and providers, had instigated** to ensure that STEM staff undertook CPD on an ongoing basis or were introduced to, or had access to, new resources and equipment. This included the strategies highlighted below.

Freeing up staff time for CPD, collaboration and sharing effective practice

- the provision of weekly CPD slots with no teaching timetabled
- regularly freeing up time on the curriculum for staff to visit other departments, plan and learn about other curriculum areas
- time allocated for collaborative practice and developing ideas cross-curricular and cross centre
- 'bite size' sharing of best practice.

Targeted training

- rotating technicians around a spread of science areas so that they developed a wider understanding and expertise
- training non-specialists in other subject areas in demand
- delivering a high-quality development programme for staff, including mentoring and training for middle management.

Pairing staff and peer mentoring

- pairing new/junior staff with more experienced staff to support their development
- peer mentoring programmes in mathematics and the development of resources placing mathematics learning within real-life contexts.

Liaison with industry

- colleges allowing staff time in industry to update their knowledge and skills – this was more than one or two days and could be as much as a month
- teachers accompanying students into industry
- industry experts being brought into colleges and employment and learning providers to develop staff ('the greatest strength to keeping up with the latest trade specific practices is having input from industry')
- colleges and employment and learning providers seeking corporate sponsorship to purchase up-to-date equipment.

Drawing on the support of other partners

- colleges drawing on the support of employment and learning providers to organise CPD for staff in STEM companies
- colleges drawing on the support of university partners to deliver CPD (e.g. showcasing practicals and new technology) or to make laboratory space available.

Use of new technologies

- the investment in new learning technologies to bring new concepts and virtual modelling into the classroom
- the use of remote learning using cloud-based technologies
- the provision of simulated learning environments that reflect the working environment.

It is interesting to note that there appeared to be no common approach to building the capacity and capability of STEM staff within colleges and employment and learning providers.

5.1.3 Supporting 'lone' teachers

Consultees highlighted the challenges that teachers who were the only teacher of their subject within their college faced in terms of keeping up-to-date. To support

these staff, one consultee gave an example of the development of a 'Virtual Science Department' which linked staff across several colleges to allow isolated science teachers to work as part of larger team and jointly develop schemes of work and teaching materials.

5.1.4 Recruitment of staff

A small number of consultees mentioned effective activities that they had introduced to recruit and/or develop new STEM staff. One consultee mentioned that their institution recruited staff from industry whose employer agreed to releasing them for half days or blocks of days to lecture in engineering. These staff were paid above the lecturer rate. This model reflects the aims of the new Teach Too programme.

Another consultee reported that their institution had initiated a strategy to 'grow its own' by developing close links with local universities to attract graduates into mathematics and technology teaching posts and then supporting them through training to develop their teaching skills and experience. Another followed a similar 'grow your own' approach by recruiting lecturers from its own engineering degrees and providing them with a package to achieve a teaching qualification.

5.1.5 Working with schools

Consultees also provided examples of effective strategies of working with schools. These included:

- specialist employment and learning providers running STEM outreach sessions in schools which included careers awareness raising, keynote speeches and practical sessions
- colleges and employment and learning providers jointly running STEM careers awareness raising activities
- the arranging of industrial visits for schools - including visits focusing on raising awareness of the importance of mathematics
- engaging groups of students with problems/projects set by industry as an alternative to work experience
- examples of targeting girls - including working with female employees from industry - for example girls only careers sessions, Level 1 and 2 groups tackling real live engineering problems, design and construction, publications that appeal to girls, work-experience and open days
- roadshows, outreach and events, including with primary schools.

Two organisations consulted ran Apprenticeship programmes alongside other STEM-related work in schools such as: matching schools with STEM Ambassadors, running Big Bang regional fairs and CREST awards, providing IAG and organising careers events, facilitating enhancement and enrichment activities, and delivering NVQs alongside A-levels. They effectively used their contacts with schools to raise young

people's and schools' awareness of STEM careers opportunities and the vocational options available to them post-16.

Examples from Ofsted of good practice in the teaching and learning of science within colleges can be found in 'Improving Science in Colleges, A survey of good practice' (Ofsted, 2011). Examples of effective practice in the delivery of work-based learning can be found in 'Twelve Outstanding Providers of Work-based Learning' (Ofsted, 2010).

6 Views on current STEM-related CPD and gaps in provision

This section presents consultees' views on the STEM-related CPD currently offered, the challenges associated with accessing STEM-related CPD, and gaps in provision.

6.1 Views on STEM-related CPD

There was a perception that the **STEM-related CPD currently offered was primarily targeted at schools** and, even when it was equally applicable to post-16 providers, the language suggested otherwise. An example was given of the 'Computing for Schools' CPD which was also of relevance to colleges.

It was also commented that **there was an issue with the quality and availability of STEM-related CPD for staff within the further education and skills sector**. It was felt that there was insufficient provision and that what was available tended to be of a low level and not accredited. As three consultees commented:

CPD is a bit ad-hoc. It is often aimed too low and not accredited.

There is a lack of availability and quality of subject-specific CPD.

The CPD needs to be sharp, relevant and rigorous and supported by evidence or examples of good practice/case studies.

One consultee commented on the reduction in face-to-face CPD from awarding bodies, particularly in relation to Level 3 STEM courses.

Another consultee commented that a 'one size fits all' approach was often taken to the delivery of CPD. This meant that **a lot of CPD was too generic and did not identify or differentiate between the different needs of individuals or institutions/organisations**. In particular, it was felt that there was a need for better differentiation of CPD by the roles of different staff: namely lecturers/trainers, technicians and assessors. It could also focus more on the needs of different subject teams enabling them to collaboratively reflect on their practice.

Other consultees commented that, due to the extent of the changes taking place in post-16 education and training currently, **the focus of most CPD that staff were attending tended to be on changes to processes and systems** (e.g. changes to assessment, examinations, inspections, administration etc.) rather than developing subject-specific and pedagogical knowledge and expertise.

When asked to provide examples of effective CPD, a number of examples were provided which have been detailed in section 5.1.2 above.

6.2 Challenges associated with accessing STEM-related CPD

A small number of consultees indicated that **funding was a problem** both in terms of funding to pay for CPD and in terms of paying for staff cover to release staff to attend training. They reported that the problem was particularly acute amongst smaller providers and colleges, where resources were particularly tight.

The second main challenge was a **lack of time or opportunity to attend CPD**. A small number of respondents reported that it was often difficult to find time to undertake CPD whilst managing a full teaching workload. In a related point, one respondent argued that CPD needed to be offered locally to cut down on travel time, whilst others suggested that a greater focus on web-based training might make CPD more accessible for staff. These comments suggest that CPD was sometimes viewed as an additional activity to be undertaken alongside other core responsibilities, rather than something that was embedded within day-to-day practice. Some consultees mentioned the importance of having time to reflect on their teaching but added that the time was not available for this. One consultee, who echoed others by stressing that CPD should be an entitlement for all staff, summed up the current position:

So, there are swathes of vocational course teachers with very little subject-specific CPD.

In addition, a number of consultees mentioned **a lack of senior management support for STEM-specific CPD**, or STEM subjects more generally:

The key issue for STEM is convincing college leaders and work-based learning providers of the need to pay particular attention to subject and pedagogical knowledge for these rapidly changing subjects.

The buy-in from college leadership and governance around STEM is critical to support ongoing staff development – without this, they are unlikely to achieve outstanding provision.

However, others felt that the issue of staff not attending STEM-related CPD was more about the lack of quality provision than a lack of senior leadership commitment. In some cases, staff were tasked with finding their own CPD which meant it often did not happen.

6.3 Gaps in current STEM-related CPD

When asked about gaps in STEM-related CPD provision, a large number of consultees focused on the need to access some kind of **refresher training or updates on the latest developments in industry**. Consultees identified a particular need to keep abreast of the latest technological developments, as one respondent explained:

Technological developments move fast in industry and teaching staff can sometimes be less exposed to these changes.

Consultees also reported that they needed updating to enable them to draw on real-life applications and developments in their teaching and to be more innovative and experimental. Some consultees suggested that these updates would be best coming direct from employers or professional bodies, as the following respondent explained:

The best way for teaching staff [to keep abreast of the latest developments in industry] is to be part of organisations that communicate the latest developments within the trade, such as the Royal Society of Chemistry and the Engineering Construction Industry Training Board.

A number of consultees suggested that there was a need for **more opportunities for industrial fellowships, staff exchanges, professional updating workshops/placements and knowledge transfer arrangements** with employers.

Other consultees commented that **stronger links could be developed with universities** which could include staff visits and use of their laboratory space. However, it was also commented that CPD did not necessarily need to include face-to-face delivery although that was the preferred format for many. More web-based options could also be provided which would respond to the challenge of lack of time for travel and which could be accessed at a time to suit the member of staff.

A small number of consultees requested **more training on mathematics and engineering and construction skills**, with specific examples including nuclear experience, pipe fitting, plate work, steel erectors and using thermo fluids. Others felt there was a need for training specifically focused on technicians and science assessors. It was also felt that staff needed more detailed information on STEM career opportunities now and in the future and the skills needed for these careers, in addition to regular research and development updates.

There was a feeling amongst some consultees that there was too much emphasis on subject knowledge and **not enough on pedagogy**, as the following quotation illustrates:

I attended a STEM CPD session a year ago and it only taught me the content (which I already knew), but it didn't teach me how to deliver the content in a fun, interesting, and engaging way.

In addition, it was felt that there should be more focus and support in relation to equality, diversity and inclusion.

A number of consultees commented that there was **a need for more networking opportunities**, particularly for 'lone' subject teachers in colleges. It was stressed that there were great benefits *for all staff* from networking in terms of raising awareness of new pedagogies, resources and materials and sharing schemes of work and lesson plans. The need for more peer-to-peer support and opportunities for work shadowing (e.g. of professional scientists and engineers) was also mentioned.

A number of consultees also commented that there should be **more support for college leadership to understand the strategic importance of STEM** in terms of local and national economic development, in addition to the benefits of STEM-related CPD for their staff.

It was felt that, although there were gaps, there was also some effective provision being delivered and that the provision should be mapped and 'joined up'. This could include the development of a website providing information on the range of provision on offer with links to the websites of the organisations delivering it.

7 Recommendations for the future priorities of the Education and Training Foundation

The Education and Training Foundation is funded to provide programmes and services to enhance the performance and professionalism of the education and training sector workforce. Consultees were asked what they thought the Foundation's priorities for the future should be in relation to building the capacity and capability of the STEM workforce within the sector. Their responses fell into shorter-term and longer-term priorities as detailed below.

Shorter-term priorities

- support the recruitment and retention of STEM staff
- provide STEM-related CPD and opportunities for sharing effective practice
- gather and disseminate examples of transferable effective practice relating to STEM
- support greater involvement from industry
- support careers awareness raising and transition
- robustly evaluate the impacts of the Education and Training Foundation's STEM CPD provision.

Longer-term priorities

- raise awareness of the benefits of STEM-related CPD
- explore existing STEM provision and identify gaps
- map STEM CPD provision targeted at the sector.

One priority suggested by a small number of consultees which is not included below is lobbying (e.g. on pay and conditions in the sector, funding of STEM subjects, bursaries for Traineeships and reinstating the requirement for college staff to have a teaching qualification) as lobbying falls outside of the remit of the Education and Training Foundation.

In supporting colleges and employment and learning providers with these areas, it will be important for the Education and Training Foundation to collaborate with other key bodies supporting the development of the sector. These include: BIS, AoC, AELP, Institute for Learning, Myscience, National STEM Centre, Gatsby, Nuffield, the Royal Academy of Engineering, National Centre for Excellence in the Teaching of Mathematics, the Institute of Physics, Royal Institution, Royal Society of Chemistry, Institute of Biology, Engineering Construction Industry Training Board, and the Sector Skills Councils (including SEMTA and Cogent), amongst others. A number of these organisations – such as the AoC and Gatsby – are undertaking STEM work within

the sector, including administering surveys to FE college staff and providing STEM-related CPD⁶ and it will be important for the Education and Training Foundation to build on, rather than duplicate, these activities. In collaborating with these organisations, the Education and Training Foundation may want to consider setting up a steering group of key partners to support the development and review of its STEM Support Programme.

In addition, if it does not have a definition already, it would be useful for the Education and Training Foundation to agree and widely disseminate its definition of 'STEM' to provide clarity as to what its activities under the umbrella of its STEM Support Programme will incorporate. In doing this, it may want to look at the definition used in the report for the FE STEM Data Project (Harrison, 2012) and which is also referred to in the report of The 157 Group Limited (2012).

More details on the shorter-term and longer-term priorities for the Education and Training Foundation are provided below.

7.1 Shorter-term priorities

In the shorter-term, the Education and Training Foundation should consider implementing the activities highlighted below.

7.1.1 Support the recruitment and retention of STEM staff

To support recruitment into the sector, the Education and Training Foundation could play an important role at a national level in **raising awareness of, and promoting, the career opportunities available within colleges and employment and learning providers**. This should build on the work of the Commission on Adult Vocational Teaching and Learning (LSIS, 2013) which went some way to raising the profile of vocational education and dual professionalism. In doing this, the Education and Training Foundation should provide accurate information upfront as to what the roles include to support retention in the sector. It is of key importance to support the recruitment of teachers/trainers of engineering, manufacturing, ICT, physics and mathematics in addition to assessors in science and technicians.

7.1.2 Provide STEM-related CPD and opportunities for sharing effective practice

One of the Education and Training Foundation's highest priorities should be **supporting the initial and continuing professional development of staff** within the sector. This is even more crucial with the revoking of the requirement for staff to possess a professional teaching qualification and to undertake a set number of hours

⁶ Gatsby, in collaboration with a number of partners, is currently surveying SET vocational staff and mathematics departments in FE colleges and mathematics departments in sixth form colleges to gain an understanding of CPD needs and workforce numbers for post-16 mathematics. It is also developing and piloting four CPD modules for new teachers of science, engineering and IT who are involved in technician training (e.g. chemical processing).

of CPD a year, as well as the need to support the development of staff with ‘dual professionalism’.

The professional development offered needs to include support for **subject-specific pedagogical development** (the ‘craft of teaching’) within the context that a quarter of provision is satisfactory or requires improvement. In terms of pedagogical developments, staff would benefit from more support, ideas and resources to place their teaching within a real-world context and to make better links between the STEM subjects.

Also important will be supporting staff to update their **subject-specific, technical and industrial knowledge and expertise and to gain an ongoing understanding of the applications of their subject within the workplace**. There is also a need to **support staff to keep abreast of the latest developments in technology** (in the workplace and in young people’s lives more generally), and to incorporate these more in the classroom. Wherever possible, it would be useful to draw on the expertise of business in delivering training and to deliver training off-site in the workplace - consultees stressed the need for experts in their field and technical experts to deliver training. This work might include drawing on the learning from the Teach Too programme during its implementation.

The delivery of **CPD targeted at STEM leaders and managers** to support their role in demonstrating high-quality STEM leadership and in enhancing teaching/training and student outcomes is also required. This will also help to raise their awareness of the value of STEM-related CPD and convince them of the benefits of their staff undertaking this form of CPD. Providing evaluation evidence as to the positive impacts of STEM-related CPD on teaching and learning and on students will be important in convincing leaders of its significance.

The Education and Training Foundation **should grasp opportunities to accredit CPD** wherever possible in order to raise the profile of this CPD amongst senior leaders and staff. It might also want to consider providing guidance to senior leaders as to the minimum amount of CPD that their staff should aim to undertake each year. Alongside this, it should also promote to senior leaders the respective benefits of varied forms of CPD to meet differing needs and the limitations of the ‘one size fits all approach’. For example, small group identification of specific issues and priorities and solutions can often result in more ownership, innovation and reflection than CPD focused at large groups.

In terms of the professional development of new recruits into teaching and training, the Education and Training Foundation should **give thought to what support new recruits may require in terms of developing either their teaching skills or/and their industrial knowledge** to support their ‘dual professionalism’. This might include, for example, guidance on induction or training modules which will vary depending on the skills and experiences of new recruits. It is suggested that new recruits possess, or be supported to achieve, a ‘minimal level of technical expertise and experience’ as well as teaching/training skills.

Alongside more formal CPD provision, the Education and Training Foundation should **put in place mechanisms to support staff to share effective practice and**

resources, for example through ‘sharing workshops’. This will prevent re-inventing the wheel and be a relatively cost-effective method of CPD. In developing support in this area, thought will need to be given to how the benefits of sharing can be demonstrated which will provide an incentive for staff to do so. Opportunities to share should be promoted as such with staff attending them being prepared to talk about their practice and taking examples of schemes of work, lessons/training plans and resources with them.

As mathematics is a key area of demand due to the requirement for students who have not achieved Level 2 in school to continue studying mathematics post-16, then **consideration also needs to be given to continuing to support staff to develop and share their expertise and resources around mathematics**. The changes in the content and assessment of GCSE mathematics, and the increased emphasis on problem solving and processing skills and multi-step questions, also mean that there is a particular need for CPD for mathematics teachers. What the Education and Training Foundation should provide has not been discussed in depth here as this is the subject of another review and work to support the sector is underway through the NCETM GCSE Mathematics Enhancement Programme.

The Education and Training Foundation may want to **consider the development of a group of STEM experts/advanced practitioners, or STEM-assured CPD colleges or employment and learning providers**, located across the regions (e.g. regional hubs or centres of excellence) which have a role in delivering CPD or facilitating sharing/networking sessions within their area. They might want to consider undertaking this in conjunction with the National and Regional Science Learning Centre Network. The organisation of larger national events to share best practice – such as an annual conference in the north and south – might also be considered.

Consultees stressed that they would benefit from **a programme that had a degree of continuity** in delivery and funding. At the same time, they emphasised the **need for local training and networking opportunities**, which would mean less travel time and the increased likelihood of staff being able to attend such opportunities. As well as face-to-face contact, CPD could include different modes of delivery such as online packages and distance learning.

As mentioned in the introduction to this section, in developing a programme of CPD it will be important for the Education and Training Foundation to **collaborate with existing CPD providers** to prevent any duplication and draw together existing provision.

7.1.3 Gather and disseminate examples of transferable effective practice relating to STEM

Consultees saw a key role for the Education and Training Foundation as **‘being the authoritative voice on what excellent practice looks like in the sector’**. This should include building on the work of the LSIS Excellence Gateway in gathering and widely disseminating effective practice amongst colleges and employment and learning provider staff. A key focus of this activity should be on demonstrating what outstanding looks like and supporting grade 3 and 4 provision to improve.

This should include effective practice in relation to:

- teaching and learning of STEM subjects (including, for example, placing learning within a real-world context)
- assessment
- supporting 'lone' teachers e.g. through cross-institution buddying systems, virtual departments
- high-quality training provision (e.g. training provider networks of excellence)
- new models of teaching mathematics at Level 2 leading to continued study
- delivering Level 1 courses/training/work experience to young people who have previously disengaged from education including positive examples of progression
- behaviour management and differentiation - particularly for vocational courses, Traineeships and Apprenticeships
- collaboration and partnerships with employers, particularly SMEs
- examples of Intermediate (Level 2) and Advanced (Level 3) Apprenticeship and Traineeship models – this will include working with STEM Trailblazers
- examples of the effective set up and delivery of Higher Apprenticeships (Level 4+)
- examples of 'over-training' to meet regional sector skills needs e.g. through Apprenticeship Training Academies
- embedding the development of employability skills in STEM provision
- addressing equality, diversity and inclusion and ensuring representation from under-represented groups
- outreach with schools and supporting transition, careers awareness raising and engagement with parents.

Should funds and time allow it, the Education and Training Foundation could, in the longer-term, gather examples of best practice from further afield e.g. from other countries within the European Union or other English speaking countries.

The Education and Training Foundation should also gather and disseminate resources from its own CPD programme. This might include, for example, podcasts, data sets, case studies, schemes of work and lesson plans.

7.1.4 Support greater involvement from industry

The Education and Training Foundation should also seriously consider how it can support the sector to develop effective two-way relationships (the 'two way street') with STEM employers. This could include **opening up opportunities for work shadowing, industrial visits and placements/secondments, staff exchanges and knowledge transfer**. This might include drawing on the effective practice of the New Engineering Foundation (NEF) in supporting industrial secondments. It might be useful to set guidance as to how often (e.g. every 3-4 years) staff should aim to

spend some more significant time in industry updating their knowledge and skills and gaining an understanding of current practices.

The Education and Training Foundation might also want to support the development of **a small number of sector partnerships with employers and universities** tasked with developing and evaluating models of effective practice – for example of updating sector staff through industry specific training, loaning industrial equipment and resources and sharing laboratory space. On the reverse side, effective practice should also be drawn together and shared regarding how colleges and employment and learning providers have supported industry colleagues, for example in updating them on current changes in qualifications, Apprenticeships and funding; training staff; and providing placements for employees.

7.1.5 Support careers awareness raising and transition

Consultees suggested that the Education and Training Foundation should play a role in supporting the sector to develop better links with schools with a key aim of supporting transition and raising awareness of STEM vocational and career options. The lack of quality and impartiality of careers advice in schools is a huge issue for the sector and there is a need for better promotion of the vast range of exciting and fulfilling STEM careers open to young people and the wage premium and kudos that they attract, as well as STEM vocational study options and Apprenticeships. In particular, there needs to be more emphasis on raising awareness amongst girls and under-represented groups that opportunities are equally open to them and raising the profile of engineering and the engagement of girls in physics. However, although there is a great need for this communications work to be undertaken, it falls outside of the remit of the Education and Training Foundation. What the Foundation could do, however, is gather and disseminate examples of effective practice where colleges and employment and learning providers have worked with schools to encourage and inspire young people to pursue training and careers in STEM-related subjects.

7.1.6 Robustly evaluate the impacts of the Education and Training Foundation's STEM CPD provision

The Education and Training Foundation will need to collate and share the impacts of the current STEM Support Programme and robustly evaluate any future STEM CPD provision it funds. In particular, data should be collected that demonstrates impacts on: leadership and management; the knowledge, understanding and skills of staff; the quality of teaching and learning; and the progress, attainment and engagement of students in STEM. The evaluation should be built in from the beginning of any future programme of STEM support.

7.2 Longer-term priorities

7.2.1 Raise awareness of the benefits of STEM-related CPD

Using data collected from the evaluation of its current and future STEM Support Programme activity, the Education and Training Foundation **should raise awareness of the benefits of STEM-related CPD amongst staff within the sector**, particularly senior leaders making decisions as to what CPD their staff engage in. It should also emphasise the role that effective STEM provision can play in increasing employability and creativity skills as well as improving the skills pipeline. This will support further engagement in STEM-related CPD.

7.2.2 Explore existing STEM provision and identify gaps

It has been recommended that, to gain a strategic overview of STEM provision, the Education and Training Foundation should map what existing STEM provision is being delivered, and by whom, within the context of the needs of the labour market. The aim of this would be to gain an accurate picture of:

- its nature and scope
- how it is being delivered
- who is doing the delivery, their knowledge, skills and understanding and their participation in CPD
- how delivery matches the needs of the labour market
- any duplication and, more importantly, gaps in provision and expertise within institutions, between institutions and nationally
- how the gaps in provision might be filled.

It has also been suggested that the Education and Training Foundation should help the sector to plan for the projected increases in the numbers of 16 year olds from 2020 (Office for National Statistics, 2013).

This work should be undertaken in conjunction with Local Enterprise Partnerships (LEPs) and in collaboration with BIS, Gatsby, Nuffield and the RAEng all of whom are currently undertaking, or have undertaken, work linked to this area.

7.2.3 Map STEM CPD provision targeted at the sector

In the longer-term, it would be useful for the Education and Training Foundation to put together a 'Directory of National STEM-related CPD' for post-16 provision. This could be web based and, at a later stage, include ratings of the quality of provision drawing on evaluation evidence. Again, this should support further engagement in STEM-related CPD.

Appendix 1: Consultees

Consultees taking part in telephone interviews

Name of institution/organisation	Type of organisation
Department for Business, Innovation and Skills (FE and Apprenticeships) – 2 consultees	Government
Ofsted	Government
National Apprenticeship Service	Government
UK Commission for Employment and Skills	Government
SEMTA	Sector Skills Council
Cogent	Sector Skills Council
E-skills	Sector Skills Council
BP	Business
Ford	Business
Begbroke Science Park	Business
Doosan Babcock Ltd	Business
Sevcon Ltd.	Business
Association of Colleges (AoC)	Sector representative body
Association of Employment and Learning Providers (AELP)	Sector representative body
Institute for Learning (IfL) – 3 consultees	Sector representative body
City and Islington College	FE college
TyneMet College	FE college
157 Group (of colleges)	FE college group
Worcester College of Technology	FE college
Raytheon	Training provider
HETA	Training provider
TDR Training	Training provider
Myscience – 2 consultees	CPD provider
Gatsby	Charitable foundation with science focus
Royal Academy of Engineering (RAEng)	National academy
New Engineering Foundation (NEF)	Independent educational charity
Career Academies UK	Charity

Consultees taking part in online consultation

Name of institution/organisation	Type of organisation
Chrisalys Ltd	Other - business
Franklin College	Sixth form college
Lambeth College	FE college
Selby College – 2 consultees	FE college
Ealing, Hammersmith & West London College	FE college
St Brendan's Sixth Form College - 2 consultees	Sixth form college
Newcastle College part of NCG	FE college
Gloucestershire College – 3 consultees	FE college
Middlesbrough College – 2 consultees	FE college
Blackpool & the Fylde College	FE college
Central Sussex College	FE college
Kirklees College	FE college
King Edward VI College Stourbridge	Sixth form college
Salford City College	FE college
Warwickshire College	FE college
Hull College	FE college
Hadlow College	FE college
Walsall College	FE college
The City of Liverpool College	FE college
Mid Kent College	FE college
Birmingham Metropolitan College	FE college
City of Westminster College	FE college
Joseph Chamberlain College	Sixth form college
Bury College – 2 consultees	FE college
Blackpool Sixth Form College	Sixth form college
The Bournemouth & Poole College	FE college
ENSFC	Sixth form college
City College Brighton and Hove	FE college
No name provided	-
Worcester Sixth Form College – 2 consultees	Sixth form college
Sussex Coast College Hastings	FE college
Skanska UK Ltd	Other - business
Academy of Music & Sound	Training provider
Trafford College	FE college
Barton Peveril Sixth Form College – 2 consultees	Sixth form college
NHS Blood and Transplant	Business/training provider
dBs Music	FE college
Itchen College – 2 consultees	Sixth form college
The 6th Form College	Sixth form college
Alton College – 2 consultees	Sixth form college
Bay House School & Sixth Form	Sixth form college
Sparsholt College	Sixth form college
Queen Mary's College	Sixth form college
Epping Forest College	FE college
EAS Group	Training provider
Portsmouth Sixth Form College – 2 consultees	Sixth form college

Name of institution/organisation	Type of organisation
Maritime and Engineering College North West	Training provider
Rolls-Royce & Rolls-Royce North East Training Centre – 2 consultees	Business/training provider
The NAC Group	Training provider
The TTE Group	Training provider
Electronic Technology Services	Other – includes training arm
4Techmoto Ltd.	Training provider
Construction Assessment & Training Services Ltd.	Training provider
Chameleon School of Construction	Training provider
Training 2000	Sixth form/training provider
Touch Consulting Ltd.	Training provider
Priestley College	Sixth form college
Loughborough College	FE college
ATG Training	Training provider
John Michael Hairdressing	Training provider
Group Training Association	Training provider
Proskills UK	Other – Sector Skills Council
CSR Group	Training provider
Thermal Insulation Contractors Association	Training provider
West Suffolk College	FE college
Grimsby Institute	FE college
Not provided	FE college
PETA Ltd	Training provider
Not provided	-
Newham College	FE college
GTA England	Other – network of GTAs
Leeds City College	FE college
Uxbridge College	FE college
Construction Youth Trust	Training provider
Brooklands College	FE college
Telford & Wrekin Council	Other – local authority
City College Plymouth	FE college
Doncaster GTA	Training provider
East Kent College	FE college
South Staffordshire College	FE college
York College	FE college
City College Coventry	FE college
Bedford College	FE college
Independent consultant	Other – Science Learning Centre
The City of Bath College	FE college
West Cheshire College	FE college
Isle of Wight College	FE college
South Tyneside College	FE college
Name not provided	FE college
Stanmore College – 2 consultees	FE college
Eastleigh College	FE college
SEMTA	Other – Sector Skills Council

Consultees taking part in Myscience conference

Name of institution/organisation	Type of organisation
East Kent College	FE college
Petroc	FE/HE college
HETA	Training provider
Ealing, Hammersmith and West London College	FE college
Wirral Metropolitan College	FE college
Begbroke Science Park	Business
Worcester College of Technology	FE college
Cogent	Sector Skills Council
Raytheon UK	Training provider
Association of Colleges (AoC)	Sector representative body
Chrisalys	Business
Newcastle College	FE college
Doncaster GTA	Training provider
TDR Training Ltd	Training provider
Franklin College	Sixth form college
Doosan Babcock Ltd	Business
Selby College	FE college
Priestley College	Sixth form college
Brooklands College	FE college
Leeds City College	FE college
City and Islington College	FE college
Middlesbrough College	FE college
City of Bath College	FE college
Kendal College	FE college
Salford College	FE college

Consultees taking part in Expert Panel meeting

Name of institution/organisation	Type of organisation
Royal Academy of Engineering	National academy
City and Islington College	FE college
Association of Employment and Learning Providers (AELP)	Sector representative body
Gatsby	Charitable foundation with science focus
TDR Training	Training provider
Sevcon Ltd.	Business
Myscience – 2 consultees	CPD provider
Education and Training Foundation – 2 consultees	Government grant funded (BIS) – education and skills sector body
NFER – 2 facilitators	Educational research charity

Appendix 2: Policy background

This appendix summarises the policy context within which the consultation was undertaken and the key policies that are impacting on colleges and employment and learning providers. What is important to stress is the extent and pace of change within the post-16 education and training arena and the impact that this is having on providers in terms of their planning for the future.

A number of reviews have been undertaken over recent years which impact on the sector. Of these, the key ones to note are:

- New Challenges, New Chances, Further Education and Skills System Reform Plan: Building a World Class System, December 2011 (BIS, 2011b)
- Review of Vocational Education – The Wolf Report, March 2011 (Wolf, 2011)
- It's about work...Excellent Adult Vocational Teaching and Learning (Commission on Adult Vocational Teaching and Learning, 2013)
- The Richard Review of Apprenticeships, November 2012 (Richard, 2012)
- Professor John Perkins' Review of Engineering Skills, November 2013 (Perkins, 2013).

The key focus of the recent reforms has been on increasing rigour, quality, accountability and employer engagement in post-16 provision.

The changes that are most pertinent to the study, most of which have been mentioned by consultees during the course of the consultation, are highlighted below. They relate to:

- changes to the Apprenticeship framework and funding
- the introduction of Traineeships
- the introduction of Study Programmes for 16-19 year olds and associated changes to funding
- loans for over-24 year olds studying in further education
- changes to the content and assessment of academic and vocational provision
- 16-19 performance measures and new Ofsted framework
- enrolment of 14-16 year olds in further education and sixth form colleges and new models of provision
- changes to careers information, advice and guidance and work experience in schools
- Raising the Participation Age
- de-regulation of teaching training for college staff
- capital investment programme for colleges.

The demand for STEM skills

This consultation needs to be placed within the national context in relation to the demand for STEM skills. The UK engineering and science industries are a vital element of the overall UK economy, with an approximate turnover of £257bn (CBI, 2010). The exact levels of demand for STEM skills are difficult to assess precisely (GB. Parliament, 2013 and Archer *et al.*, 2013). However, skills shortages in STEM sectors are considered to represent a real threat to the UK's capacity for growth and at least one source estimates that around 82,000 engineers and technicians are needed just to deal with retirements up to 2016 and that 830,000 graduate-level science, engineering and technology professionals will be required by 2020 (GB. Parliament. HoC. Select Committee, 2013). Although the past decade has seen significant improvement in the STEM skills supply, demand has risen and businesses continue to report difficulties in recruiting STEM-skilled staff. As the economy continues to improve, these recruitment difficulties are set to escalate (CBI, 2014).

Changes to the Apprenticeship framework and funding

Apprenticeships lie at the heart of the government's Skills Strategy (BIS and Skills Funding Agency, 2012) with a plan to deliver at least 250,000 more Apprenticeships between 2011 and 2015. In November 2012, Richard (2012) undertook a Review of Apprenticeships which has led to an overhaul of the Apprenticeship programme with key actions described within the government's Apprenticeship Implementation Plan (HM Government, 2013). A key focus of Richard's recommendations is improving quality and employer engagement in the design, delivery and assessment of Apprenticeships.

Work has started on the development of a small number of clear standards for each occupation, which allow for freedom in the curricula and of teaching methods. These are being developed by employers or employer-led coalitions and being linked to existing and recognised certification processes within sectors and across professions so that they will be widely accepted. Alongside working towards the standards, there is a requirement for apprentices to work towards English and mathematics at Level 2 if they have not already achieved GCSEs grades A*-C in these subjects. In addition, skills and competencies will be robustly and independently tested and validated. This will include a final, end-point synoptic test which will assess the full breadth of competencies and be performance and real-world based. The end test will, in most cases, incorporate two-thirds of the assessment and apprentices will be awarded a pass, merit or distinction. In addition, there is a requirement for Apprenticeships to last for a year or more to protect against poor quality delivery. Within this, at least 20 per cent of the time should be off-the-job training.

The funding of Apprenticeships has also been over-hauled. Government will continue to contribute to the cost of training but the proposal is for the purchasing power to be in the hands of the employer and for the funding to be routed through the employer. The exact process for funding has not yet been agreed. A Funding Reform Technical Consultation document was published in the middle of March 2014 (HM Government, 2014) and the consultation is ongoing. Co-investment is at the heart of the proposals with employers expected to contribute to the cost of the Apprenticeship alongside a

government contribution. There are two key proposals for payment mechanisms – a PAYE system and Apprenticeship Credit. Responses to proposals will be received up until 1st May 2014.

The first set of Apprenticeship standards are being developed by eight 'Trailblazers'. These are projects led by employers and professional bodies. The first set of Trailblazers was announced in the October 2013 Implementation Plan (HM Government, 2014) and they include a number of STEM sectors: aerospace; automotive; digital industries; electro-technical; energy and utilities; financial services; food and drink manufacturing; and life sciences and industrial sciences. Phase 2 Trailblazers are just starting and Phase 3 Trailblazers will be announced in September 2014. Trailblazer activity will continue and grow during 2014/15 and 2015/16. Once new standards are approved they will be implemented, with the first being piloted in 2014/15. 2017/18 will be the key period of transition to full implementation of the reforms.

The introduction of Traineeships

Traineeships are a new programme for young people, introduced in August 2013 (DfE and BIS, 2013c). They are targeted at young people aged 16-24 and those with learning difficulty assessments up to the age of 25. The core target group is young people who:

- are not currently in a job and have little work experience, but who are focused on work or the prospect of it
- are 16-19 and are qualified below Level 3 or 19-24 and have not yet achieved a full Level 2
- providers and employers believe have a reasonable chance of being ready for employment or an Apprenticeship within six months of engaging in a Traineeship.

Traineeships form part of the new Study Programmes for young people aged 16-19 years. For 19-24 year olds, they are part of the existing flexibilities within the Adult Skills Budget.

The core content of Traineeships is: work preparation training, English and mathematics and, very importantly, high-quality work experience.

The aim of Traineeships is to secure young people's progression to an Apprenticeship or sustainable job as quickly as possible. Around 250 providers are currently involved which are Ofsted grade 1 and 2 which is the condition of approval to assure quality.

Traineeships last a maximum of six months and the recent guidance (DfE and BIS, 2014) is for work experience to last between 100 and 240 hours.

The introduction of Study Programmes for 16-19 year olds and associated changes to funding

The Wolf Review concluded that funding based on qualifications in the past discouraged time spent in investing in more challenging vocational qualifications and work experience. So, in response to this review, in July 2012 it was announced that,

in September 2013, funding for 16-19 year olds would change to a per student basis and students would be offered 16-19 Study Programmes (DfE, 2012). There are three principles behind the new programmes:

- improving the value of post-16 qualifications – more students achieving high-quality, useful vocational qualifications and progressing onto higher levels of study and skilled employment
- raising standards in English and mathematics
- improving employability skills.

All students should be given the opportunity to follow a Study Programme that:

- provides progression to a higher level than their prior attainment
- includes qualifications of sufficient size and rigour to stretch students and which are linked to further progression routes
- requires students who have not already achieved a GCSE A*-C grade in mathematics and English to study these, or a stepping stone towards these, qualifications
- allows for meaningful work experience related to the vocational area
- includes other activities that develop skills, attitudes and confidence that support progression.

Study Programmes include vocational qualifications, Traineeships and A-levels. Regarding A-levels, they will usually include non-qualification activity such as tutorials and work to develop personal or study skills and to support further progression, including work experience.

There have also been recent changes to funding and weightings for 16-19 provision (Education Funding Agency, 2013). These include changes to the funding for 16-19 Study Programmes, with differential rates for 16/17 year olds and 18 year olds. Colleges will receive at least 600 hours funding per 16/17 year old student as long as they study at least 540 hours. From September 2014, funding for 18 year olds will be 17.5 per cent below the funding for 16/17 year olds (funding for 450 to a maximum of 539 hours). This excludes students with a learning difficulty assessment or statement of special educational needs.

In addition, programme weightings for provision targeted at 16-19 year olds have changed. With the exception of academic programmes, weightings are now allocated based on the Sector Subject Area Tier 2 classification of the main learning aim of a student's whole programme. This contrasts with the previous approach, where a database of approved qualifications was maintained and a weighting assigned to each. The number of programme weighting bands has reduced from seven to four. This includes: base (1.0), medium (1.2), high (1.3) and specialist (1.6). In relation to academic programmes – such as A-levels - they are weighted 1.0 regardless of content whereas previously they were weighted 1.0 or 1.12 depending on the subject content.

Within the STEM field, most vocational areas attract a medium or high weighting (e.g. engineering and manufacturing technologies, engineering, manufacturing technologies, construction, planning and the built environment). However, science and other science and health-related courses are set at the base rate. A Research Report on the 16-19 Funding Formula (ACL Consulting, 2013) recommended that the weighting of science vocational courses should be changed from base to medium and that construction might be weighted high rather than medium. There is also a concern around the funding of science A-levels due to the amount of practical work and associated resource requirements.

Loans for over-24 year olds studying in further education

Further education loans were first mentioned in *New Challenges, New Chances: Further Education and Skills System Reform Plan* (BIS, 2011a) and introduced from September 2013 for adults aged 24 or older studying Level 3 and above. However, this age group can still undertake their first Level 2 programme free.

Changes to the content and assessment of academic and vocational provision

Alongside the introduction of the new 16-19 Study Programmes, a number of changes have been introduced to the content and assessment of academic and vocational courses. These changes include the reform of A-levels and AS levels with changes being introduced including:

- AS levels becoming standalone qualifications and not related to A-levels
- changes to assessment with the focus on end of course assessment by exam and a reduction in coursework
- strengthened and more consistent mathematics requirement in science subjects
- the input of universities into course design
- A-level computer science replacing the A-level in ICT which will encourage the development of 'computational thinking skills' and include a strengthened mathematical content and 20 per cent non-exam assessment
- proposals for the grade for practical work to be separate from the main A-level grade.

Phase one subjects include the sciences and computing which will be taught from September 2015. Mathematics is in phase two with first teaching of the new course commencing in September 2016. The Perkins Review of Engineering (Perkins, 2013) called on the Royal Academy of Engineering and the Institute of Physics to engage in consultations over revisions to A-level physics.

In relation to GCSEs:

- a new grading system is being introduced including grades from 1 to 9, with 9 being the highest
- assessment will be at the end of the course and content not divided into modules

- a more challenging GCSE mathematics is being developed with emphasis on solving problems which require multi-step solutions
- they will be linear with terminal assessment - exams will be the default method of assessment except where they cannot provide a valid assessment.

Mathematics will be reformed for teaching in 2015. The timeline for the introduction of the new science curriculum is September 2016.

In relation to vocational courses, the key change has been the introduction of the synoptic assessment and the requirement for a significant amount of content to be subject to external assessment.

16-19 performance measures and new Ofsted framework

Alongside the introduction of Study Programmes are new accountability arrangements, including reformed 16-19 performance tables and Ofsted framework.

The 16-19 performance measures include:

- the publication of student destinations
- the publication of data on GCSE attainment (including English and mathematics) and other Level 1 and 2 qualifications, in addition to A-level results and other Level 3 qualifications
- a new Ofsted inspection framework
- robust minimum standards that all 16-19 providers will be expected to meet.

For 16-19 year olds, there are now two 'types' of qualifications in addition to A-levels. These are 'Tech Level' (DfE, 2013b) and 'Applied General' (DfE, 2013a).

Tech Level are Level 3 qualifications for students specialising in a technical occupation or occupational group. They lead to recognised occupations such as engineering, IT or construction. To be recognised as Tech Level, qualifications must be: Level 3, lead to a recognised occupation and have public support from professional bodies or five registered employers.

Applied General are Level 3 qualifications providing broad study of a vocational area rather than a single occupation, for example applied science. To be included in the 2016 Schools and Colleges performance tables for 16-19 learners, they need the official backing of three universities.

For a learner's Level 3 qualification to be recognised, and to be included within the 16-19 performance tables, they need to be studying qualifications in these lists of approved Tech Level or Applied General qualifications, or be studying A-levels. This affects learners starting two-year courses in September 2014.

There are also approved high-quality vocational qualifications for 14-16 year olds that will be included in the 2016 performance tables.

In April 2013, the Secretary of State announced the introduction of the Technical Baccalaureate performance table measure that will record the achievement of students taking part in Level 3 programmes (DfE, 2013f). This will mark the

achievement of 16-19 year olds in three areas and will be introduced for courses starting in September 2014. The three elements are:

- a high-quality Level 3 vocational qualification
- a Level 3 core mathematical qualification, including AS-level mathematics
- an extended project which develops skills in extended writing, communication, research and self-discipline and self-motivation.

A new Ofsted framework was introduced from September 2012. It includes a continued focus on weaker providers, with greater attention to observing standards of teaching, learning and assessment. From September 2013, there is an emphasis on assessing the quality and coherence of Study Programmes and progression (Ofsted, 2014).

Enrolment of 14-16 year olds in further education and sixth form colleges and new models of provision

Following the recommendations of the Wolf Review, from September 2013, colleges were able to recruit 14 and 15 year olds into their institutions (DfE, 2013c). Colleges are required to offer a programme of study that delivers the mandatory requirements of the Key Stage 4 national curriculum alongside a technical vocational qualification. Eight institutions have registered to recruit 14-16 year olds in 2013/14.

In addition, new school models have recently been introduced in England, based on a common theme of greater autonomy and freedom from public control (GB. Parliament, 2013). These include:

- Academies - publicly-funded schools granted significant freedom over curriculum delivery and administration
- University Technical Colleges (UTCs) - industry or university sponsored technical academies intended primarily to provide 14-19 year olds with practical skills needed to meet the needs of STEM employers
- Studio Schools - state schools offering both academic and vocational qualifications, taught in a practical and project-based way intended to develop core skills and employability
- Free Schools - independent, not for profit, state-funded schools set up by a variety of groups.

Changes to careers information, advice and guidance and work experience in schools

In 2012, the responsibility for providing careers information, advice and guidance was transferred to schools and a statutory duty was placed on schools to secure access to independent careers guidance for pupils aged 14-16. From September 2013, this included pupils from year 8 (aged 12/13) and aged 16-18 in schools and colleges (DfE, 2013d).

Recent studies have suggested that the transfer to schools of the statutory duty for providing careers information, advice and guidance has resulted in a loss of quality

and impartiality. This includes a recent report by Ofsted (2013) and a report focused on the construction industry (CITB, 2014).

In addition, in 2012, the duty on schools to provide year 11 pupils with two weeks of 'work-related learning' was repealed on the advice of the Wolf Report (2011).

Raising the Participation Age

Alongside all of the other changes, the Government has raised the participation age (DfE, 2013e). From 2013, this requires young people to stay in education and training until they are 17 years and, from 2015, this will increase to 18 years. This includes full-time study at school, college or with an employment and learning provider, an Apprenticeship, or full-time work or volunteering combined with part-time education or training.

De-regulation of teacher training for college staff

The Draft Deregulation Bill presented to parliament in July 2013 (GB. Parliament. HoL and HoC, 2013) revoked the power of the Secretary of State to impose qualification requirements in respect of staff and principals at further education institutions in England. This was in line with Lord Lingfield's recommendations (Independent Review Panel, 2012) which questioned the effectiveness of qualification requirements in improving the standards of teaching. In addition, it is no longer a requirement for staff to complete at least 30 hours of continuing professional development each year and provide an annual record to the Institute for Learning (IfL).

Capital investment programme for colleges

Since May 2010, over £330 million of new FE college capital investment has been made available to FE colleges across the country. The Autumn Statement 2012 published on 5 December 2012 confirmed £270 million of additional capital funding for further education colleges in the financial year 2013-14. This supplements the £280 million for 2014-15. The FE College Capital Investment Strategy (BIS and Skills Funding Agency, 2012) outlines the Government's capital investment plans for the remainder of this parliament, sets out key priorities and an outline delivery plan. It announces the creation of a new programme incorporating three elements. These include: a Project Development Fund to support college project development; a College Capital Investment Fund targeted at improving the estate of those colleges in the greatest need; and Targeted Capital Allocations to ensure emerging pressures and demands can be responded to. The objective of the fund is to provide capital grant support for renewal, modernisation and rationalisation of the FE college estate. This funding is likely to benefit STEM subjects but is not targeted specifically at them.

Appendix 3: Online survey

Introduction

On behalf of the Education and Training Foundation (the Foundation), NFER is conducting a strategic consultation on STEM to help inform the Foundation's future strategic planning and programmes of work in relation to education and training. As you may be aware, the Education and Training Foundation is funded to provide programmes and services to enhance the performance and professionalism of the workforce within colleges and employment and learning providers.

We are consulting with further education colleges, sixth form colleges and employment and learning providers involved in the delivery of courses and training (such as Apprenticeships).

Colleges, providers and employers have already stressed the importance of STEM to the Foundation and the aim of this consultation is to gain further information in order to thoroughly understand the STEM landscape in post-16 education and training and what support the Foundation might provide. The consultation builds on previous STEM development work and aims to identify new and continuing areas of challenge.

This consultation document includes five key questions and will take around 15 minutes.

Your responses will be confidential and anonymous. No individuals will be named in any reporting.

Please remember to press 'Done' when you complete the survey. NFER's Code of Practice means that we are not able to include your views in our analysis if you have not done this.

About you

***1. What is the name of your institution/organisation?**

2. What type of educational or training organisation do you work for?

- Further Education College
- Sixth Form College
- Employment and Learning Training Provider
- Other (please specify)

***3. What is your role?**

4. Do you have any specific responsibilities in relation to STEM?

- Yes No

Yes (please specify)

Key issues and challenges relating to STEM within colleges and training pro...

***5. What do you feel are the broader issues and challenges relating to the delivery of STEM courses and training within colleges and/or employment and learning providers?**

***6. More specifically, what do you feel are the key issues and challenges relating to the capacity and capability of STEM teaching and technical staff within colleges and/or employment and learning providers?**

Effective practice and gaps in STEM-related continuing professional develop...

7. What effective practice are you aware of in relation to building the capacity and capability of STEM teaching and technical staff within colleges and/or employment and learning providers?

(This may include, for example, initiatives tackling recruitment and retention issues; continuing professional development (CPD); provision of facilities, equipment and other resources and materials etc.)

8. What are the gaps in STEM-related continuing professional development (CPD) provision for STEM teaching and technical staff in colleges and employment and/or learning providers?

Future priorities of Education and Training Foundation in relation to STEM

***9. The Education and Training Foundation is funded to provide programmes and services to enhance the performance and professionalism of the education and training sector workforce.**

What do you think the Foundation's priorities for the future should be in relation to building the capacity and capability of the STEM workforce within colleges and employment and learning providers?

10. If you have anything else to add, please use the box below.

11. If you are willing to be contacted again as part of the consultation, please include your name and email address below. The consultation period runs until the end of March 2014.

Thank you very much for your time

That's all of our questions. Thank you very much for sharing your views with us. Please remember to press 'Done' below to send your views to us.

Appendix 4: Interview schedule

A strategic consultation on STEM to help inform the Education and Training Foundation's future priorities and activities

Schedule for consultations

- Thank you very much for agreeing to be interviewed for the consultation.
- I am from the National Foundation for Educational Research, which is an independent research organisation.
- We have been commissioned by the Education and Training Foundation to carry out a consultation on STEM to inform The Foundation's future strategic planning and programmes of work in relation to education and training. The consultation builds on previous STEM development work undertaken by the Foundation and aims to identify new and continuing areas of challenge.
- As you may be aware, the Education and Training Foundation is funded to provide programmes and services to enhance the performance and professionalism of the education and training sector workforce.
- We are consulting with experts and stakeholders in the STEM arena and those involved in the delivery of further education and training.
- The interview will take around 30 minutes, is that okay?
- The interview is confidential and anonymous and no individuals will be named in any reporting. Would you mind if I record the interview in order to ensure I gather all the information accurately?

1 Background information

1.1 Could you give me some brief details about your background please, in terms of...?

Organisation:	
Job title:	
Role and remit:	
STEM sector/FE/training sector:	

2 STEM policies and initiatives relating to education and training

2.1 What do you feel are the key policies and initiatives currently impacting on STEM provision within colleges and employment and learning providers, and those likely to impact in the future?

Probe:

- STEM and FE
- STEM and the training sector (including Apprenticeships and Traineeships)
- STEM and 16-19 Study Programmes
- What are the current/likely future impacts of these policies/initiatives?

2.2 More specifically, what do you feel are the key policies and initiatives impacting on the capacity and capability of the STEM workforce within colleges and employment and learning providers?

Probe:

- STEM and FE
- STEM and the training sector (including Apprenticeships and Traineeships)
- STEM and 16-19 Study Programmes
- What are the current/likely future impacts of these policies/initiatives?

3 Key issues in relation to STEM in education and training

3.1 What are the broader issues and challenges in relation to the delivery of STEM courses and training within colleges and employment and learning providers?

Probe:

- Gain details of the **current and future issues and challenges** relating to:
 - recruitment, engagement and retention of students
 - teaching and learning (curriculum)
 - assessment
 - priority of CPD – see 3.2
 - equality and diversity (e.g. representation of girls, older or younger age groups)
 - provision for high need students (LLDD)
 - links with employers, work-experience opportunities
 - Apprenticeships and Traineeships (e.g. availability/competition for places, retention)
 - funding and resources
 - careers and transitions to employment (e.g. employability skills, careers advice, supply and demand)?
- Gain details on the **scale** of these challenges? Which are the most important/pressing?

3.2 More specifically, what are the key issues and challenges relating to the capacity and capability of STEM teaching and technical staff within colleges and employment and learning providers?

Probe:

- Gain details of the **current and future issues and challenges** relating to:
 - staff skills and expertise (e.g. non-specialist teaching, shortages in particular areas of STEM)
 - recruitment and retention
 - subject-specific CPD .e.g. lack of SMT commitment, opportunities and access; quality; focus etc.
 - materials and equipment/training facilities
- Gain details on the **scale** of these challenges? Which are the most important/pressing?

4 Progress and effective practice in relation to STEM in education and training

4.1 What has improved in the delivery of STEM provision over the past 12 months?

4.2 What effective practice are you aware of relating to the delivery of STEM provision within colleges and employment and learning providers?

Probe:

- Use of funding
- Recruitment, engagement and retention of students
- Teaching and learning (curriculum)
- Assessment
- Focus on subject-specific CPD – see 4.3 below
- Equality and diversity
- Provision for high need students (LLDD)
- Partnerships/links with employers or the public sector, work-experience opportunities
- Apprenticeships and Traineeships
- Funding and resources
- Careers and transitions to employment (e.g. employability skills, careers advice, supply and demand)?

4.3 What effective practice are you aware of in relation to building the capacity and capability of STEM teaching and technical staff within colleges and employment and learning providers?

Probe:

- Development of staff skills and expertise
- Initiatives related to recruitment and retention
- SMT commitment to subject-specific CPD and offering quality opportunities
- Provision of materials and equipment/training facilities

4.4 What do you feel are the current gaps in STEM-related continuing professional development (CPD) provision for STEM teaching and technical staff in colleges and employment and training providers?

5 Specific STEM professional development programmes in the education and training sector

5.1 Are you aware of the STEM CPD Programme delivered by Myscience to colleges and training providers?

[Details if required: Programme comprises:

- 1) a range of STEM-related training courses with various foci and delivered by various providers
- 2) action research projects addressing specific issues in relation to STEM
- 3) learning visits.]

[If YES] Probe:

- Check how involved (e.g. received/participated in training; staff/colleagues received/participated in training; provider of training included in the programme; contribute to the programme etc.)

[If NO, go to section 6]

5.2 Are there any aspects of the programme that you feel are working particularly well?

Probe:

- What aspects?

5.3 Are there any aspects of the programme that are working less well?

Probe:

- If so, what aspects and how could they be improved?

5.4 How should the programme be developed from hereon?

6 Future priorities and actions for STEM in the education and training sector

6.1 As you may be aware, the Education and Training Foundation is funded to provide programmes and services to enhance the performance and professionalism of the education and training sector workforce.

What do you think the Foundation's priorities for the future should be in relation to building the capacity and capability of the education and training sector workforce in relation to STEM?

Probe:

- Which should be short-term priorities and which more medium and longer-term?
- How could you/your organisation help the sector to meet these priorities?
- Who else should be involved?

6.2 What else should be prioritised to enhance STEM provision in the education and training sector?

Probe:

- Which should be short-term priorities and which more medium and longer-term?
- How could you/your organisation help the sector to meet these priorities?
- Who else should be involved?

7 Next steps for the consultation

7.1 We are putting together an ‘expert panel’ to help inform the development of recommendations to the Foundation regarding their future strategic planning and programmes of work in relation to STEM.

The panel representatives will be invited to participate in a workshop to discuss findings and agree recommendations, and to contribute to the development of an outline specification of programmes. We would really value your continued input to the consultation. Would you be willing to be considered for this panel?

7.2 Is there anyone else (within your organisation or elsewhere) who you feel is key to this consultation and who we should be contacting?

7.3 Are you aware of any conferences or workshops coming up on this theme which we should link into?

8 Further comments

8.1 That is all my questions. Do you have any further comments or anything you would like to reiterate?

Thank you very much for your time and contribution.

References

- ACL Consulting (2013). *16-19 Funding Formula Programme Cost Weightings Review: Research Report*. London: DfE [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/261266/RR312.pdf [26 March, 2014].
- Archer, L. with Osborne, J., DeWitt, J., Willis, B., Wong, B. and Orpwood-Russell, M. (2013). *What Shapes Children's Science and Career Aspirations Age 10-13?* (Interim Research Summary, SPIRES Project). London: King's College, Department of Education & Professional Studies [online]. Available: <http://www.kcl.ac.uk/sspp/departments/education/research/spires/ASPIRES-summary-spring-2013.pdf> [15 April, 2014].
- CBI (2010). *SET for Growth: Business Priorities for Science, Engineering and Technology*. London: CBI [online]. Available: http://www.cbi.org.uk/media/878512/16B6A4AD035FF3D88025778B0053D94D_20100801-set-for-growth.pdf [15 April, 2014].
- CBI (2014). *Engineering our Future: Stepping up the Urgency on STEM*. London: CBI [online]. Available: http://www.cbi.org.uk/media/2612000/engineering_our_future.pdf [15 April, 2014].
- CITB (2014). *Educating the Educators: Construction's Unique Opportunity to Work with Careers Advisers to Inspire a New Generation of Recruits*. King's Lynn: CITB [online]. Available: <http://www.citb.co.uk/documents/construction%20careers/citb-educating-educators-careers-report.pdf> [26 March, 2014].
- Commission on Adult Vocational Teaching and Learning (2013). *It's About Work... Excellent Adult Vocational Teaching and Learning: the Summary Report of the Commission on Adult Vocational Teaching and Learning*. Coventry: Learning and Skills Improvement Service [online]. Available: <http://repository.excellencegateway.org.uk/fedora/objects/eg:5937/datastreams/DOC/content> [26 March, 2014].
- Department for Business, Innovation and Skills (2010). *Skills for Sustainable Growth: Strategy Document. Full Report*. London: BIS [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32368/10-1274-skills-for-sustainable-growth-strategy.pdf [26 March, 2014].
- Department for Business, Innovation and Skills (2011a). *New Challenges, New Chances: Further Education and Skills System Reform Plan: Building a World Class System*. London: BIS [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/145452/11-1380-further-education-skills-system-reform-plan.pdf [26 March, 2014].
- Department for Business Innovation and Skills (2011b). *New Challenges, New Chances: Next Steps in Implementing the Further Education Reform Programme*. London: BIS [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/145449/11-1213-new-challenges-new-chances-implementing-further-education-reform.pdf [26 March, 2014].

Department for Business, Innovation and Skills (2011c). *New Challenges New Chances: Skills Investment Statement 2011-2013: Investing in a World Class Skills System*. London: BIS [online]. Available: <http://dera.ioe.ac.uk/12712/1/11-1374-skills-investment-statement-2011-2014.pdf> [26 March, 2014].

Department for Business, Innovation and Skills and Skills Funding Agency (2012). *FE College Capital Investment Strategy*. London: BIS [online]. Available: <http://www.bis.gov.uk/assets/biscore/further-education-skills/docs/F/12-1340-further-education-college-capital-investment-strategy-plan> [26 March, 2014].

Department for Business, Innovation and Skills and Skills Funding Agency (2014). *Skills Funding Statement 2013-2016*. London: BIS [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/278529/bis-14-p172a-skills-funding-statement-2013-2016.pdf [26 March, 2014].

Department for Education (2012). *Study Programmes for 16-19 Year Olds: Government Response to Consultation and Plans for Implementation*. London: DfE [online]. Available: <http://webarchive.nationalarchives.gov.uk/20130401151715/https://www.education.gov.uk/publications/eOrderingDownload/1.%20Government%20response%20to%20consultation%20on%20study%20programmes%20for%2016-%20to%2019-year-olds%20for%20publication%20july%202012.pdf> [26 March, 2014].

Department for Education (2013a). *16 to 19 Performance Tables: Applied General Qualifications 2016*. London: DfE [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266043/16_to_19_applied_general_qualifications_2016.pdf [26 March, 2014].

Department for Education (2013b). *16 to 19 Performance Tables: Tech Level Qualifications 2016*. London: DfE [online]. Available: DfE, December 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266042/16_to_19_tech_level_qualifications_2016.pdf [26 March, 2014].

Department for Education (2013c). *Full-time Enrolment of 14-16 Year Olds in Further Education and Sixth Form Colleges*. London: DfE [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268614/14_to_16_enrolment.pdf [26 March, 2014].

Department for Education (2013d). *Statutory Guidance: the Duty to Secure Independent and Impartial Careers Guidance for Young People in Schools*. London: DfE [online]. Available: www.education.gov.uk/aboutdfe/statutory/g00205755/statutory-careers-guidance-for-young-people [26 March, 2014].

Department for Education (2013e). *Statutory Guidance on the Participation of Young People in Education, Employment or Training for Local Authorities*. London: DfE [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268972/participation_of_young_people_-_statutory_guidanceev3.pdf [26 March, 2014].

Department for Education (2013f). *The Technical Baccalaureate Performance Table Measure*. London: DfE [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266408/TechBacc_policy_statement_FINAL.pdf [26 March, 2014].

Department for Education and Department for Business, Innovation and Skills (2013a). *The Future of Apprenticeships in England: Next Steps from the Richard Review*. London: BIS [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/190632/bis-13-577-the-future-of-apprenticeships-in-england-next-steps-from-the-richard-review.pdf [26 March, 2014].

Department for Education and Department for Business, Innovation and Skills (2013b). *Rigour and Responsiveness in Skills*. London: BIS [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/186830/13-960-rigour-and-responsiveness-in-skills-amended.pdf [26 March, 2014].

Department for Education and Department for Business, Innovation and Skills (2013c). *Traineeships: Supporting Young People to Develop the Skills for Apprenticeships and Sustainable Employment. Framework for Delivery*. London: DfE [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223591/Traineeships-framework-July2013.pdf [26 March, 2014].

Department for Education and Department for Business, Innovation and Skills (2014). *Traineeships: Supporting Young People to Develop the Skills for Apprenticeships and Sustainable Employment. Framework for Delivery*. London: DfE [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311739/140515_Traineeships_Framework_for_Delivery_1415.pdf

Education Funding Agency (2013). *Funding Guidance for Young People 2013/14 Rates and Formula*. London: Education Funding Agency [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277269/Funding_rates_and_formula_2013-14.pdf [26 March, 2014].

Great Britain. Parliament (2013). *STEM Education for 14–19 Year Olds* (POSTNOTE 430) [online]. Available: www.parliament.uk/briefing-papers/POST-PN-430%20%5b12 [15 April, 2014].

Great Britain. Parliament. House of Commons. Select Committee (2013). *Education Reforms Could Damage Engineering Warn MPs* [online]. Available:

<http://www.parliament.uk/business/committees/committees-a-z/commons->

[select/science-and-technology-committee/news/engineering-skills-report-press-release/](#) [15 April, 2014].

Great Britain. Parliament. House of Lords and House of Commons. Joint Committee on the Draft Deregulation Bill (2013). *Draft Deregulation Bill: Report. Session 2013-14*. London: TSO [online]. Available:

<http://www.publications.parliament.uk/pa/jt201314/jtselect/jtdraftdereg/101/101.pdf> [26 March, 2014].

Harrison, M. (2012). *FE STEM Data Project: November 2012 Report*. London: Royal Academy of Engineering [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/284787/FESTEMreport_nov12_final.pdf [15 April, 2014].

HM Government (2013). *The Future of Apprenticeships in England: Implementation Plan*. London: BIS [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253073/bis-13-1175-future-of-apprenticeships-in-england-implementation-plan.pdf [26 March, 2014].

HM Government (2014). *The Future of Apprenticeships in England: Funding Reform Technical Consultation*. London: BIS [online] Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287260/bis-14-587-future-of-apprenticeships-in-england-funding-reform-technical-consultation.pdf [26 March, 2014].

HM Government (2014). *The Future of Apprenticeships in England: Guidance for Trailblazers*. London: BIS [online]. Available:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287276/bis-14-p194-future-of-apprenticeships-in-england-guidance-for-trailblazers-revised-version-2.pdf [26 March, 2014].

Independent Review Panel (2012). *Professionalism in Further Education: Final Report of the Independent Review Panel*. London: BIS [online]. Available:

<http://www.bis.gov.uk/assets/biscore/further-education-skills/docs/p/12-1198-professionalism-in-further-education-final> [26 March, 2014].

Office for National Statistics (2013). *National Population Projections, 2012-based Projections* (Released 6 November 2013) [online]. Available:

<http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-318453> [16 April, 2014].

Office for Standards in Education, Children's Services and Skills (2010). *Twelve Outstanding Providers of Work-Based Learning*. London: Ofsted [online]. Available:

<http://www.ofsted.gov.uk/resources/twelve-outstanding-providers-of-work-based-learning> [26 March, 2014].

Office for Standards in Education, Children's Services and Skills (2011). *Improving Science in Colleges*. London: Ofsted [online]. Available:

<http://www.ofsted.gov.uk/resources/improving-science-colleges> [26 March, 2014].

Office for Standards in Education, Children's Services and Skills (2013a). *Going in the Right Direction? Careers Guidance in Schools from September 2012*, London: Ofsted [online]. Available: <http://www.ofsted.gov.uk/resources/going-right-direction-careers-guidance-schools-september-2012> [26 March, 2014].

Office for Standards in Education, Children's Services and Skills (2013b). *Further Education and Skills: the Report of Her Majesty's Chief Inspector of Education, Children's Services and Skills 2012/13*: London: Ofsted [online]. Available: <http://www.ofsted.gov.uk/annualreport1213/fe-report> [31 March, 2014].

Office for Standards in Education, Children's Services and Skills (2014). *Handbook for the Inspection of Further Education and Skills*. London: Ofsted [online]. Available: <http://www.ofsted.gov.uk/resources/handbook-for-inspection-of-further-education-and-skills-september-2012> [26 March, 2014].

Perkins, J. (2013). *Professor John Perkins' Review of Engineering Skills*. London: BIS [online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/254885/bis-13-1269-professor-john-perkins-review-of-engineering-skills.pdf [26 March, 2014].

Richard, D. (2012). *The Richard Review of Apprenticeships*. London: School for Startups [online]. Available: <http://www.schoolforstartups.co.uk/richard-review/richard-review-full.pdf> [26 March, 2014].

The 157 Group Limited (2012). *The Challenges of Stem Provision for Further Education Colleges*. London: The 157 Group Limited [online]. Available: <http://www.gatsby.org.uk/~media/Files/Education/Gatsby%20Challenges%20of%20Stem%20FE.ashx> [26 March, 2014].

Wolf, A. (2011). *Review of Vocational Education: the Wolf Report*. London: DfE [online]. Available: <http://www.education.gov.uk/16to19/qualificationsandlearning/a0074953/review-of-vocational-education-the-wolf-report> [26 March, 2014].

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