School organisation and STEM career-related learning

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National STEM Centre careers project

Context

In November 2010 the Gatsby Charitable Foundation commissioned a short review of STEM careers support. The STEM Careers Review , authored by Sir John Holman reported on provision of information, advice and guidance at secondary and further education level in England, and made fifteen recommendations to guide the targeting of future activity.

STEM is an acronym for science, technology, engineering and mathematics.
The number and quality of teachers and lecturers recruited to train to teach STEM subjects plays a significant role in the success of students. Alongside this, one challenge for STEM teaching is to help young people recognise how the science, design & technology, computer science, engineering and mathematics that they study at school or college can lead to rich and varied career pathways. This complexity is a challenge – but also offers an enormous opportunity for STEM teachers to engage young people with these strategically important subjects.

Purpose

The STEM Careers Project was set up to address three recommendations made by the Review to the National STEM Centre, and in doing so contributed to improved access to STEM careers information, advice and guidance for young people both directly and through gatekeepers – careers professionals, senior leaders in schools, and teachers.

Activity

Several work streams were undertaken during 2012 and 2013. The project drew on previous work in this area by several organisations, including the Science Council, Centre for Science Education (CSE, Sheffield Hallam University), EngineeringUK, International Centre for Guidance Studies (iCeGS, University of Derby), and Centre for Education and Industry (CEI, University of Warwick).

These work streams have generated several important outputs for school leaders, subject teachers, careers advisers, and young people. These are:

- strategic planning tools to support school senior leaders in embedding, throughout their school, activity to raise awareness and aspiration for STEM careers. The tools were based on research evidence from the STEM Timelines Project, run by the Centre for Education and Industry (CIE, University of Warwick).
  www.nationalstemcentre.org.uk/stem-in-context/stem-planning-tools

- an openly accessible STEM careers resources database, which brings together several existing catalogues of STEM careers materials. The database is freely available for interrogation by any partner organisation, who may then wish to display results through their own online interfaces, which have been developed to meet the needs of various audiences. The database draws in part on physical and online STEM careers collections built and maintained at the National STEM Centre, but much of the information draws on sector specific sources.
  www.nationalstemcentre.org.uk/stem-in-context/careers-database

- high-quality online training module, designed to increase the knowledge and understanding of STEM careers amongst the careers profession and newly qualified teachers. The module was based upon work developed at Institute of Employment Research (IER, University of Warwick) and CSE and is freely available to any training provider.
  www2.warwick.ac.uk/fac/soc/ier/ngrf/stem/

- provided a sustainable base for Future Morph, the online student interface to sources of STEM careers guidance supplied by the Science Council. Through Future Morph, improved the provision of information for young people regarding vocational qualification routes to STEM careers.
  www.futuremorph.org

- this report represents the output from a research work stream undertaken by the iCeGS.

What job would you like to have when you get older?

"Doctor; lawyer; accountant; surgeon; entrepreneur: psychologist."

Year 9 girl

"There are many. To name a few: architect, some kind of engineer, astrophysicist or cosmologist or other scientist, mathematician."

Year 9 boy

"Singer, solicitor, teacher, bank-manager, accountant."

Year 9 girl

"I want to be either a photographerist (sic), in the police – rapid response, or a mechanic."

Year 9 boy

As these quotes demonstrate, many young people at age 13 or 14 are just at the start of their STEM career learning journey. They deserve help and support to make choices that will make the most of their talents. This report provides a summary of research managed through the National STEM Centre to look at how school leaders and their senior management teams respond to the challenge of supporting their students in their STEM career-related learning.

1.1 Research aims

The aim of the research project has been to identify the range of factors that shape senior leadership team decisions with regards to STEM (science, technology, engineering and mathematics) career-related learning. The factors that have been explored include:

- the type of school: for example, academy status, 11 to 16 or 11 to 18 provision, levels of progression to university
- the location of the school: for example, whether or not in an area with significant employment opportunities at all levels in STEM-related jobs
- the connectedness of the senior management team: for example, to their community, to STEM or career learning networks and professional groups, within clusters of schools
- the background of the senior management team: including their employment histories, and subject specialisms

The research was delivered as one element of the National STEM Centre's STEM Careers Project, which also includes a range of other activities such as supporting the development of on-line learning resources for use by the school workforce, a reinvigoration of STEM career learning resources, and the further development of the Futuremorph website.

Evidence has shown that the support of school senior leaders and their organisation of STEM within the school is highly significant in determining the success of STEM in an individual school. The seriousness with which STEM is taken is largely determined by the commitment shown by school leaders – this helps to shape both the allocation of resources and also their prioritisation of STEM and of associated career learning within the school strategy (Finegold et al, 2011). Yet little is known about what factors shape school leaders' decisions on prioritising STEM career-related learning in relation to the many other programmes and activities within schools. This is not a straightforward choice, because the prioritisation of STEM impacts upon many other aspects of school activities, including curricular decisions, support for enhancement and enrichment activities, management structures and responsibilities, and liaison with external organisations.

Choices made by schools in these respects have a significant impact on students' career choices and consequently, in the long term, on the future economy. Whilst they are at school, students tend to find science and technology enjoyable and to regard mathematics as important (Hutchinson et al, 2009). The Wellcome Trust (2013) found that 82% of young people said that they found science lessons to be very or fairly interesting, and that 82% thought that science was a good area for employment, but that only 41% said they were personally interested in a career in science.

The flow of young people through lessons in STEM subjects in school and sixth form and into college and university courses is also illustrative of these issues. Department for Innovation, Universities and Skills (DIUS) (2009) reported that although the numbers of young people studying chemistry, biology and mathematics at A-level were increasing, the proportion of the cohort of young people taking these subjects was declining. For physics the situation was worse: numbers taking physics A-level were declining along with the proportion of the cohort. Despite this, he Higher Education Funding Council for England (HEFCE) (2009) noted that increasing proportions of those who took science subjects at A-level were choosing to continue to study them at university. In fact, the number of students in chemistry, physics and mathematics programmes had been growing at a faster rate than average across all subjects, although student numbers taking engineering had been declining (albeit with distinct differences between sub-disciplines).

The concern among employers and policy-makers is whether or not this flow of students into STEM learning is enough to meet demand for their skills and expertise. There remains widespread concern in the UK that there is a current and projected shortfall between the number of jobs that need people with STEM skills and the number of people with the appropriate STEM qualifications. This concern has been reported by employers, with the CBI (2011) suggesting that 43% of businesses currently have difficulty in recruiting STEM-skilled people, with this proportion expected to rise in three years' time. More recently, Broughton (2013) warned of a STEM "human capital crunch", noting estimates from the Academy of Engineering and Big Innovation Centre that demand for new workers will average 104,000 STEM graduates and 56,000 STEM technicians in each year between now and 2020, contrasted with around 82,000 UK-domiciled graduates studying STEM subjects in 2011–12, of which an estimated 18,000 will go into non-STEM occupations. Based on these data, Broughton calculated that there is currently an annual shortfall in domestic supply of around 40,000 STEM graduates. The DIUS (2009) research was more specific in its assessment of these skill shortages, citing them as being focused on particular areas of biosciences, engineering and IT, but with a more general concern from employers that STEM graduates lacked employability skills.

The problems associated with the mismatch between STEM skill supply and demand is more perplexing given the evidence that not only do STEM-related jobs exist but that STEM skills command a wage premium. Research (Greenwood et al, 2011) has shown that many qualifications have additional value in the labour market if they are in a STEM subject area (though less so in science and more so in engineering); and that people working in science, technology and engineering occupations attract wage premia (though, again, less so for science and more so for technology and engineering). In other words, there are wage rewards to be had from STEM qualifications in any job, but particularly in a STEM-related job.

Career-related learning is one way to help young people to consider taking their STEM studies further. A programme of career-related learning can support young people to build their self-awareness, develop skills, acquire knowledge, and support a positive attitude towards engaging in planning their futures. It can help to give them the information they need to make subject and career choices and the skills they need to make sure they are on appropriate paths to fulfil their ambitions.

The phrase "career-related learning" is used here purposefully. It includes three areas of activity which have tended to be seen as discrete aspects of the curriculum and to have been managed separately within schools: career education; work-related learning; and career information, advice and guidance (IAG) (see Figure 1). When combined, they provide a programme of learning to help young people to develop into their future selves.

Career education is a term used to describe a series of activities and engagements that help young people to understand themselves and the influences upon them (self development), investigate opportunities in learning and work (career exploration) and make and adjust plans to manage change and transition (career management). These three categories of activity are reflected in resources developed to support career education in schools (DCSF, 2010).

Career education therefore includes a range of learning that allows young people to articulate their own strengths, values and ambitions, as well as their skills and competencies. It also encourages them to develop their views of the world through career exploration, and supports them in developing the skills they need to make effective decisions and transitions and to develop strategies that encourage resilience when things do not go according to plan.

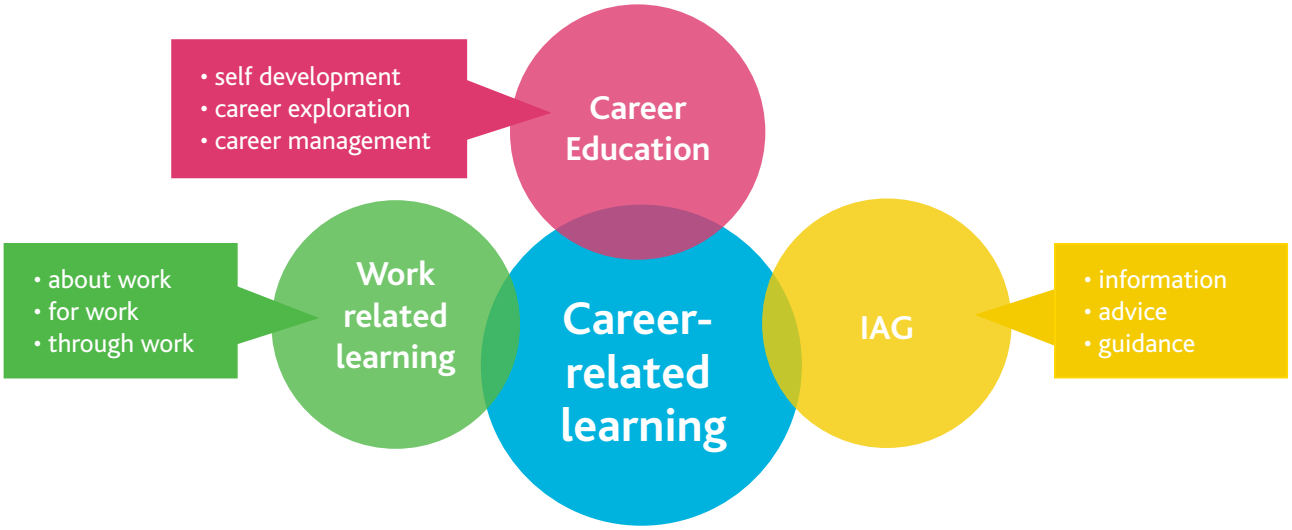


Figure 1: Career-related learning

Work-related learning complements career education but is frequently managed as a separate stream of activity within schools. It has been summarised (DCSF, 2009) as comprising:

- learning for work: to develop skills for enterprise and employability (for example, through problem-solving activities, work simulations, and mock interviews)
- learning about work: to provide opportunities for students to develop knowledge and understanding of employers, employment and enterprise (for example, through vocational courses and career education)
- learning through work: to provide opportunities for students to learn from direct experiences of work, including developing the employability skills and "can-do" attitude that employers value (for example, through work experience or enterprise activities in schools and learning through vocational contexts in subjects)

Finally, there is career information, advice and guidance (IAG) – which has often been used to include services sourced externally, formerly through the Connexions service (Hooley et al., 2012). It is seen as an umbrella term which incorporates three elements:

- the provision of accurate, up-to-date and objective information about personal and lifestyle issues, learning and career opportunities, progression routes, choices, where to find help and advice, and how to access it
- the provision of advice through activities that help young people to gather, understand and interpret information and apply it to their own situation
- the provision of impartial guidance and specialist support to help young people understand themselves and their needs, confront barriers, resolve conflicts, develop new perspectives and make progress (DCSF, 2007)

Schools support career-related learning in different ways. There are four models of career education (Watts, 2001):

- a specific enclosed model; in which career education is provided as a separate subject or module within the curriculum
- an extended enclosed model; in which it is provided as part of a more broadly based subject or module (such as in personal, social and health education (PSHE))
- an integrated model; in which it is integrated across the curriculum as a whole
- an extra-curricular model; in which it is provided as an additional element outside the formal curriculum

A typical school might chose to organise its career-related learning activity with career education and aspects of work-related learning as a component of the PSHE curriculum (the extended enclosed model), further aspects of work-related learning as part of a separate module, and career guidance as an extra-curricular activity. Career-related learning is not an assessed part of the curriculum and schools have developed a range of ways to deliver the statutorily required minimum (Morgan et al., 2007). It is worth noting that policy has changed the statutory requirement for both careers education which is generally offered within PSHE, and careers guidance where the duty for impartial independent guidance has been placed from Year 8 through to the end of compulsory education. (Watts, 2013).

Of particular interest to this research study is the models of practice which link career-related learning to learning about STEM subjects, because it is in this space that young people can build upon their interest in science, mathematics and technologies and learn how these are applied in the wider world, including the people who perform those roles in the workplace. Consequently, the research is particularly focused on schools' applications of the integrated model where career-related learning is built into the various STEM curricula, and the extra-curricular model where activities in clubs, collapsed timetable days and involvement in external events combine aspects of both STEM and career-related learning.

The extent of a school's engagement with these dual agendas is often driven by the experiences and attitudes of the senior leadership team (Finegold et al., 2011). Finegold et al. suggest that there are two main factors which contribute to a school environment that fosters engagement with both STEM and career-related learning: the first is active support from the school leadership team; the second is having a cross-curricular infrastructure which enables the school to integrate career learning opportunities into the curriculum. These provided the context for the research project reported here.

1.3 The research study

This report presents the findings of a research project which explores the role of school leaders in relation to schools' engagement in the following range of STEM career-related areas:

- management and responsibility for STEM career-related learning and its prioritisation in the context of whole-school strategy and planning
- co-ordinating STEM enhancement and enrichment
- integrating career-related learning with STEM curriculum delivery
- supporting continuing professional development (CPD) needs of subject teachers in career-related learning
- commissioning career information, advice and guidance in line with statutory requirements
- community engagement, including with the business and learning provider communities
- active management of student progression in the context of the proposed Department for Education (DfE) progression performance measure along both vocational and academic pathways

The research has two important roles: firstly, to add to collective understanding about the role and influence of senior leaders; and secondly, to identify the factors influencing them in taking forward STEM career-related learning across their schools.

The research study had two phases: qualitative work in nine case study schools, followed by a self-completion survey among school leaders.

Nine case study schools (Table 1) participated in the research. These schools were self-nominated in response to a call for participants on the National STEM Centre and International Centre for Guidance Studies websites and active promotion of the research by the National STEM Centre team. The schools that participated reflected:

- three different geographic contexts – three towns, three schools in city peripheries and three coastal areas – thus representing different socio-economic contexts
- schools with and without sixth-form provision
- schools which already had academy status, those that were applying and those that were not
- schools which had a range of STEM specialisms

The fieldwork comprised interviews with a range of leaders and teachers in each school. In addition, in four schools the researchers had the opportunity to speak to students. Fieldwork was conducted between February and May 2012.

Table 1: Participating case study schools

School	Location	Age range	Type
Barr Beacon School	Walsall, West Midlands	11 to 18	Academy
Bradfield School	Sheffield, Yorkshire and the Humber	11 - 16 soon 11 - 18	Academy order *
Garibaldi College	Mansfield, East Midlands	11 to 18	Maths specialism
Great Sankey High School	Warrington, North West	11 to 18	Engineering specialism. Academy order*
Longfield Academy	Darlington, North East	11 to 16	Academy. Sports specialism
Newland School for Girls	Hull, Yorkshire and the Humber	11 to 16	ICT specialism
Richard Rose Morton	Carlisle, North West	11 to 18	Academy - shared 6th form
Royton and Crompton	Oldham, North West	11 to 16	Science specialism
St Thomas More, RC	North Shields, North East	11 to 18	Academy. Faith school

* If the Secretary of State for education agrees with a school's application for academy status he will issue an academy order. It is an indication that the school is in the conversion process.

A draft summary of key themes was developed from this research, discussed by the project's steering group and then used to inform the research instrument for the second phase: the on-line self-completion survey of school leaders. The specific purpose of this survey was to:

- reinforce or re-examine the findings from the qualitative work of phase one
- secure specific reaction from schools about CPD networks, database services, web based information resources and other activities that are offered into schools to support STEM career-related learning

The survey was developed in November and December 2012 with input from the project steering group and piloted with three schools in Derbyshire. The survey was distributed to named contacts from the Spirit database and from the National STEM database list of contacts.

It was sent to 3,570 contacts, as follows:

- senior leaders (226)
- careers/PSHE staff (90)
- head of design & technology or of technology (599)
- head of engineering (142)
- head of science (2,302)
- head of mathematics (211)

The survey was live between March and May 2013 and secured 196 respondents. The majority were either from state-funded academy schools (40%) or from state-funded local authority maintained schools (36%); independent school accounted for 8% of returns; with the rest coming from other types of schools or colleges. 43% said they had some major STEM employers locally, while 39% had some small STEM employers locally. Whereas 11% had no STEM employers nearby, 7% said their local economy was dominated by STEM employers.

Three-quarters of the respondents were either heads of science or heads of design & technology. Two-fifths of respondents worked in an academy; while 36% worked in a state-funded local authority maintained school. The survey presents the perspectives of leaders of STEM subjects in secondary schools in England on issues associated with career-related learning in the context of their own schools and subject areas. This is quite distinct from other surveys which provide feedback on careers work in schools from service providers or their own careers co-ordinators (e.g. Careers England, 2012; ICG, 2012).

The level of response is insufficient to claim that the findings are statistically representative; however, with a confidence interval of 7 for this sample size and for simple response questions, it is possible to assume that +/-7% of the population would have provided the answers that this sample provided.

1.4 The policy context

The research was undertaken over a period of significant change for schools. New education and skills policies had been developed and implemented by the Coalition Government since May 2010, alongside fiscal and budgetary constraint (see Watts, 2013). These cannot be discussed in detail here, but it is useful to mention the range of factors which have created a policy whirlwind with schools at its core. One intensely debated policy change has been the Education Act of 2011 and its statutory duty upon schools to secure independent career guidance for all registered students in Years 9, 10 and 11 (House of Commons Education Committee, 2013). The age limit has subsequently been extended to include Years 8, 12 and 13 (Department for Education, 2013). The new duty requires the school to secure career guidance for students, whilst providing no extra money to fund it; at the same time, the Connexions service which formerly worked with schools has been effectively dismantled (Hooley & Watts, 2011).

In addition, following the Wolf report (DfE, 2011a) which questioned the value of work experience for students pre-16, the government has removed the statutory duty on schools to provide work-related learning (of which work experience is a component) to students up to Year 11. At the same time, the government has also removed the duty to provide a programme of careers education.

Schools have also had to respond to new curriculum initiatives including qualification reform with changes to the examination bodies, the introduction of the English Baccalaureate, the abandonment of Diplomas, and the restructuring of vocational qualifications.

Furthermore, following a policy of fiscal constraint, a number of networks and co-ordinating bodies have been lost to the school environment. These include Education Business Partnerships which in some areas were responsible for the provision and management of work-experience opportunities. Aimhigher partnerships, too, have seen their funding cut, with the responsibility for widening participation transferred to individual higher education institutions, overseen by the Office for Fair Access.

Finally, the choices that young people can make have changed with the continued expansion of apprenticeships and the creation of university technology colleges providing different opportunities. Also, the removal of the Education Maintenance Allowance for 16-18 year olds and the introduction of higher university fees (following the Browne Report, 2011) have increased the focus on financial aspects of individual risk and potential reward to be gained from educational choices.

These changes have all informed the response of school leaders to their focus on STEM learning, on career-related learning and on the integration of the two. This report starts by highlighting the various ways in which STEM career-related learning is being developed in schools. It goes on to explore the ways in which various factors such as the school leaders themselves, the nature of the local economy within which their school is situated, and their school priorities, influence their STEM career-related learning activities. The report concludes by outlining some recommendations to enhance STEM career-related learning in schools.

1.5 Acknowledgements

This report has benefited from the wisdom of many people, not least the project steering group and the National STEM Centre team, notably Jenifer Burden and Michele Jones. Thanks are also due to colleagues at iCeGS who have supported fieldwork and quality assurance including Tristram Hooley, Nicki Moore and Siobhan Neary.

The greatest debt of thanks is owed to those teachers who have given up their valuable time to contribute to the research either through participating in the fieldwork or through responding to the survey. Thanks are also due to the students who spoke to us about their school activities. They were bright, engaging and very insightful in their responses; when asked what job they wanted to do in the future, they expressed diverse and often multiple ambitions for themselves and their future families.

2 STEM career-related learning in practice

2.1 Introduction

What is STEM career-related learning? Is it a curriculum or a set of activities? Where does it fit within the school timetable, and who should manage and deliver it? This section presents STEM career-related learning in practice, drawing evidence from both the case study schools and the survey.

The research found a lot of interesting practice within schools that focused on enhancing and enriching the curriculum, particularly in science and technology. Similarly, there was some excellent practice in career education and work-related learning. Furthermore, in several cases schools had, at least in some instances, undertaken activities or projects that brought together learning about STEM subjects with learning about some jobs and careers that require STEM skills and knowledge. This section presents findings that describe:

- STEM subject learning – which focuses on how schools explore the themes that cut across learning in science, design & technology, engineering, and mathematics
- career-related learning – in particular, what activities schools undertake and how they organise their career education curriculum, work-related learning, and information, advice and guidance provision
- STEM career-related learning – the extent to which the activities which schools undertake to support STEM subject learning connect with their students' career-related learning

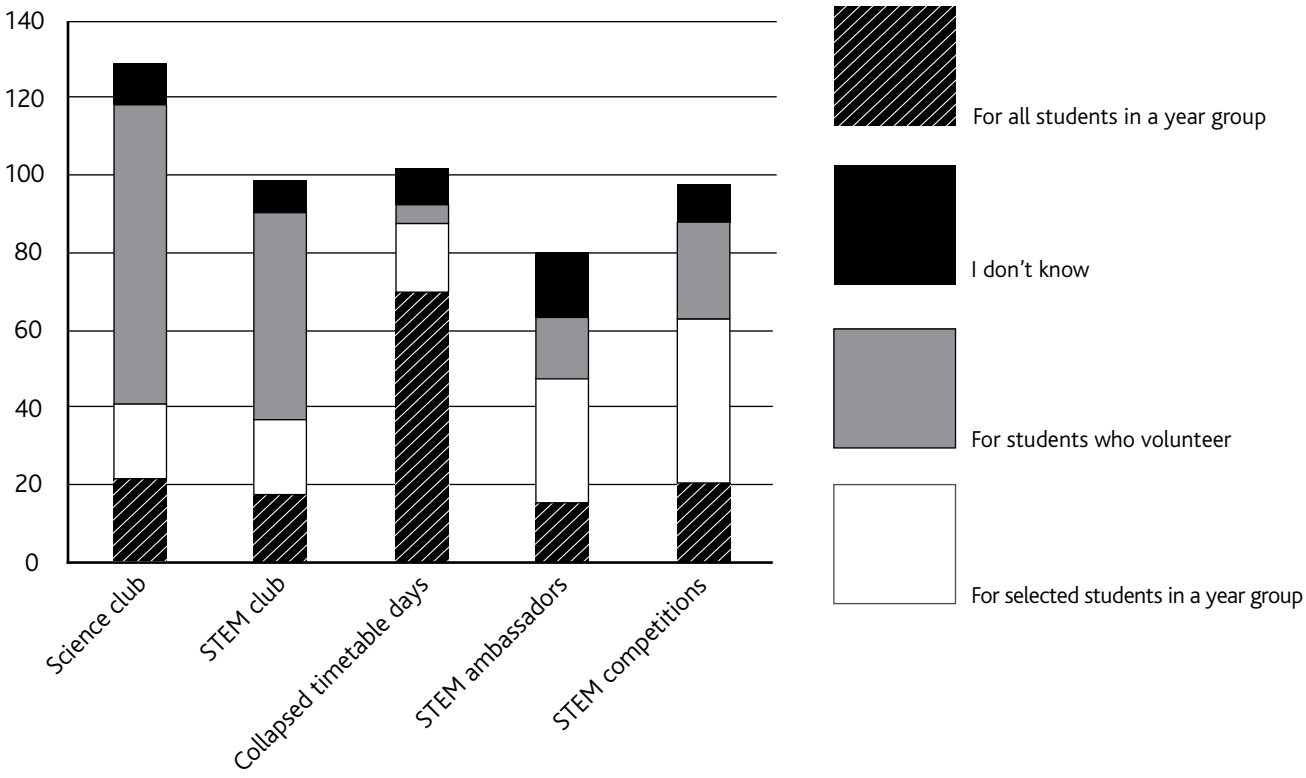
Although the subjects that are drawn together within the STEM acronym are distinctly different from one another, the concept of STEM is familiar to both staff and students in schools. All the case study schools found the concept to be helpful for them and their students because it allowed the integration of learning across subjects and encouraged students to apply elements of learning from one subject to another – using mathematics in science, or science in design, for example. Many of the students we spoke to were also familiar with the acronym: in fact, only one school mentioned that their students would not recognise it.

Schools can offer opportunities outside class time to support students to learn more about either science or mathematics, or about STEM more broadly. The most frequent activity that schools undertake to support STEM learning is to run science, mathematics or STEM clubs either at lunch times or after school. In some schools these are targeted at the more academically able, whilst others encourage anyone who is interested. Some of the case study schools noted that whilst the opportunities to participate were open to all, they tended to attract more boys and that they were aware of the need to encourage more girls. Only one of the case study schools had run a STEM enrichment activity specifically for girls.

In addition, some schools encourage cross-curricular project work or learning as part of their delivery of the national curriculum. This takes a variety of forms:

- Bradfield uses engineering and Royton & Crompton uses technology as a cross-cutting theme for all their STEM activities. They encourage either the use of new technologies in their classes or the application of technological or engineering concepts into science and mathematics classes
- other schools have collapsed timetable days where they focus on a particular aspect of learning across a whole school year-group. For example, at Garibaldi the school has "flexi-Fridays" every week where the whole day is given over to a subject for a year group in rotation, to allow for a deeper exploration of issues than is possible in the normal lesson span
- projects or special assignments are used in one school (Bradfield) across the whole curriculum which encouraged the integration of engineering in all subject areas; for example, the PE Department has been involved in a project to design an efficient swimsuit

Figure 1: Which of the following things that help students to learn more about STEM subjects are offered at your school?



The survey showed this type of activity to be quite common in schools (Figure 1). Of those respondents that provided information to this question, the majority worked in schools that had science clubs (71%, n=129) or STEM clubs (54%, n=99), participated in STEM competitions (53%, n=98) and/or had STEM ambassadors (53%, n=80). Students were either selected or volunteered. In addition, many schools undertook collapsed timetable days for cross-curricular learning.

One of the nine case study schools had developed a very innovative approach, developing a STEM course which was a curriculum choice within Key Stage 3. Longfield Academy had a curriculum option of STEM in Year 9 which was very practical, was oriented towards employability skills as well as STEM awareness, and attracted students across the ability spectrum. This involved a range of learning activities including problem-solving activities, challenges and practical engineering, as well as visits and activities with STEM employers. The boys who took the option represented the full spectrum of academic ability and really enjoyed their STEM learning:

> *"We learned different skills throughout STEM – it helps us figure out what our best skill is and what skills we need to improve so then we can figure out to decide on an option that would help us improve those skills and also head for the career that we would like."*

> *"STEM is like a little quiet zone, it's like a little bubble like [boy's name] he would never speak in front of the class but now he will talk in the class."*

> *"I like the skills what we've learned and how they have improved us – creative, team work, and listening we do a camp fire where we talk about our ideas."*

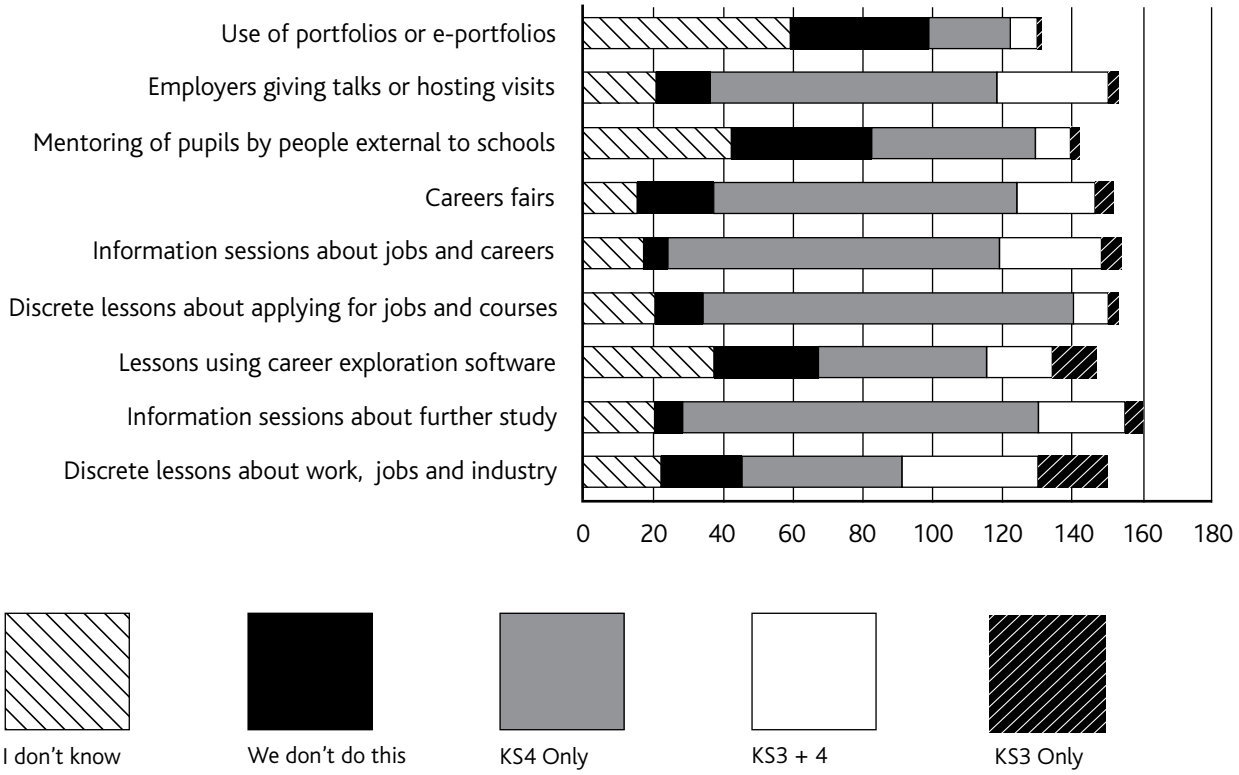
> *"Helps you to express yourself – to do what you want to do and not just doing it the way the textbook says."*

These students were making a presentation to the Board of Governors to request that they repeat it next year and extend it into Key Stage 4. The course was not accredited but it was hoped that it would encourage students to want to study STEM-related qualifications in Key Stage 4.

We know from the case study schools that most career-related learning takes place within PSHE lessons where schools will help students to understand what work is, how work requires skills knowledge and aptitudes, what subject options are, and how subject choices might lead on to particular types of jobs. This may be delivered by the teacher with nominated responsibility for careers, but more usually is a shared responsibility. So at Bradfield, for example, careers activities fall under the PSHE and citizenship departments, but heads of house who are non-teachers also have some responsibility for delivering careers work.

The survey responses suggest that very little career-related learning takes place during Key Stage 3 only, though some starts in Key Stage 3 and continues into Key Stage 4. Most career-related learning takes place only during Key Stage 4 (see Figure 2). In Key Stage 4 the most popular activities are discrete lessons about applying for jobs and courses, information sessions about further study, and information sessions about jobs and careers.

Figure 2: What types of career-related learning are taking place in school in this academic year?



Careers fairs are a popular source of information offered by schools, although these also tend to cater just for Key Stage 4 students – only 14% of the schools who responded suggested that these were designed for both Key Stage 3 and Key Stage 4 students.

Eighty per cent of the survey respondents said that students in their school would be undertaking work experience; 18% said that this was not happening at their school; and only 2% did not know. Although most said that the work experience was following the traditional model in Year 10, some were also doing it in Years 11 and 12. This is higher than might be expected, given the removal of the duty for schools to provide work-elated learning. It will be interesting to see whether in subsequent years schools review their strategies towards work experience, or continue to offer it as an integral part of the learning experience for their students.

It is worth noting that a small but significant number of respondents reported that they did not know what career-related learning took place at their school. Highly visible activities such as careers fairs and employer talks were more likely to be known about by the STEM leaders who responded to the survey. However, those that took place within careers education lessons were less likely to be known about, so for example 42% did not know whether or not the school encouraged the use of portfolios, 30% did not know about mentoring, and 26% did not know about the use of career exploration software. These activities may not happen anyway in the respondents' schools, but the fact that the respondents were not sure could mean that opportunities to integrate STEM learning with career learning are being lost.

2.4 Linking STEM with career-related learning

Where STEM-related learning intersects with career-related learning, then either an integrated model or the extra-curricular model is applied.

Some case study schools linked their STEM activities with some form of career-related learning within the integrated model (as part of the subject curriculum). Several schools provided examples of the ways in which they had integrated career-related learning into their STEM subject lessons. These examples included:

- Longfield Academy had put STEM in the Year 9 curriculum as an option: the learning emphasised employability skills and vocational and academic route-ways into STEM employment.
- Royton & Crompton sought to apply learning about technology and its practical applications across all subjects, including elements of occupations and job roles.
- Barr Beacon asked all teachers to deliver a lesson on the career destinations that study of their subject could lead to, as part of their careers week.

In other cases the extra-curricular model was applied, with external speakers being invited in to support a project or a theme (STEM ambassadors were mentioned by most schools). Examples included:

- QUEST Challenge at Richard Rose, which asked students to deliver a range of team and personal challenges on a STEM agenda, such as problem-solving activities related to bridge building, aerodynamics (rocket building) and robotics projects.
- a Beauty Box project undertaken in preparation for Mother's Day at Newland School for Girls. This collapsed timetable day integrated aspects of subject learning incorporating chemistry, engineering, mathematics and design with an element of enterprise. The project concluded with a career-related learning opportunity in which students reflected on the skills they had learned and how the roles they had played reflected those in the workplace.
- Great Sankey's participation in a range of schemes which brought ambassadors into school to talk about their careers, and also encouraged students to go out of school to interview STEM workers about their roles and career routes.
- Royton & Crompton's links with science departments at Manchester University and Salford University; in addition, every year students visited Christie Hospital in Manchester to speak with people who worked there and find out more about what they did.

Examples using the extra-curricular model were more frequently mentioned in the case study schools than those which applied an integrated model. Great Sankey (Box 1) offered a good example of a school which provided its students with a core career-related learning curriculum (starting from Year 7), developing a foundation for a wide and exciting range of extra-curricular activities that engendered a continued enthusiasm for STEM subjects and related careers. The provision at Great Sankey brought together teachers from different subject areas including science, enterprise and mathematics with their careers co-ordinator to build a diverse and inclusive range of learning opportunities.

Barr Beacon represented another example, with career-related learning starting in Year 7 and providing a foundation for the integration of STEM skill building and learning about STEM careers into their enterprise learning. The programme of career-related learning started in induction days for new Year 7s and featured career learning in PSHE lessons, speakers including STEM ambassadors, a careers resource supported by students, a web resource designed by students, enterprise days on a STEM theme and a STEM careers fair (see Box 2 for further details).

Box 1: STEM and career support activities – Great Sankey School

The school has developed a range of ways to link STEM learning with career-related learning, including:

STEM learning
LEGO Innovation Centre: a £25,000 investment from LEGO in robotics, wind turbines, solar panels and other educational kit was secured by the school following a competitive bid. This is used by the school STEM clubs and in teaching and also is open to primary schools, which helps the transition from primary to secondary and helps interest younger students in applied science learning.

STEM clubs: run by different STEM teachers in Key Stages 3, 4 and 5. The activities are project-based and students are encouraged to help their younger peers. These include projects such as building rockets, a trebuchet, and a forensics challenge.

Three themed weeks in each year including the National Science and Engineering Week.

Participation in challenges and competitions, such as the visit from the Olympic Skelton bobsleigh team who brought in a simulator on which participants could test their own bobsleigh. Recently their Viz Robotics team won the semi-finals of the national competition and were planning to attend the finals in California.

Links with universities and colleges which provide tickets to lectures and other special events, and include teaching links between undergraduates and school students.

Career-related learning
Careers lessons in each year from Year 7 through to 11. Work experience in Year 10 and executive shadowing in Year 12 ("where we try to up the ante and say go and shadow a consultant at a hospital for 3 days and work in a lab for 2...don't just go to a shop and stack shelves").

Options evenings, assemblies, taster days for each subject and discussions with students and senior teaching team member to discuss options and advise accordingly.

Various assemblies on careers and invited speakers from local businesses or from STEMNET's STEM ambassadors.

STEM career-related learning
Involvement in STEM Leader Challenge: for example, one sixth-form boy said that "We had to interview someone from a profession... related to science, technology, engineering or maths. For me I chose to interview a paramedic... this was arranged through the college, through STEM, otherwise I would not have been able to do that and I've got booked for this summer, actual work experience with that paramedic, so it's providing me a good link."

Participation in the Discovery Challenge: run by Warrington Borough Council for five students from each school to engage in a range of extra-curricular activities, challenges and events such as employer visits and a trip to the Big Bang science exhibition.

Curriculum groupings: including enterprise and ICT alongside STEM with a team teaching approach and a creative use of project work. For example, students linked a STEM project with enterprise; with their profits they funded a visit from a Wilder Beast man who brought in snakes and spiders.

Box 2: STEM and career support activities – Barr Beacon School

After identifying STEM as a whole-school priority, the headteacher appointed a STEM co-ordinator, to take the lead on developing activities related to STEM learning. In recognition of her efforts, the STEM co-ordinator achieved first prize in the 2013 STEM Leaders Teachers Award. All STEM events are also reported to the school governors.

STEM learning
All Key Stage 3 students participated in the STEM Leaders Award through English lessons.
The Year 7 STEM day focused on science activities, where students explored science and engineering. Year 9 took part in a STEM Curriculum Day, where workshops were completed with STEM Ambassadors. Students also had the opportunity to take part in the Go4Set challenge. The school promoted engineering events, particularly targeting girls' participation. STEM activities featured prominently in the termly newsletter, with their own regular column.

Career-related learning
Each year, the school takes part in both the National Apprenticeship Week and National Careers Week. In 2012 all subject teachers and form tutors described their own career paths and progression routes. The focus for 2013 has been on Barr Beacon's version of the top ten employability skills. Staff are also expected to update their own knowledge about new careers, UCAS applications, apprenticeships and newly created jobs.

The school has created a career aspirations database for individual students, which is updated regularly. It tracks current student interests in career choice and university ambition, and helps to capture the continual development and change in the thought processes of students with regard to their career choice. "With parents, universities, apprenticeship providers, careers advisor and local businesses support, we are able to make the presentations more personalised and focused" (assistant headteacher).

Careers ambassadors have been selected from each year group to work as a team in supporting careers events. Two of the Year 11 career ambassadors developed a careers based website, which now includes all careers information under one tab on the school webpage.

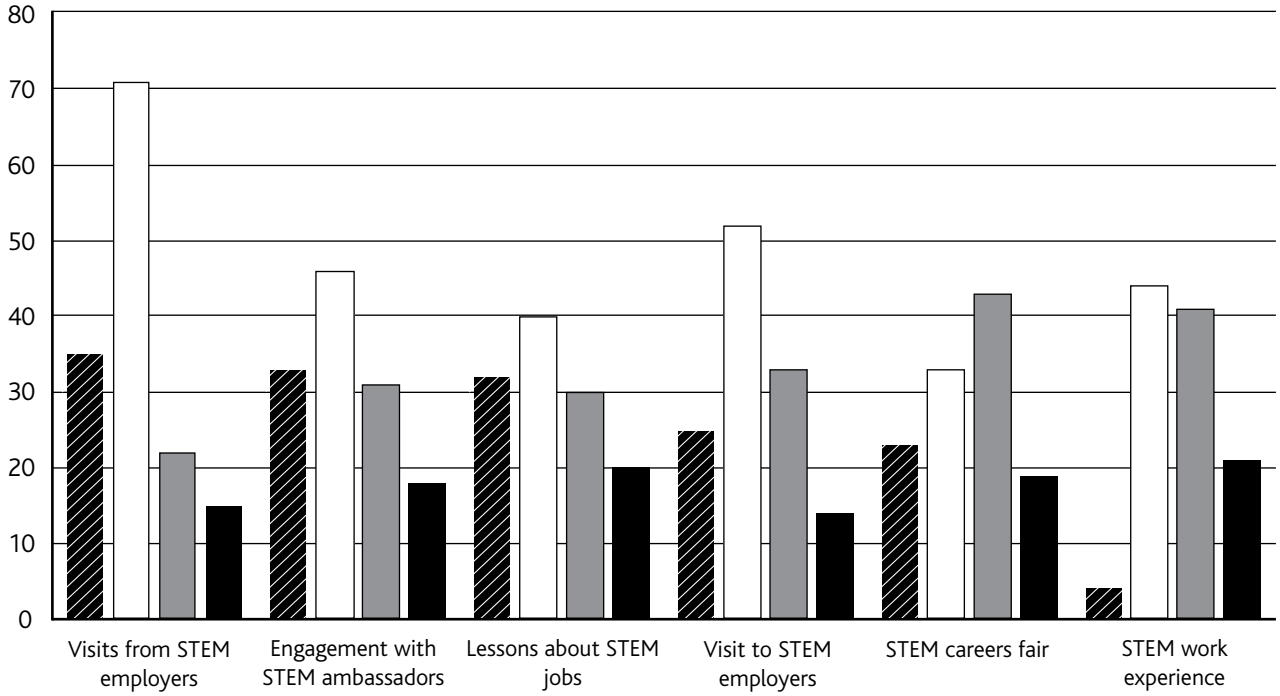
STEM career-related learning
STEM is integrated throughout the curriculum. This includes the careers education module of the PSHE programme. Students track their knowledge by completing a booklet which enables them to take part in their own career development. The school has recently focused on developing employability skills, which is a focus for both subject teachers and form tutors. STEM features heavily in this: a handy reference version appears in all student planners.

The after-school STEM club, for both Key Stages 3 and 4, has given students the opportunity to take part in visits and competitions. STEM ambassadors gave their support in helping students prepare for the Olympics build-up for Sports Day. The STEM club also visited the Big Bang, which sparked off even more interest in STEM careers.
Assemblies reflect the school's focus on supporting students in developing a sound approach to selecting an appropriate career path, which includes attention to STEM careers. In one assembly, the career champions gave a presentation with alumni graduates, local employers and a parent (graduate nurse) to recall their own career paths: "this was memorable because the students made the link between their individual learning and the impact on their own lives" (assistant headteacher).

Careers fair: During the last 3 years the school has held successful careers fairs for all year-groups and in 2013 it developed a STEM-focused fair. It was also very pleased with a STEM parent and student evening which took place in June: "it was fabulous seeing parents and students enjoying making a buggy and racing it against each other" (STEM co-ordinator). A student commented: "This is fun!"
Progress Evenings now feature support from other providers, giving parents and students up-to-date information on STEM careers, which contributes to developing higher aspirations.

The survey sought to ascertain the extent to which STEM career-related learning activities were undertaken across all schools, using a set of pre-determined activities. Visits from and to STEM employers were the most frequently undertaken, with the use of STEM ambassadors also being popular (Figure 3). STEM-related work experience and STEM careers fairs were undertaken in many schools, but many respondents said these did not happen or they did not know whether they did or not – and many more simply chose not to respond to this question.

Figure 3: Which of the following activities take place in school to help students learn specifically about STEM career opportunities?



STEM career-related learning therefore brings together aspects of enhancement and enrichment and gives them a career dimension; conversely, career and work-related learning are given a STEM dimension. These activities are purposefully planned and delivered by teams of teachers from a range of different STEM disciplines including science, mathematics and design & technology plus careers co-ordinators, but also including teachers of geography, enterprise and business studies.

2.5 Measuring impact

The types of activity revealed by the case study schools and in the survey require significant investment in terms of teacher time, allocation of physical resources and involvement of external providers including employers and other local stakeholders. Discussions with teachers and students revealed that some of the activities were thought to be inspirational, and were enjoyed and valued by those who participated in them.

Accordingly, the researchers were curious to find out the extent to which schools measured the impact of these activities. There are a number of different dimensions that could be measured. For example (based on the Kirkpatrick (1959) model):

- impact on student engagement and interest – did they enjoy it? would they do it again?
- impact on student learning – what do they know now about STEM subjects and STEM careers that they did not know before?
- application of student learning – how might this new learning be applied in the study of STEM subjects or in their consideration of STEM careers?
- activation of student learning – what have students done as a direct consequence of the activity?

The survey revealed, however, that there was little systematic evaluation of the impact of STEM career-related learning. The survey asked respondents: "Have you measured the impact of activities that take place in school to help students learn specifically about STEM career opportunities?" Eighteen respondents said some such evaluation had taken place in their school: half of these were academies; the other half were state funded local authority schools. Their brief accounts of how they measured impact suggest that in most cases their evaluations comprised student satisfaction surveys, which provided an assessment only of the first stage of impact according to the Kirkpatrick model.

Three respondents described evaluation activities which went a little further. One had conducted survey research among parents, students and visiting professionals to gauge the impact of a new range of STEM activities at Key Stage 3 on student uptake of those subjects in Key Stage 4. They reported an increase in take-up of STEM subjects but also an increase in understanding of opportunities within STEM careers, particularly for girls. Two other respondents said that they did surveys to track progression of interest in studying STEM subjects following STEM engagement at Key Stages 4 and 5, and then into higher education. Clearly some schools have found that they can both evaluate the initial impact of an activity, and then track the effect of that activity on participation in learning and progression.

Where such evidence within schools exists, there are positive indications of the impact of STEM career-related learning on students. However, that evidence is not being systematically sought within schools to inform their prioritisation of this issue among the range of other issues that shape school strategies. There have been other research studies that assess the impact of various aspects of STEM career-related learning, such as the impact of STEM ambassadors (Straw et al, 2011), and of other career-related learning activities including work experience (see Hooley et al, 2011); and the Wellcome Trust recently published a meta-analysis of the impact of a range of activities on young people's subject choices (Bell, 2010). All of these indicate that under certain circumstances individual initiatives can have a positive impact. However, the evidence specifically relating to the impact of STEM career-related learning on students' engagement, attainment and progression remains insubstantial.

3.1 Introduction

One of the primary aims of the research was to explore the nature and characteristics of school leadership teams that support the development of STEM career-related learning activities. However, it is equally important to understand the context within which any leadership group is working. Research has found that effective leadership has to be sensitive to the schools' context, which may be derived from external factors including where it is, the student and parent population, and opportunities for wider partnership working (Ofsted, 2003; Southworth, 2004). Alternatively, internal school factors such as staff absenteeism, recruitment issues, morale, Ofsted assessments, or the school's own drive for continuous improvement, shape the response of school leaders. This research therefore examined the following aspects of school leadership and factors that shape the school context:

- school leadership and delegated responsibility
- teachers' prior work experience
- careers provision
- school networks
- the local economy
- student attainment and progression
- school structure

It is clear that school leaders have a great influence on the success of their school. Ofsted (2003) confirms the importance of "strong leadership and good management in bringing about improvement in schools, particularly in schools which are implementing special programmes to address low achievement and social inclusion, including those facing challenging circumstances". Some researchers focus on leadership as being synonymous with a charismatic and directive figurehead leading a school through their single vision and in control of all aspects of school management (Lewis & Murphy, 2008). However, Leithwood et al (2004) define leadership as being more of "an influence process" than a directive one. In a more recent study, Leithwood & Mascall (2008) provide further survey evidence to support the view that good school management combines effective transformational leadership with delegation of responsibility for achieving outcomes distributed across the school workforce. They conclude that "higher-achieving schools awarded leadership influence to all school members and other stakeholders to a greater degree than that of lower achieving schools" but that within this "principals were awarded the highest levels of influence in schools at all levels of achievement." In other words, leadership of schools is not simply about the role of the headteacher but about how they influence, support and empower all their staff members.

In five of the nine case study schools, the drive to focus on STEM and combine within it aspects of career-related learning came from the headteacher. In these schools there was general acknowledgement from their teacher colleagues that the headteacher was closely and personally linked with the STEM initiatives and focus in the school. These headteachers set the school priorities and culture, which were cascaded and followed throughout the school. One of these schools was coming out of special measures: the head's initial focus had been on behaviour and attendance, followed by a focus on English and mathematics, and only subsequently on STEM. This set a very clear direction and insisted on high aspirations for teachers and parents of their students in terms of educational attainment.

In other schools there were clear links between the headteachers' professional interests and priorities and the strategic direction set for the school. So, for example, the headteacher at Royton & Crompton was nationally networked in the science community and was energetically pursuing excellence in science and related subjects as a way to enhancing attainment and inspiring ambition among the students; this was felt in his school through their science focus. Similarly, the headteacher at Longfield Academy was committed to curriculum innovation and fostered an environment in which this took place, so was keen to support innovations relating to the STEM curriculum. Again, the recent headteacher at Great Sankey was an advocate of employer links and fostered several such links including one which led to the creation of its vehicle workshop being fully equipped by the RAC.

Another headteacher had a very different style which focused on issues more closely associated with career-related learning. She had a strong focus on the dual aspect of pastoral care and academic attainment, with a commitment to the personal development of each and every student and recognition of the role that STEM had to play in this.

In these five schools the focus on STEM and on career-related learning was linked to the personal vision of the headteacher. However, other schools had equally varied programmes of STEM career-related learning that developed without the guardianship of a directive headteacher. These schools had delegated leadership structures in place. Such structures gave responsibility and authority to individuals and teams, which enabled them to co-ordinate activities, encourage participation from across the school workforce, manage budgets, and innovate and experiment. These teams provided STEM leadership at a delegated level in the school hierarchy but one which was distributed among several people. Such schools often talked of links between their science departments and other departments including mathematics, ICT, design & technology, business skills and enterprise and geography. In most cases, STEM leadership was located within the science department. It is worth adding that even those schools with a strong and charismatic leader also had the support of strong and proactive teams of teachers.

Where schools saw STEM as a secondary priority, key activities were managed within subjects and relied more on leadership from enthusiastic teachers who took on that responsibility but without formal authority and sometimes without recognition or reward. Individual teachers who took on this role were supported by their line managers, who were happy to notice and support STEM clubs or visits from STEM ambassadors, but this was done in a facilitative style rather than a directive one. This was the case in two of the nine case study schools.

The case study research team also spoke to a number of teachers who had a co-ordination role. Their job titles varied and included STEM Director, STEM Co-ordinator, STEM Leader and Head of STEM; as mentioned earlier, some had no formal title or responsibility but nonetheless worked on the STEM agenda in their school. Their subject specialisms included chemistry (3), health science, quantity surveying, mathematics (2), architecture, textiles, and landscape architecture. This role, which we will collectively call STEM Co-ordinator, was most often located in the science department, but design & technology teachers were also sometimes taking this responsibility. Mathematics teachers were involved but to a lesser extent, either as part of a team or as a voluntary lead.

3.3 Teachers' prior work experience

Survey evidence (Hutchinson & Bentley, 2011) suggests that young people are more likely to ask their subject teacher for careers advice than they would their form teacher, a careers teacher or a Connexions adviser. Subject teachers can be well placed to offer advice on what study of a subject at a higher level is like, and to offer their experiences of related employment (Hutchinson, 2012). However, subject teachers may not feel that they have the knowledge or experience to do this well, and can be reluctant to take on any additional responsibilities. A recent poll by the Association of Colleges (2012) reports that 44% of school teachers admit to giving a student bad or uninformed advice in the past, and that 82% of school teachers do not feel they have the appropriate knowledge to advise students on careers.

Within this context, the research was curious to find out more about the backgrounds of teachers who have STEM or career co-ordination responsibilities and their knowledge of work beyond the education sector. Unfortunately there are no benchmark measures available for this, as the annual School Workforce Census (DfE, 2011b) does not provide any indication of the employment background of school teachers beyond their subject specialisms.

Five of the nine case study schools' STEM co-ordination activities were led by teachers whose career pathways had been conducted entirely within the education sector, and indeed the majority of those we interviewed had pursued these relatively linear career routes. It was more usual for the design & technology, business skills and enterprise teachers interviewed to bring more varied career backgrounds: these included work in TV and media, landscape gardening, commercial property and accountancy.

However, several of the teachers who were either nominated or "unofficial" STEM co-ordinators had postgraduate experience of employment outside education.

This varied considerably, and ranged from laboratory technician roles through to industry chemists, factory work or higher-level research roles. It was a noticeable feature of discussions with these teachers that they volunteered ways in which they thought that their employment background gave them skills or insights that were beneficial in their teaching or co-ordinating roles:

> "So I have an industry and a background it's helpful – because I can tell the KS4 kids something about what happens in industry. Having something to refer back to is an advantage. I like to think that they think that I've got something to tell them."

> "With freelance if you don't network you don't work… so I have networking skills which has made is easier for me to bring partnerships in…"

> "I wouldn't know half as much about career pathways and how to do things if I hadn't been in industry myself."

These observations were explored further in the survey and appeared to be typical of the STEM school workforce as a whole. The respondents to the survey were mostly heads of science (55%) or heads of design & technology (18%). In addition, 11% of responses came from heads of STEM or STEM co-ordinators, with the remaining comprising PSHE tutors, and mathematics, engineering or geography teachers. Over half of the respondents (51%) said they had had some form of "substantive employment" prior to moving into teaching.

The majority of the careers co-ordinators, heads of design & technology and heads of PSHE had some prior employment before turning to teaching (see Figure 4, although caution must be exercised due to the low responses within these categories). 44 per cent of the heads of science had some former employment experience. The types of previous employment varied, though many of the STEM teacher respondents had held scientific, laboratory technician or engineering roles. Others included designers, academics, a farmer, local government officers or working in marketing. One had worked in sales for a computer manufacturer, and had then moved into the police force and subsequently done some teaching of English as a foreign language prior to becoming a school teacher.

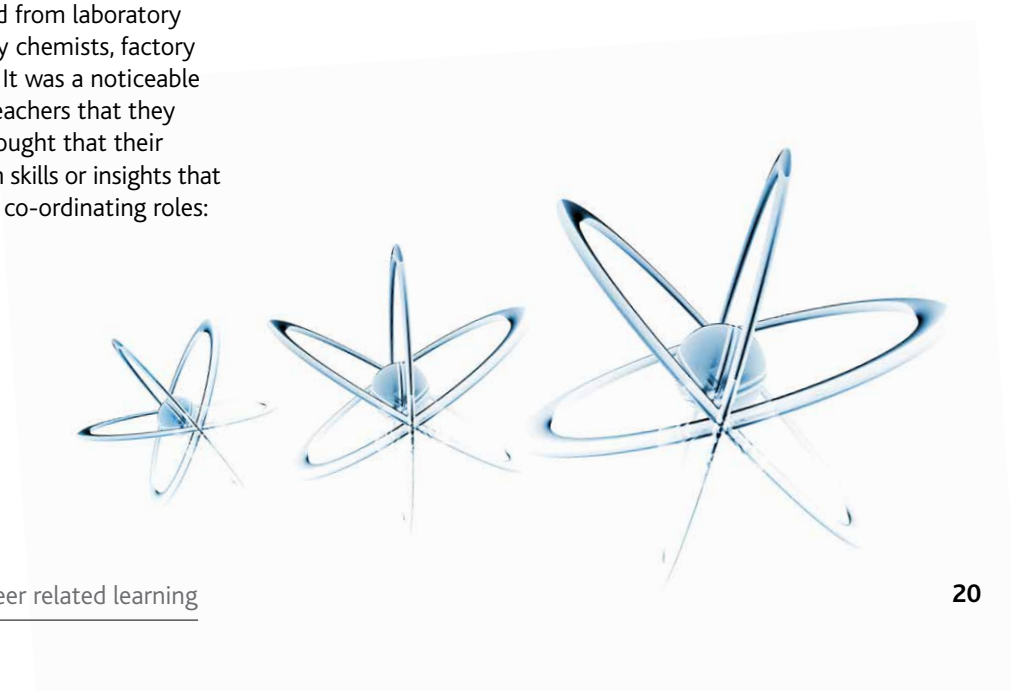
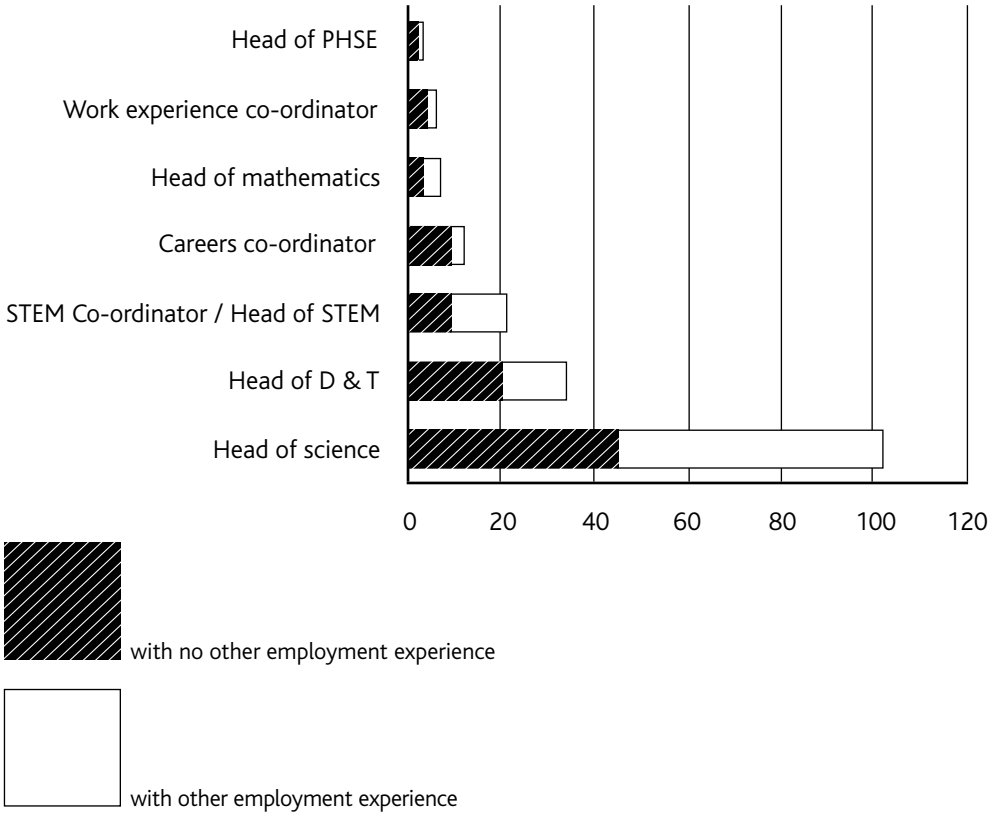


Figure 4: Proportions of respondents that have had other forms of substantive employment compared with management roles



The survey findings indicate that across the teaching workforce there are many who have wider employment experiences, knowledge of different career paths and a range of additional skills that they bring into the classroom. These are used both to inform their curriculum through the application of applied learning, and also to help their students understand how they can use their skills and knowledge to build pathways into a range of different careers.

3.4 Careers provision

The organisation of career-related learning in schools varies considerably in detail, but tends to comprise a number of key functions. These include design and delivery of the career education element of the curriculum (usually within PSHE), organisation of work experience, liaison with external providers of career advice and guidance, employer liaison, one-to-one advice for students, support with progression to sixth form, college or higher education, management of careers resources, and contribution to the professional development of colleagues. These activities are managed by the careers co-ordinator in whole or in part (McCrone et al, 2009).

The role of the careers co-ordinator is critical but research demonstrates that it is often a challenging one. In research that was undertaken to inform a new qualification for careers co-ordinators, it was found that the esteem of the role and resources allocated to the role varied considerably between schools. Co-ordinators were not always from a teaching background and would not necessarily have a qualification in careers advice or guidance (Andrews, 2008) Within this context, in the past the quality of career learning in schools has been very variable. The Ofsted review of information, advice and guidance (Ofsted, 2010) concluded that: "When careers education was provided by the schools themselves, its quality varied considerably and the provision was perfunctory in some of the schools visited. Not all the staff teaching had enough knowledge or experience to do this effectively. The provision of information, advice and guidance about the options available to students at the age of 16 was not always sufficiently impartial." Meanwhile, analysis of a longitudinal study of young people in England suggested that only 40% could recall having had an individual career interview (Hutchinson et al., 2011) compared with virtually all school leavers in Scotland (and pre-Connexions in England) (Watts, 2008). Clearly, even prior to the provisions of the Education Act 2011, careers provision in schools was not always recognised as high quality and did not always reach all students.

The schools that participated in the case study research all provided a range of opportunities to learn about careers and progression routes. The types of activity delivered by careers co-ordinators and colleagues in schools included careers fairs, invited speakers, parents' evenings, subject taster sessions, trips to colleges or universities, and facilitation of guidance interviews.

The career co-ordinators that participated in the case study element of the research (eight of the nine schools) had varied backgrounds and a range of responsibilities. Their teaching responsibilities included design & technology (food and textiles), religious education, business studies and geography. Two of the nine were not teachers but were employed specifically to fulfil the co-ordination role: one was a former Connexions personal adviser; another had worked in retail banking.

Line management structures varied. In some schools the careers co-ordinator was either a member of the senior leadership team or reported directly to either a deputy or assistant head. In one school they were managed alongside the STEM co-ordinator. Other schools had a more complex matrix system of management to cover both pastoral systems (linked to a house system), and subject departments, with careers co-ordination spanning both. Similarly, the responsibilities of career co-ordinators varied and included teaching, pastoral and/or progression support (through a house system) and staff training alongside their role as careers co-ordinator.

Only two of the careers co-ordinators had a specific careers qualification. The first was a teacher who had taken the Diploma in Career Guidance alongside her teaching role to help her in her new role after she was appointed; the other was a former Connexions personal adviser who was already qualified when appointed. The remaining career co-ordinators said that they had had some training from Connexions but that most of their learning had been "on the job".

There was an association between those schools which had strong careers programmes (evidenced either by acquisition of a quality award (in one case), or recognition of their role among other teachers), and those schools that integrated the careers co-ordinator within their teaching teams. It appeared that this was easier to do when the careers co-ordinator had other teaching responsibilities and was therefore already well acquainted with the team briefings, INSET, and inspection and other school frameworks. Those schools with a tradition and a culture of valuing careers and investing in the role of the careers co-ordinator or head of careers were more likely to have strong STEM career-related learning programmes. It had become part of the identity of the school.

Teachers and other members of the school workforce can build and use their networks to promote STEM career-related learning. Such networks can include those between school colleagues, or with parents, community governors, alumni and local employers. They can be utilised to promote the work of a parent teacher association, to support extra-curricular activity or to promote STEM career-related learning. There is a plethora of STEM networking opportunities for schools to link to both nationally and locally. All the case study schools had some external relationships with providers of STEM career-related enhancement and enrichment activities.

All the schools talked about the importance of local networks and local opportunities for engaging in STEM competitions, liaising with employers or CPD activities. Four of the nine schools also mentioned the role of their local authority in helping to maintain or set up new employer networks and build bridges between employers and schools.

Approaches to building or maintaining STEM networks vary. All rely to a certain extent on teachers' own personal and professional networks. Others are part of locally convened networks (such as the Mansfield Learning Partnership), or the STEW network in Warrington convened by the local authority (where the M was sacrificed for a neat acronym). Opportunism also has a role to play, with several teachers at the schools mentioning the power of opportunities that are shared via email or at teacher meetings or briefings. A small set of schools actively manage their networks by identifying a student need and seeking out a potential partner to meet those needs. One respondent said: "A local university came in and said 'We want to do this one competition with you' and I said 'I don't want that, we've got lots of competitions that we do all the time'. But, I said, 'We have students who struggle to understand the applications of maths and why maths is important and they want to do engineering. Can you come up with a programme where you set them some real life university problems and we will work on them in maths.' So we are setting up a pilot scheme for that now."

The creation and application of networks can be managed to support the schools' strategic priorities. The nature of those networks is however closely linked to the nature of the local area.

3.6 The local economy

The research engaged schools from across a broad swathe of England from Walsall in the Midlands to Carlisle in the North-West and North Shields in the North-East, and various points in between. Their engagement in STEM activities and STEM career learning were set within their own particular contexts, which in turn were shaped by the local socio-economic status, the structure of local provision and their particular school history and culture.

The schools were located in areas that relate to three broad geographical categories.

Firstly, there were three schools in coastal areas which all benefited from proximity to employment opportunities that were linked to marine engineering, renewable energy and manufacturing as well as those relating to leisure and tourism. One of the features of these three schools was their knowledge of these industries and awareness of opportunities for future growth and jobs: they tailored their curriculum and their careers provision towards local growth sectors. In Carlisle, for example, the Richard Rose Morton sixth-form had linked its prospectus to focus on a range of broad industrial sectors of significance to Carlisle and Cumbria, such as the creative, cultural and heritage industries, and the digital industries. Meanwhile, Newland School for Girls encouraged links with local employers and the neighbouring university to engage their students in a wide range of activities that promoted STEM and particularly mathematics and computing including their use in industry. This included a STEM trade fair where local STEM employers and learning providers offered activities to Year 9 as well as enthusiastic engagement with STEM Week (linked to the National Science and Engineering Week).

A second group was those schools which were located at a city periphery, such as Walsall, Mansfield and Worral (near Sheffield). These areas were characterised by being sufficiently close to urban areas to feel their economic influence, but too far away to benefit directly from it.

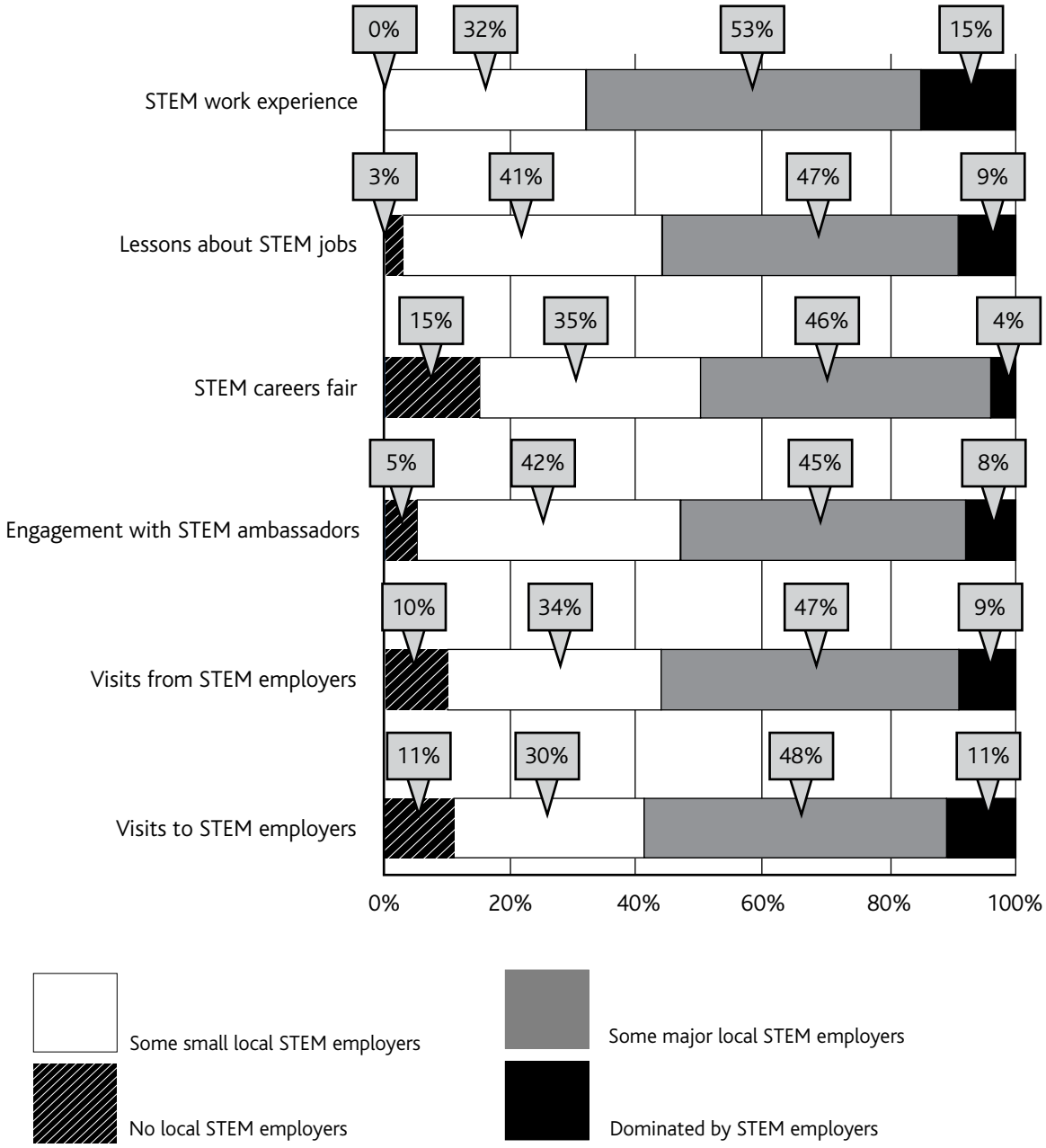
They accordingly tended to be characterised by a mixed economy, where major employers would be in the retail or public service sector, with a significant element of service engineering and self-employment (white-van territories) and higher than average unemployment. Students living in such areas tend to come from backgrounds where parents have not been to university and whose employment would traditionally have been low or semi-skilled.

Their academic attainment would generally be around or less than average: consequently these schools focused on raising aspiration, delivering the core subjects and achievement of 5 A*-C GCSEs. Their engagement with STEM was seen as a desirable addition to the curriculum rather than an integral priority, and they faced a challenge in engaging students in an employment sector which was not visibly apparent to them.

Thirdly, schools in towns which had a strong engineering or manufacturing heritage with residual or growing engineering and manufacturing economies were more likely to be focused on those sectors and have links with local STEM employers. Their culture was to extend STEM learning to all learners of all abilities, building on a cultural awareness that STEM skills were useful and desirable in the workplace.

Thus the extent and range of how schools' STEM networks varied was largely explained by their local socio-economic context and distance to travel. For example, in schools that were situated in towns, their links tended to be within the town and its immediate hinterland. The more prosperous the town and the more numerous the STEM-related employers, the stronger and more extensive those links were. Conversely, schools that were located on a city periphery could take advantage of proximity to universities and other learning providers, and make links with one or two significant local,employers, but their STEM networks tended to be more limited.

Figure 5: Link between STEM career-related learning in school at Key Stage 4 and the presence of local STEM employers.



Whilst location can provide an advantage, it does not necessarily follow that all schools in a STEM-rich local economy will engage with STEM employers or career-related learning. For example, one of the case study schools secured some funding to take support for setting up STEM clubs into their neighbouring schools and were thwarted by a lack of interest from those schools, which simply were not interested or thought it was a low priority.

These issues are explored further in the survey findings. If the presence of STEM employers was a necessary pre-requisite for the development of employer links, then there should be a positive correlation between STEM employers and the number of school-employer links. However, as Figure 5 shows, schools can do some activities despite having no STEM employers in their area (for example, 15% of the schools that ran a STEM careers fair had no local STEM employers). Similarly, the figure shows that most schools that did any of these activities had either some small or major STEM employers, but only a few were dominated by STEM employers.

In general, it is clear that the presence of STEM employers does shape how a school builds its STEM career-related learning activities. Schools that are part of a local economic community which is built on STEM-related industries or see growth in STEM areas are better placed to take advantage of links with STEM employers than are those whose local employers are dominated by retail or hospitality sectors, for instance. However, the local presence of STEM employers is neither sufficient nor necessary for schools to engage with STEM employers.

3.7 Student progression and attainment

It can be argued that STEM career-related learning can help to improve motivation, attainment and positive progression in a number of ways. Research has found that young people who not only enjoy particular subjects, but who perform well in them, are more likely to use this to set their parameters for the kinds of careers to which they could reasonably aspire (Alloway, 2004). Consequently, finding ways of engaging them in STEM learning that they find enjoyable should have a positive impact on their attainment. In addition, there is research that links students' engagement with a programme of careers learning and their ability to make career choices that they are happy with (Blenkinsop et al, 2006). Therefore it is not unreasonable to suggest that a programme of STEM career-related learning could enhance students' enjoyment of STEM subjects, and raise awareness of the processes linking STEM study with career opportunities, which in turn could raise attainment and promote positive progression.

However, the schools in the case studies tended either to prioritise attainment across all subjects (perhaps with an emphasis on STEM), or to ensure that all students had secured some form of progression route after their time with the school was over. It was unusual for a school to link STEM career-related learning with attainment and progression.

Four of the nine schools were 11 to 16 schools, although one of these was shortly to open its own sixth-form. The four were acutely aware of their responsibility to support progression of their students in a relatively short period of time. Their strategies to achieve this varied, in that STEM was seen either as a driver to high attainment, or as a mechanism for building a broad range of employability and life skills. Royton & Crompton, for example, had a strong science department which sought to enhance and enrich its STEM curricula through their passion for their subjects, with the ultimate aim of raising attainment ("We like to punch above our weight") so that their students would have a good choice of alternatives for their post-16 learning. The other two 11 to 16 schools had a strong focus on STEM attainment, but also saw it as a way to build a wide range of inter-personal and employability skills, such as with the STEM course at Year 9 in Longfield Academy. The 11 to 16 schools tended to be more focused on progression beyond their institution, or – as one headteacher put it – "begin with the end in mind", than the 11 to 18 schools. However, in this small sample they were no more or less likely to have a strong and integrated programme of career-related learning than schools with sixth-form provision.

The research also asked the case study schools about their schools' priorities. All schools were committed to doing the best for their students, but their curricular responses to achieving this varied. Work-related learning was important to six of the nine schools. This was evidenced through links with employers, a cross-curricular focus on technology or engineering, or embedding work related learning across all curriculum areas. This focus was in addition to academic achievement and attainment. Academic attainment was the primary goal for the three schools where the local employment situation was tough and where students came from backgrounds associated with lower levels of attainment.

Teachers in the case study schools mostly associated the word "progression" with measurement related to individuals' progress towards achieving their minimum or their aspiration target grades for each subject. They described the in-school monitoring and tracking systems set up and the support measures that kicked in when students fell behind their anticipated grades (including senior teacher learning mentors, after-school and Saturday morning extra sessions, and lunch-time revision sessions).

When asked about progression in the sense of destinations beyond their school, it was clear that this was interpreted as the proportion of students who were recorded in the NEET category. It was more common for schools to say that they had a higher or lower proportion of students ending up NEET than other schools in their area, rather than specifying what those numbers might be.

Nevertheless, some schools gave precise accounts of the proportions of their students who had progressed to a range of destinations. Some schools had good relationships with their local colleges, which provided them with destination data (including which courses and which universities their former students had gone to), whilst others used information from their own sixth-from cohorts. One school made a point of staying in touch with some of its alumni, who were invited back as "ambassadors" to talk about their experiences of university and of work.

In the survey, many respondents chose to skip the question that asked about progression data, suggesting either that they were not aware of the existence of these data or that they did not know what the figures were for their school. Those that did provide information gave approximate measures, suggesting that monitoring and reporting of destination data was not a priority for STEM leaders in these schools.

A minority of case study schools were aware that a new progression measure would be introduced but were not clear about the form it would take or what it would mean in terms of data collection and management for their school. It was not seen as a threat because those schools felt that they were doing well in progressing their students on to the next stage of their learning. It was viewed, if at all, as an additional management information requirement rather than as a strategic issue for which a strategic response was required. If progression measures are to be used as a policy lever to focus attention on careers policy in schools, they need higher recognition with school leaders.

Finally, the research questioned schools about their specialist status and its impact on their STEM and careers provision. Seven of the nine case studies mentioned having had specialist status; of these seven, all bar one had a specialism that was STEM related. It is reasonable to assume that this factor will have encouraged teachers to engage in STEM-related activities including their own professional development and enhancement and enrichment activities for their students. However, only two of the schools (Great Sankey and Royton & Crompton) spoke of their specialist status as being significant in the development of the school's priorities or in establishing a foundation for the future of the school. In Royton & Crompton the specialist status had informed its recruitment of high calibre teachers with specialist scientific knowledge (seeing themselves as scientists first and teachers second). In Great Sankey, its engineering designation prompted structural reform of its school leadership profile, active engagement in supporting other schools in its local area and the creation of a national profile and reputation which had supported its success in fund raising and opportunity building.

Six of the nine schools had either converted to academy status or were in the process of doing so. Their attitude was that academy status did not fundamentally change their prevailing culture, and that their plans for future development tended to reflect the academy ethos anyway.

Similarly, the survey evidence found no particular difference in the responses from teachers at state funded academy schools and at state funded local authority maintained schools. For example, whilst 55% of respondents from academy schools thought that their school promoted career-related learning, the equivalent for local authority maintained schools was 58%. There was similarly little difference between the proportions that offered work experience, the figures here being 81% and 75% respectively.

Some case study schools were acutely aware of their situation in terms of their place in the marketplace for students, including in some cases their vulnerability to competition for students in their catchment areas. St Thomas More, for example, had been affected by the creation of a Microsoft school at nearby Monksheaton High School; while the sixth-form at Garibaldi in Mansfield was adversely affected by the opening of the new Samworth Church Academy barely a mile away. Even within schools, the competition for students between subject areas was beginning to be acknowledged – particularly around those subject areas that comprised the EBacc and those that did not.

The need to sustain student numbers is seen not only as an end in its own right, but also as important because opportunities for enhancement, enrichment, cross-curricular working and the capacity to offer a range of progression routes depend upon minimum threshold numbers. Several schools commented that an element of their design & technology teaching had been cut in recent years, with others worried about the impact of the Ebacc and the review of vocational qualifications on future curricular diversity.

In general, therefore, neither the former specialism of the school nor the current governance structure appeared to have significant impact on the activities of the schools as they related to STEM career-related learning. However, the competition for students either within schools to study particular subjects, or between schools to capture sufficient student numbers, was an important contextual factor influencing the approach of the school. These competitive factors did not lend themselves to exploration in an already complex self-completion survey instrument, so were not investigated further in the survey phase of the research.

3.9 Summary

There are some inspiring examples of schools that have taken the STEM agenda, linked it to career-related learning, and applied it in their own context for the benefit of their students. These schools share few similarities in terms of leadership, the presence of STEM networks, curriculum offer, type of school or student destination. They tend however to have clearly delegated leadership, teams of teachers working across subjects, careers co-ordinators with strong links into the teaching teams, and be working in areas with a STEM industry presence.

Those students who were selected to participate in the research said that they benefited in a range of ways from their engagement in STEM career-related activities: they learned more about science, engineering, technology and mathematics, they had fun and made friends, they learned about themselves and they were thinking about what they might want to achieve in their future.

> "For me it's like... like from when we're choosing our options and everything, you know you can't really get enough opportunities and every opportunity you do get I believe you should take it because then you're not narrowing down."
> **Year 9 boy**

4 Enhancing STEM career-related learning

4.1 Introduction

The research has demonstrated that there are a numbers of factors whose combination can be applied by schools to generate interesting STEM career-related learning opportunities for students. These include school leaders that are open to the ideas, teachers who have a range of employment backgrounds and/or wide networks, some local STEM employers, and well-established practices related to careers education and guidance. However, the research has also suggested that interesting practice can occur in the absence of some, although not all, of these factors. This final section therefore examines how schools can enhance their STEM career-related learning provision, both within their local context, but also in the context of shifting policy and infrastructure. It examines, in particular, commissioning career guidance services, staff development, and, firstly, the role of school strategy.

4.2 Linking STEM career-related learning to school strategy

All the case study schools were clearly committed to supporting their students to learn and to develop; they all wanted the best for their students so that they could move on, be happy, and make a positive contribution to their communities. However, they had different ideas about how they thought this could be achieved – and whether or how STEM career-related learning had a role to play.

The teachers at the case study schools expressed different views on how career-related learning could help and support their students, and their careers provision was shaped accordingly. Teachers saw it in one or more ways:

- to support students to make decisions about subjects and progression routes
- to encourage them to aspire higher, either in terms of good jobs, or getting to university, or getting to the best university they can
- to help build students' key skills and competences (employability skills) through links with work-based learning and work experience

In the definition of career-related learning that informed this study, these three are not mutually exclusive, indeed, some of the most proactive schools developed areas of activity across all three. Those schools that saw careers provision in terms of choices about subjects and courses would place emphasis on interviews in Year 9 and perhaps again at the end of Year 10 to verify subject choices and progression routes. This view of career-related learning is quite functional and places importance on attainment and remaining academically engaged. Careers is then seen as part of the remit of the progression team whose role is to monitor academic progress and includes heads of year and learning mentors as well as careers co-ordinators.

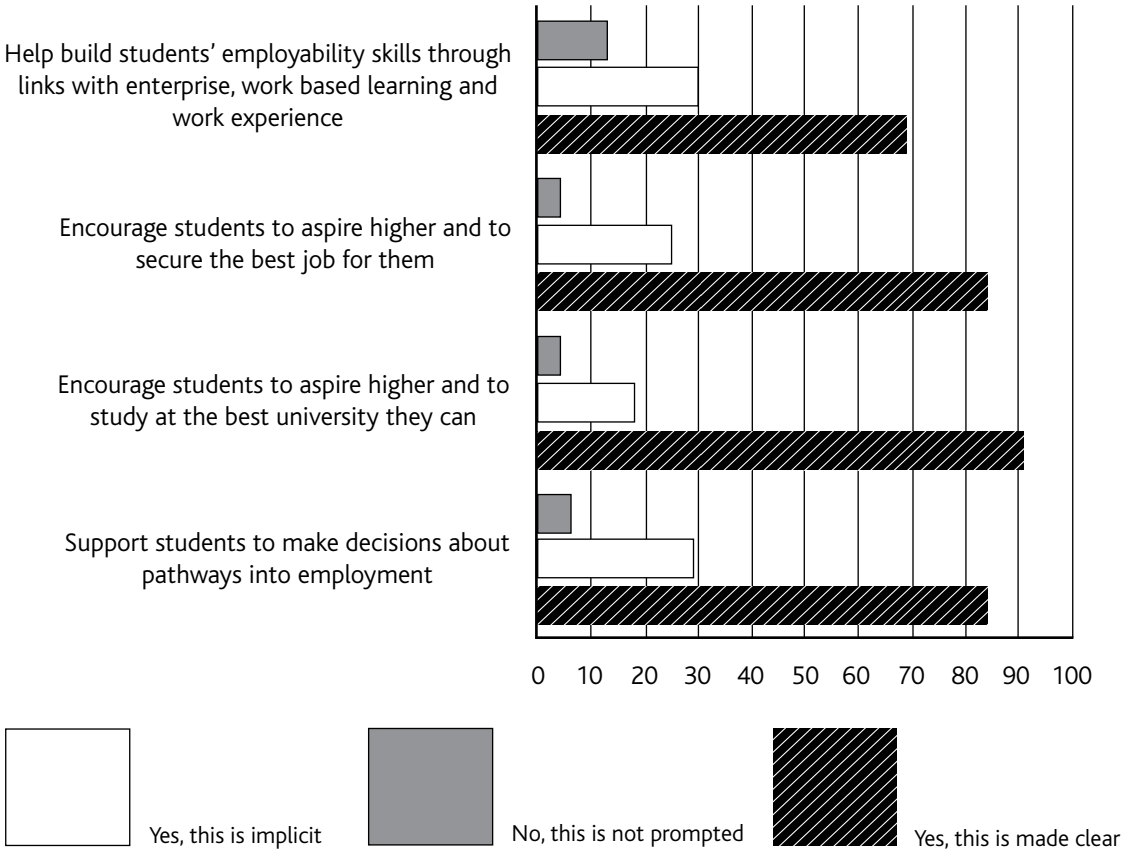
The view of career-related learning as being about raising aspiration was most frequently cited in terms of entry to university and/or, more specifically, to the best university that the students could secure places at. The focus here is on professional level careers, building links with universities and academics or university students, preparing for university entry, and ensuring that as many students as possible remain engaged and interested in their subjects and achieve well in them.

Career-related learning can also build students' employability skills. Careers work here is more likely to focus on building key skills through the integration of work-related learning into the classroom. This can be done through special projects and the co-development of curriculum by teachers with careers co-ordinators and others.

The survey was designed to explore this further, examining the extent to which schools prioritised career-related learning and how they saw it linking to their main school priorities. It is difficult to explore strategy in the context of a survey and the questions which explored this were the most skipped questions. Nevertheless, 77% of 165 respondents said that their school did deliver some activities to help students learn about STEM careers.

However, while three-quarters were happy to say that they delivered activities, a lower proportion (58% of 166 respondents) said that they thought that their school promoted career-related learning. The inference here is that they do it, but either it is not a key feature of the school, or it is not one that features high in the school's strategic goals.

Figure 6: Respondents' views of the purpose of career-related learning



The survey then asked respondents: "In your view, does your school leadership team promote career-related learning as a means to.....". The results are presented in Figure 6. As this shows, the response rate dropped even further, suggesting that STEM leaders in schools found it difficult to articulate the purpose of career-related learning. The responses show that career-related learning is most frequently linked to raising aspirations with respect to attending university, and least associated with employability through enterprise and work-related learning.

The overall lack of prioritisation of career-related learning, linked to the emphasis on its applicability to raising aspirations and in particular to raising aspirations for study at university, is problematic in at least two ways. Firstly, it is likely to be seen as most relevant to only the half of all students who might hope to achieve 5 A*-C GCSE's (or the incoming English Baccalaureate), whereas career-related learning is an important part of the developmental process for all young people. Secondly, linked to the much less widely reported view that career-related learning is about employability skills, it suggests either that career-related learning and employability are seen as different or that employability is viewed as less important than progression to university, whereas in fact employers are repeatedly saying that university graduates and school graduates alike do not have the level and types of skills that they are looking for (CBI, 2011) – something that is particularly true of STEM graduates (Mellors-Bourne et al, 2011).

Consequently, if schools associate STEM career-related learning with subject choices, aspiration raising and employability skills, then the actions they need to take to achieve those strategic goals will need to generate a good and sustainable programme of STEM career-related learning for all their students.

4.3 Commissioning career guidance

The case studies were undertaken in schools after the Education Act had been passed but before the statutory guidance relating to careers guidance provision was published. Schools were therefore aware of the need to respond to the Act, but the nature of the required response was not always clear to them. They had also had to respond to changes in the services that they had received from Connexions. In some cases, this had remained the same as usual but was shortly due to end completely; in other cases, their personal adviser time had already been drastically reduced (in one case from 8 person days a week a week to 40 days a year); and in one case they still did not know what would happen to Connexions, in the same month that the service was due to transfer to the local authority. Resourcing provision was a critical consideration for most schools, as they had now to find money to pay for a service that hitherto had been free to them – although at this stage schools were more likely to talk about this in relation to the requirement to pay for health and safety risk assessments related to work experience rather than to the provision of independent and impartial career guidance.

On commissioning career guidance, the nine schools had adopted one of four approaches:

- two schools (both 11 to 16 schools) were very happy with the service they had from their Connexions personal adviser and had taken the opportunity to employ them directly as a resource for their own school or shared between schools.
- two schools' senior leadership teams had discussed the issue and had taken a strategic decision to train selected staff as "career champions" or to retain and enhance the role of their careers co-ordinators, while awaiting guidance on how to secure independent and impartial advice.
- two schools had no plans to commission further independent career guidance but were exploring ways to enhance their in-house provision, which could include access to web based and telephone guidance.
- three schools were awaiting the statutory guidance before discussing it further. Two of these were in areas where there were local authority facilitated networks of schools which were discussing collaborative options to provision of independent and impartial career guidance.

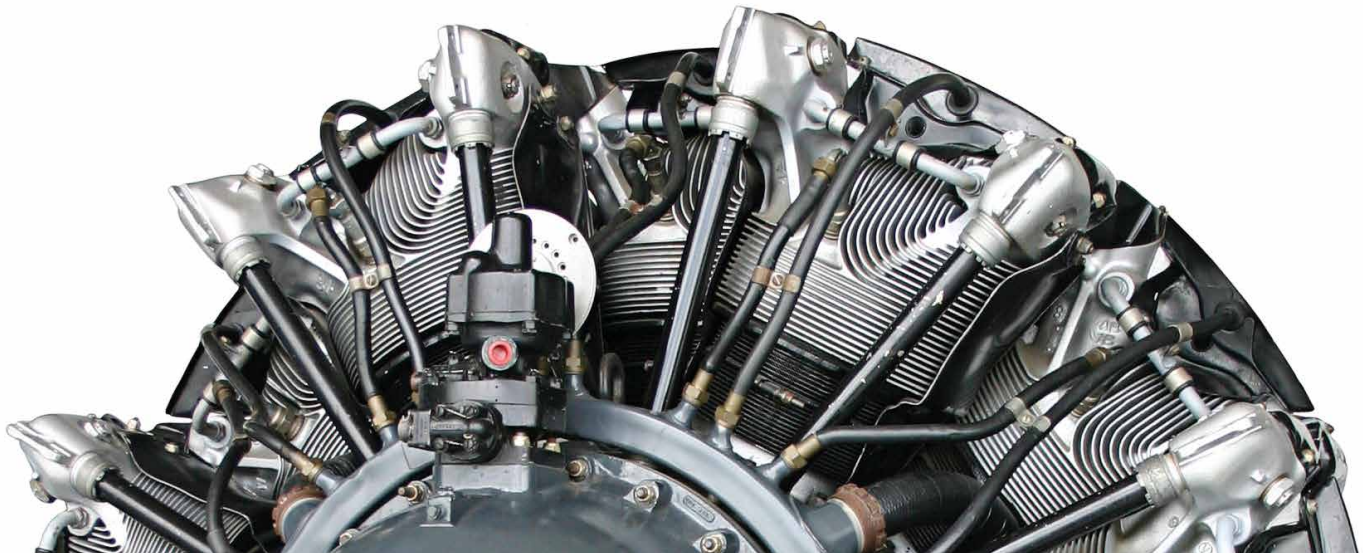
Additional commissioned independent services offering impartial careers advice were not being treated as a priority by any of the schools that were involved in the study, for a number of reasons. Firstly, the schools thought that they were meeting the requirements of the Act already, through the provisions described above. Secondly, the loss of a Connexions service was not always seen as the loss of a careers service, but rather of a resource to support vulnerable young people to prevent them from becoming classified as NEET (not in education, employment or training): therefore the school's focus was on these young people. Finally, they were seen as expensive and their added value in the context of constrained budgets was not well-recognised. The survey was conducted one year later. Forty eight per cent of the STEM leaders who responded said that their school had commissioned career guidance for the current academic year; a further 25% did not know. Of those that said their school had commissioned a career guidance service, 40% did not know who was providing this service (Table 2). Careers advisers known to the school from formerly working through a Connexions organisation provided most of the commissioned support that respondents did know about. They were now employed directly by the school, or engaged on a self-employed basis, or provided through the local authority. Given the disappointing level of awareness of commissioned career services, it is unsurprising that 88% of respondents were not aware whether or not any such provider had been awarded the Matrix quality standard.

Table 2: Respondents' awareness of the providers of commissioned careers guidance in their school

Who is providing this careers guidance?	Response (percent)	Response (count)
A former Connexions PA employed by the school	19%	24
A Connexions PA provided by the local authority	17%	22
A career advisor from a private company	13%	16
A former Connexions PA working freelance	12%	15
A private company via website and phone support for students	2%	3
A career teacher from another school	0%	0
I don't know	40%	51
Other (uncoded)	15%	19
Other members of straff (re-coded)	10%	13
	Answered question	**126**

Since the implementation of the Education Act, some schools are aiming to provide all their students with the career-related support they will need as they prepare to move into the next stages of their education and on into employment. Some of the examples in this report show how, in addition, they tailor this provision to focus on STEM careers. Other schools have chosen not to prioritise careers work. However, the Act does provide an impetus for schools to reflect and consider what is in the best interests of all their students and to manage their own curriculum and commission independent provision accordingly.

Schools are now empowered to design their own career guidance programmes. This represents an opportunity for STEM career-related learning to be considered as one theme of an overall approach to supporting their students as they prepare for their future careers.

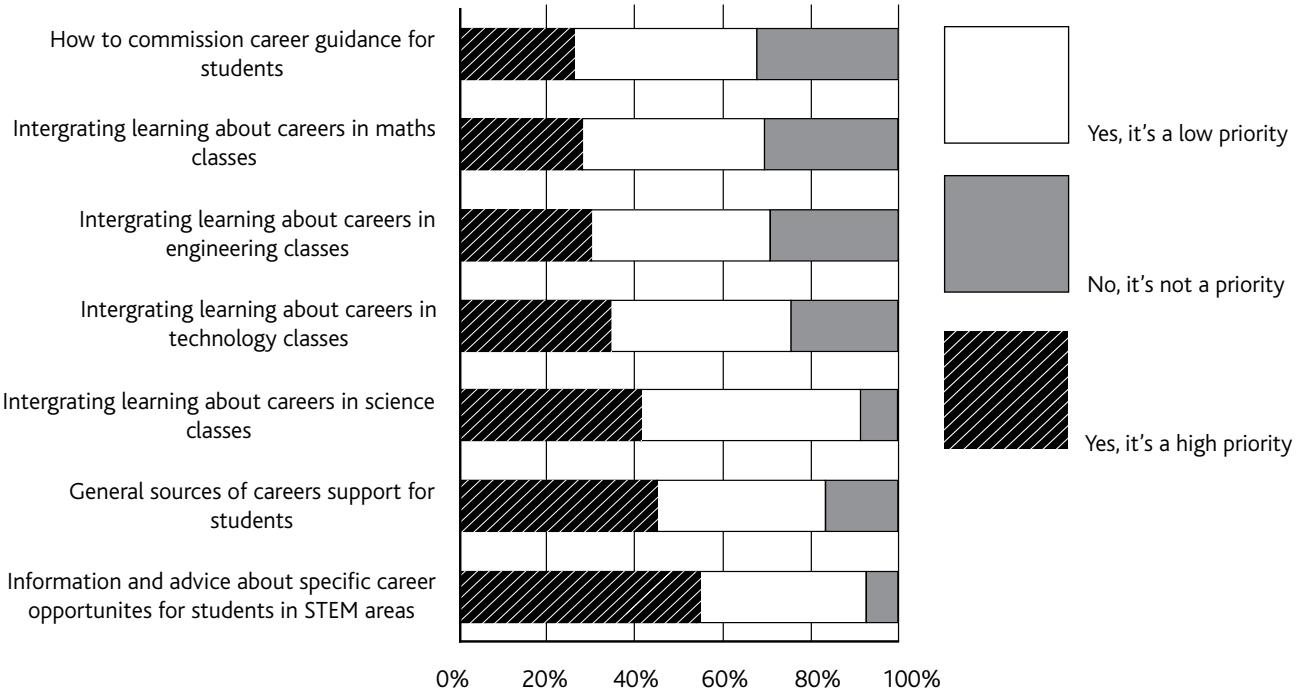


4.4 Continuing professional development opportunities

A third way in which schools can act to enhance their STEM career-related learning activity is to provide professional development opportunities for their staff. A previous study indicated that 48% of students at Key Stage 3 had gained their information about jobs and careers from a subject teacher, compared with those gaining it from family (78%), careers teachers (50%), form teachers (23%) and careers advisers (20%) (Hutchinson et al, 2009). It is therefore important that career-related learning is not seen as the sole responsibility of a careers co-ordinator or a small group of careers teachers.

The survey asked respondents about their interest in professional development opportunities. They were most interested in learning about specific career opportunities for students in STEM areas and about other general sources of careers support for students (Figure 7). Subject teachers thus implicitly indicated their recognition that they were an important source of information and advice to their students by stating that they wanted to enhance their own understanding of STEM careers, but also their recognition of their limitations in this respect by wanting to find out where they could direct their students for other sources of information and advice. Learning how to integrate learning about careers in STEM areas into STEM classes was viewed as a much lower priority.

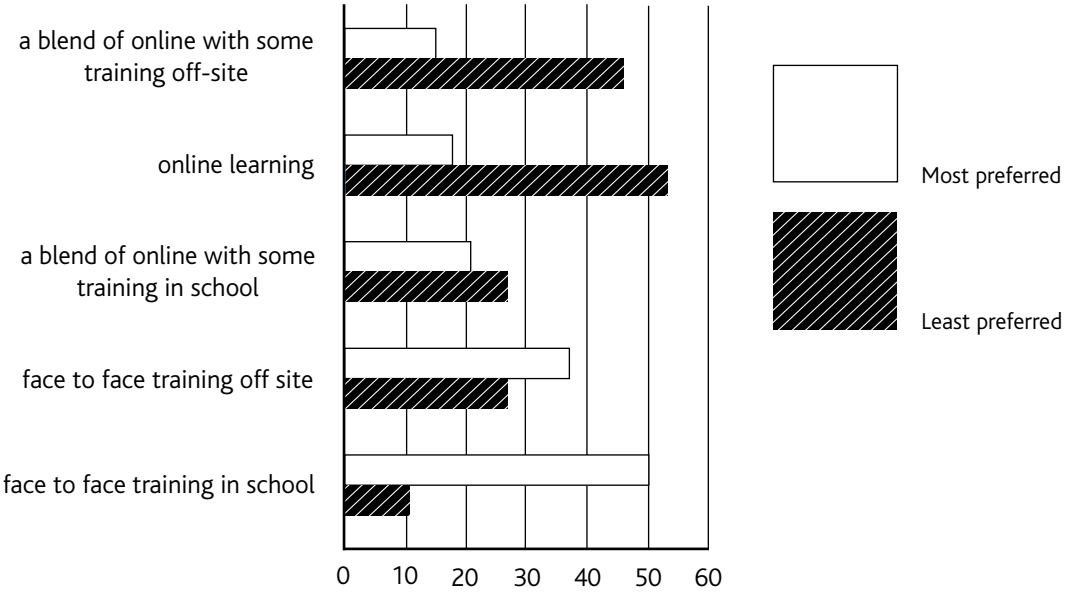
Figure 7: STEM career-related learning CPD priorities



A significant minority of STEM leaders, who tended not to have careers responsibilities in their schools, indicated that they did not know whether the various elements of career-related learning took place within their school. For example, 25% of 165 respondents said they did not know whether any career software was used in their school; 30% did not know whether mentoring opportunities were available; and 45% were unsure about the use of portfolios. This lack of certainty of what was offered within the school indicated at least the potential that students' career questions could go unaddressed. This lack of knowledge also extended to whether the school had commissioned career guidance: a quarter of respondents did not know this – and would presumably therefore have had difficulty in directing their students to professional advisers.

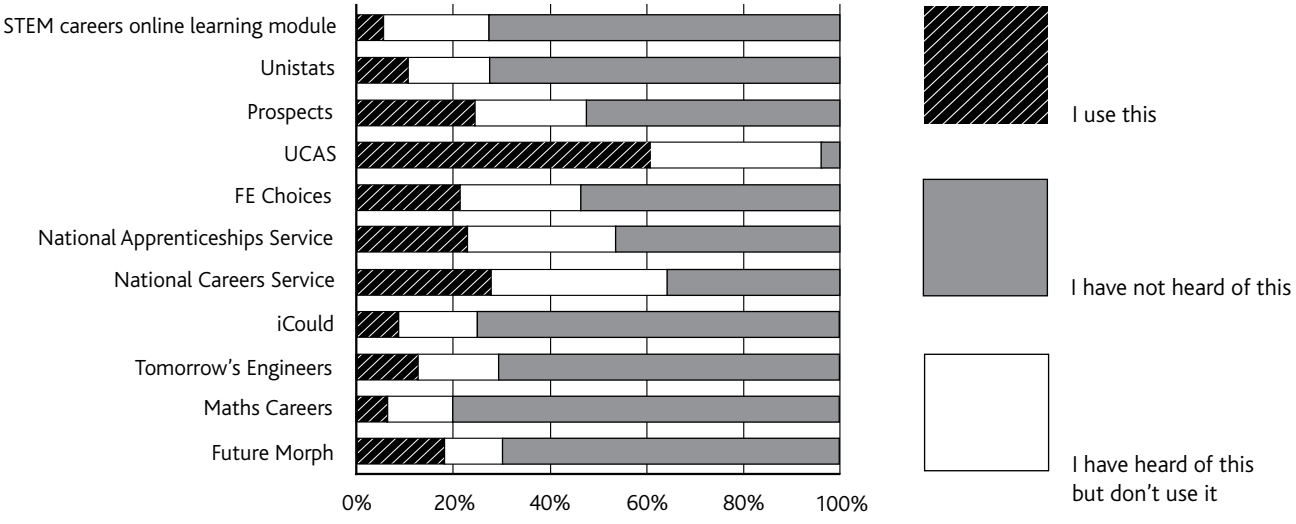
In the light of all this, it is interesting that relatively high proportions of the STEM leader respondents said that they wanted professional development in this area. They also said (Figure 8) that their preferred mode of delivery was for face-to-face training delivered either in school or off-site, suggesting that this would be a useful focus for INSET events within individual or clusters of schools.

Figure 8: Which of the following describe your preferred training modes?



One particular area where further training might be useful is to develop greater awareness amongst teachers of the range of web based resources which exist for students and their advisers. The survey asked about awareness of a number of resources which feature on the National STEM Centre's STEM careers resources webpage (http://www.nationalstemcentre.org.uk/stem-in-context/signposting-links).

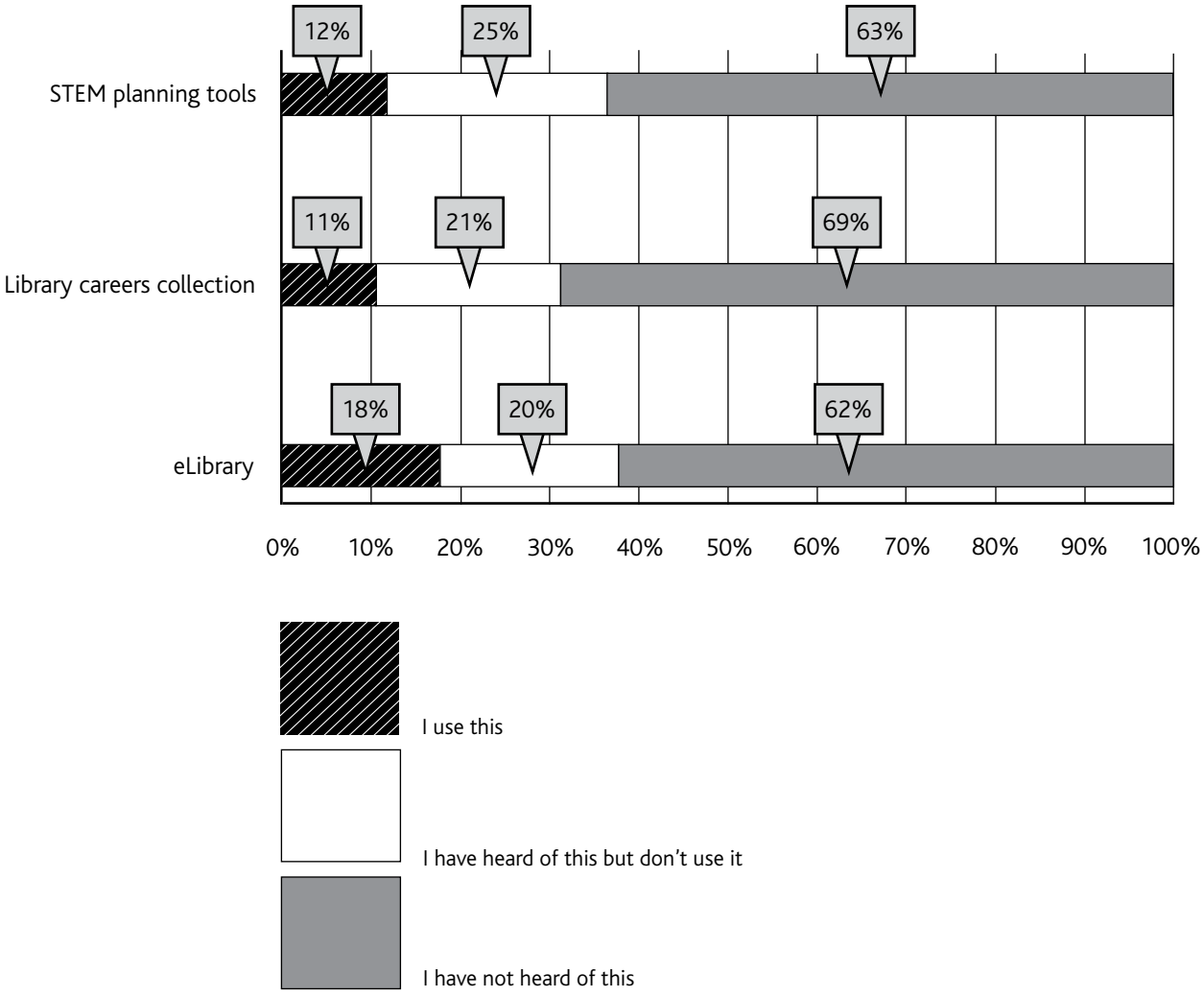
Figure 9: Which of the following web based resources which support teachers and career co-ordinators are you aware of and use?



4.4 Continuing professional development opportunities

As Figure 9 shows, the most used web resource is the UCAS site for university admissions, with national organisations such as the National Careers Service, the National Apprenticeships Service and Prospects (whose directory has been used in schools for many years) also having high levels of recognition. Futuremorph, Tomorrow's Engineers and the STEM careers online learning module are as well known as sites such as Unistats and iCould. Overall, there is relatively low recognition and use of most web based resources. More specifically, greater awareness and use of resources that are especially designed for STEM leaders in schools could have a positive impact on the STEM career-related learning of their students. The data in Figure 10 suggests a modest level of awareness and use of the STEM careers project resources. As teachers become more familiar with these resources and refer students to them, it could be expected that the level of awareness of STEM career opportunities would rise. If accompanied with a careers programme that supported decision making processes, this could translate into further attainment and progression of students into STEM subject areas.

Figure 10: Which of these National STEM Centre resources do you know and use?



5 Summary and recommendations

5.1 Approaches to learning about STEM, careers, and STEM careers

The case study schools demonstrated a range of different approaches to STEM career-related learning. Some schools had a wide and varied STEM curriculum offer, with opportunities for learners in all year groups and of all abilities to engage in some form of enhancement and enrichment. In our assessment, four of the nine case studies met this description. Other schools focused their activities on a particular year group or on a specific ability level, but all of these used their STEM networks and all recognised the potential for STEM to support their students' learning and achievement in a way that a simple focus on mathematics or science or its constituents would not.

Just as their approach to STEM learning varied, so did schools' approaches to career-related learning. All schools had a programme of careers education that commenced from Year 7, which was generally located within form tutor lessons (called various names but understood to be part of a broad PSHE curriculum) and taught by form tutors with some specialist input. Similarly, they all engaged in a range of thematic events such as careers fairs, option choice events, involvement of parents (albeit quite limited in most cases), and the involvement of external speakers. In previous years they all had had specialist input from their Connexions advisers to assist with transition interviews, and support for more vulnerable learners, although this was under review at the time of the research. Some schools had always managed their work experience in-house, whilst others were reviewing their processes in this respect and their selection of young people to participate in it.

Several schools could provide examples of the ways in which they had integrated career-related learning into their STEM subject lessons. Others integrated career-related learning with STEM subject learning on an extra-curricular basis.

Schools that had made a clear commitment to enhancing their STEM learning alongside a programme of career-related learning were able to articulate a perceived improvement in their students' attainment of qualifications, their ability to both articulate and demonstrate employability skills (such as team skills, planning, communication) and an improved or sustained popularity in terms of subscription to places.

5.2 Leadership structures

A clear commitment from the headteacher to integrating career-related learning within STEM learning can provide a fertile context for developing interesting and engaging learning opportunities for students in secondary schools. Where headteachers clearly identify STEM subjects and STEM careers as a priority, schools are more likely to have a range of activities operating across different subjects and for all year groups.

There are, however, some examples of schools where the headteacher is not personally associated with the STEM agenda, but where the model of delegated leadership permits STEM leaders in the school to work with their career colleagues and build a wide range of learning opportunities for their students. In these cases there are often one or a few committed members of teaching staff who are driving forward the agenda within their school. Leadership structures in some schools were well developed with respect to STEM career-related learning. These were associated with allocated roles and responsibilities, and regular meetings to facilitate the interaction of the STEM team with careers teams through the development of teaching teams, INSET training days and regular briefing opportunities. A delegated leadership style was observed in almost all schools. Schools that had a nominated STEM leader, working with a number of colleagues who also had formal recognition of their roles, and linked with the senior teaching team, were able to demonstrate an approach to STEM learning that was more integrated with their careers provision than was the case elsewhere.

A number of factors were explored that might influence whether or not a school leadership team focused attention on STEM and career-related learning. No single individual factor was identified that was especially associated with active STEM career-related learning. Rather, schools can choose whether or not to harness the potential associated with factors such as presence of STEM employers or activation of their networks. The factors that were explored included:

- the school's careers tradition – schools with a culture of a strong teaching team to guide and support students alongside independent career guidance practitioners were better able to build an integrated STEM career-related learning programme.

- school networks – half of STEM leaders had previous substantial employment experience prior to moving into teaching, and all teachers and school staff had links into their local communities, including parents, alumni, staff and employers. Their combined skills, knowledge and networks could be harnessed to support a range of learning activities.

- school structure – the governance structure of schools appeared to have no influence on a school's engagement with STEM career-related learning. Schools without a sixth-form were more focused on progression and career-related learning than those with provision for students aged 11 to 18.

- school strategy – career-related learning was most closely linked to aspiration to attend university, although other strategic goals such as positive progression and enhanced employability skills were also important. STEM career-related learning could be used as a tool to achieve these goals in schools.

- industrial geography – there was an association between those schools that were located in areas of STEM-rich employment and their engagement in STEM and career-related activities. Schools that were able to call upon local employers or bring in ambassadors who had a connection with their area tended to be those that offered a range of engagement opportunities for their students. The relationship was not predictively causal – just because a school was located in such an area did not mean that they were inevitably actively engaged in enhancement or STEM career-related learning. Neither was it exclusive; schools in less STEM-rich areas were still able to offer rich STEM career learning experiences.

5.4 Recommendations

The lack of evaluative evidence of the impact of STEM career-related learning on outcomes for students or teachers is restrictive. The case study schools were able to demonstrate some interesting activities, and the students we spoke to were clearly engaged and enthused by their experiences. Such enthusiasm and engagement could result in more students continuing to study STEM subjects, and progressing into STEM careers; but without systematic and robust evidence to prove the case, it is challenging to persuade more sceptical school leadership teams of the benefits of such activities. Similarly, without such an evidence base it is likely that the teachers and other colleagues who invest their enthusiasm, time and energies are not getting the recognition they deserve.

Recommendation 1: Build evaluation capacity at a school level that helps to develop an evidence base for STEM career-related learning.

Survey evidence suggests that only half of schools are thought by their senior STEM leaders to prioritise career-related learning. Where it is prioritised, this is in the context of raising aspirations with a particular focus on progression to higher education. The new freedoms granted to schools with academy status and through the Education Act with respect to career guidance need to be taken seriously. Each school should publish a plan to explain how it will meet its duty to secure that all registered students at the school are provided with independent career guidance in the relevant phase of their education (as recommended by House of Commons Education Committee, 2013). That plan could start from the basis of what the school already does. The survey results for this research indicate that many schools undertake a range of activities that provide a good starting point.

Recommendation 2: Schools should audit their current offer of career related learning and use this as a starting-point for a published school plan that explains how they provide career-related learning for their students.

STEM career-related learning involves a wide range of people. Examples were provided that included engagement of subject teachers, career co-ordinators, parents, employers, other learning providers and, of course, students. Most involved co-working of STEM subject teachers (some of whom were STEM co-ordinators) and the school careers co-ordinator. STEM co-ordinators and career co-ordinators work together most effectively when their school leadership teams recognise and actively support their work.

Recommendation 3: Teachers who design, implement and manage STEM career-related learning initiatives need to be allocated time, responsibility and esteem. There may be implications for teaching and learning responsibility points.

STEM career-related learning activities also harness the skills, contacts and knowledge of their colleagues who have worked in sectors outside education. This can help them to build applied learning approaches to the delivery of the curriculum and also to discuss work roles and employability skills with students.

Recommendation 4: Teachers who have wider work experiences should be encouraged to share their learning and contribute their skills to support STEM career-related learning programmes.

A minority of STEM leaders in schools said they were unaware of whether some aspects of career education and guidance happened within their school. A minority were also unaware of who if anyone was providing independent external guidance for students. There is therefore the potential that some students will ask them for information which they do not have – this represents potential for missed learning opportunities. Furthermore, the majority of STEM leaders in schools said that they would like to know more about sources of information and advice on careers in general, plus sources of specific information about STEM careers.

Recommendation 5: Headteachers should allocate time to inform all teaching staff of the career-related learning that occurs within school, and should facilitate further training for STEM leaders on general sources of careers information and on the nature of STEM careers.

The extra-curricular model that brings together aspects of STEM subject learning with career-related learning appears to be the most prevalent, through science and STEM clubs, collapsed timetable days and participation in events and competitions. The career-related learning aspects of all this activity should be made explicit to all participants. This is particularly true when external visits or visitors are involved, as this provides an opportunity for students to learn first-hand about particular jobs, what they involve, their rewards and downsides, and the entry qualifications they require.

Recommendation 6: Extra-curricular activities should be designed to integrate STEM with career-related learning, and this should be a clear expectation of their delivery and their success.

STEM career-related learning is important for all students, not just those destined for university. It is also important for businesses and the economy, as STEM skills are needed at both technical and professional levels. The research found some evidence of inclusive activities that encourage all abilities, both genders and all ages to build an interest in STEM. But these tended to exceptions rather than the rule.

Recommendation 7: STEM career-related learning should be undertaken for all young people in secondary school.

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