centre for science education

babcock

STEM Subject Choice and Careers Lessons Learned (Part 1)

Sheffield Hallam University

Contents

Executive summary

This report, the first in a series, sets out the approach taken by the Centre for Science Education alongside Babcock within the STEM Subject Choice and Careers Project funded by the Department for Education.[1] The approach provides an overview of a model we developed that can reflect the wide spectrum of where STEM subject choice and careers may be within any school as well as the different aspects.

The report illustrates how schools have raised STEM careers awareness by means of a range of interventions, together with some review of the impact of those interventions. The three year project has been able to draw on a range of new and creative resources and products, both from within the project and from allied organisations, that can enthuse young people and support teachers and careers advisers. How those products and resources reach schools, teachers, careers professionals and students is key to whether we can enhance STEM Subject Choice and Careers.

There are six case studies and all of them provide some messages for other schools as well as identification of the challenges that still remain to all involved in the development of this important work.

1 Formerly Department for Children, Schools and Families

Introduction and background

The STEM Subject Choice and Careers project is part of a substantial national investment by government to combat the decline in the numbers of students choosing subjects, courses and careers in the STEM field. The key message of the campaign is that a decision to study STEM subjects leads to a very wide range of interesting and well-paid jobs both inside and outside the STEM arena.

Two[2] of the main elements of the STEM Subject Choice and Careers project have been to

- lead and coordinate a campaign to promote STEM careers awareness among students, parents, teachers and information, advice and guidance (IAG) professionals – led by the National STEM Careers Coordinator, Kate Bellingham
- make available high quality information and resources about STEM careers, linked to subject and qualification choice and deliver associated CPD, from the beginning of Key Stage 3 through a variety of agents including subject teachers.

The Centre for Science Education (CSE) in partnership with Babcock have brought together the UK's largest university based team working on STEM education projects with one of the country's leaders in Careers IAG practice and policy to manage these elements of the project.

This report is the first stage of reflection and review of the wide range of interventions that have taken place as part of our involvement with STEM Subject Choice and Careers. We need to ensure that STEM careers work can continue to grow and improve beyond this three year project and that the growth is based on the learning from the substantial investment already made. To ensure our learning can draw from evidence in schools, we recruited twelve schools to be part of the project. Six schools from a range of backgrounds and types including academy and comprehensive schools were recruited as test-bed schools – they have tried out and reviewed materials and resources, undertaken attitude research[3] in two stages to date (one more to come) and been involved in a range of activities including Teacher TV programmes. Another six schools were recruited in partnership with SSAT[4] with appointed STEM Careers Lead Practitioners across all STEM subjects to develop their own practice in STEM Careers and to share their knowledge with other staff and partner schools.

At the outset of the project we established a model of school engagement that identified a multiple level of awareness across a number of key strands, together with suggested interventions to improve STEM careers awareness and engagement. We have drawn on those key strands in this preliminary report (and will continue in the second full report to be published in March 2011) to share what we have learned and to identify the challenges we can see that remain in taking the agenda forward.

One of the key strands identified is Equality and Diversity. Our approach to STEM Careers recognises that practice should tackle the under-representation in STEM of many groups and to this end we appointed an Equality and Diversity Advisory Group drawing on expertise from equality groups, STEM and education[5]. While the importance of equality and diversity has been acknowledged by some,[6] our project would appear to be one of a very small minority that are actively tackling the barriers that exist across all strands of equality in a holistic approach.

2 Other parts of the Action Programme include Future Morph, a website resource for young people hosted by the Science Council, a 3 year communication campaign 'Science and Maths, see where they can take you' and a research 'Timeline Project' to audit in-school provision of STEM careers and encourage planning and collaboration between STEM departments and careers services, led by Centre for Education and Industry, University of Warwick.

3 Wave 2 (1468 Y9, 10 & 11 students, 72 teachers and careers professionals, 615 parents and carers across 5 schools)

4 Specialist Schools and Academies Trust

5 A separate section of the STEM Choices pack focusing on Equality and Diversity will be published in March 2011.

6 Science for Careers, BIS, 2010

What outcomes have been achieved so far?

The long-term aim remains to increase the numbers of young people choosing STEM qualifications and careers. Within the scope of the limited three years life of the project a lot has been achieved against the set objectives – and there are clear indications that STEM careers awareness in schools is increasing, according to the latest NFER[7] evaluation report. A summary of project outcomes are included below.

a) changes in the emphasis given to STEM careers awareness

- STEM Careers profile raised in the IAG community and associated groups and organisations via the STEM Choices IAG pack in hard copy (4,000) and online on Future Morph and TeacherNet
- STEM group on ICG website
- regular briefings via cegnet, raised profile of science and maths on www.connexions-direct.com/jobs4u/
- dissemination about Future Morph
- See where they can take you campaign and Maths Careers at national and regional teachers and careers events
- project brochure to all secondary schools
- range of CPD interventions with IAG and teachers and Teacher TV programmes
- embedding careers awareness in a range of new STEM teaching resources and related activities like work experience and role model schemes and delivering via a wide range of existing routes into schools
- mapping and evaluation of STEM careers resources
- development of an online equality and diversity toolkit
- raised profile with stakeholders via National STEM Careers Coordinator

b) observable improvements in young people's awareness of and positive attitudes towards STEM careers

- Wave 2 of research with students in test bed schools indicates that nearly two thirds of students (64%) agree that STEM careers can be enjoyable compared with less than half (45%) in Wave 1.
- Wave 2 research also showed an increase in interest in finding out more about careers in Science (34% to 37%) and Maths (24% to 30%) and in wanting to continue in science and maths (from Wave 1).

c) Observable changes in confidence and attitudes of science and maths teachers and other staff towards careers awareness as part of the teaching and learning process

- This objective is still at a very early stage but there are positive indications.
- Wave 2 of research with teachers and careers staff in test bed schools has shown an increase in the use of STEM career related activity in schools, for instance teachers reported that problem solving days have increased from 27% to 54%.
- Case studies from the SSAT Lead Practitioners illustrate the changes in and development of teacher confidence and attitudes.
- Evidence from other regional events with teachers delivering workshops and sharing practice and knowledge.

7 NFER, The STEM Cohesion Programme: second evaluation report, July 2010

Developing school policy and practice in STEM Careers

The Four Levels model

Attention given to STEM subject choice and careers (SSCC) in schools covers a wide spectrum from little or no focus, through to a whole school approach drawing effectively on external partnerships. In order to structure the use of project resources, including Teachers TV programmes, CPD, curriculum materials and practice-focused guidance materials, we produced a developmental framework, based on aspects of school practice that we feel contribute to effective SSCC delivery in schools. The main areas we covered were:

SSCC Aspect	
A.	Teaching and learning to create greater pupil engagement and to promote STEM careers awareness, including cross-departmental work
B.	Development of pupil personal skills and capabilities
C.	Teacher awareness of the application of STEM in the workplace and careers pathways
D.	Use of enhancement and enrichment activities to promote greater engagement with STEM, and promotion of awareness of STEM careers
E.	Effective practice in equality and diversity
F.	Communication about STEM careers and use of personal advisers
G.	Leadership and management in school of STEM subject choice and careers policy and practice
H.	Establishment and utilisation of external partnerships to promote STEM subject choices and careers

Obviously schools may be at different positions in terms of their practice in different areas in the previous list. To assist schools in identifying their current position, and also to provide a route map for development of school policy and practice, we developed a Four Levels model, which sets out generic descriptions of practice in each of the above eight areas, showing the progression from little if any inclusion of SSCC work in a particular area, through to a fully integrated whole school approach. This can be used as an audit tool, to identify a school's current position, or a template for ongoing developments. The Timeline Project led by CEI is working on a strategic planning tool to support schools in establishing a STEM ethos.

In the SSCC publication *STEM and Economic Wellbeing* we suggested using the audit as follows:

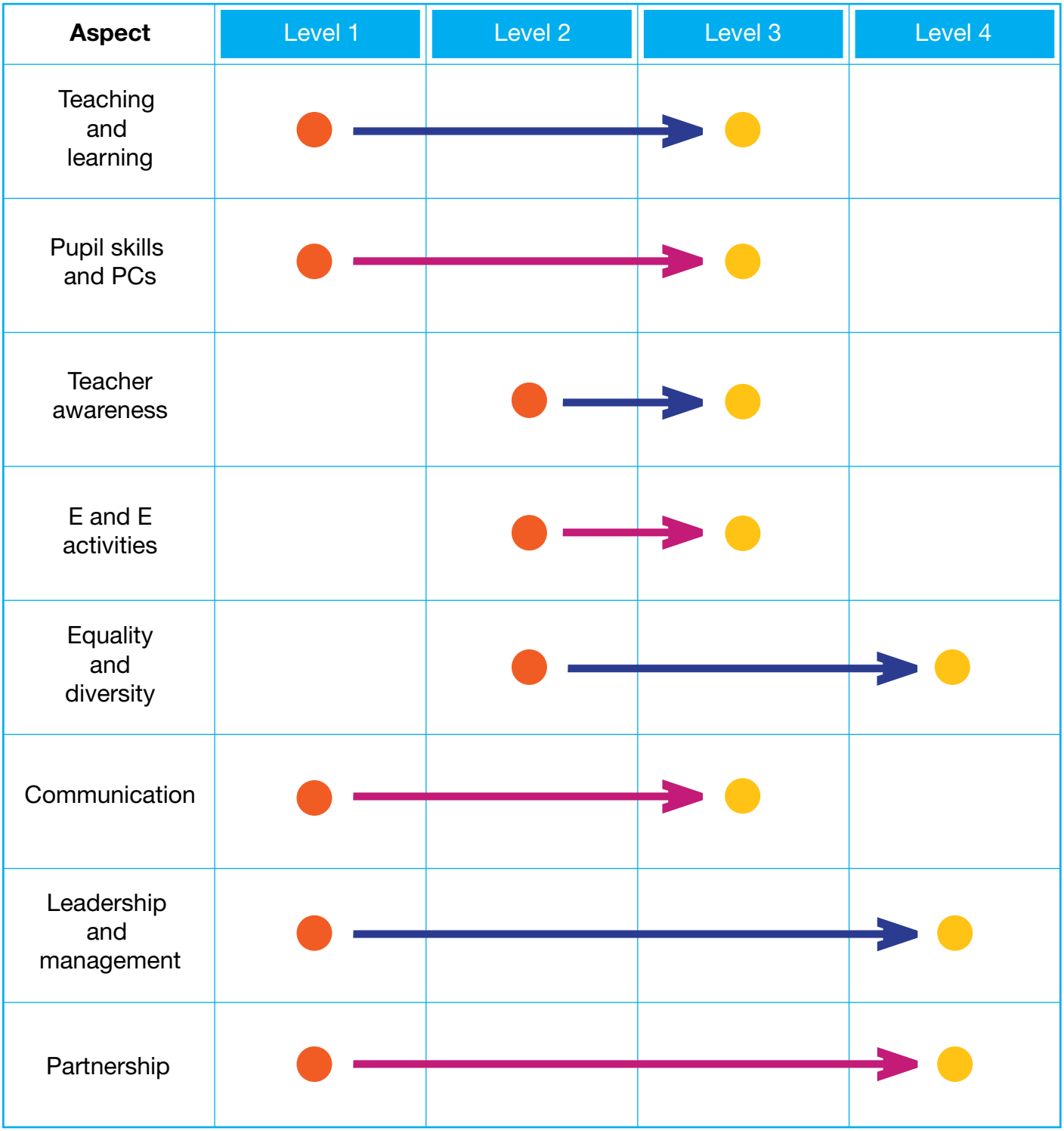
- identify where you are on each of the aspects of school practice (A-H)
- identify the changes needed to make the transition from your current level to the next on each of the eight aspects
- identify the mechanisms or interventions to help you achieve change
- identify existing resources and sources of support for making the transition
- Identify any gaps in the help available and how they can be plugged

The table shown on the next two pages are taken from the STEM and Economic Wellbeing Pack.

	A. Teaching and learning	B. Pupil personal skills and capabillities	C. Teacher awareness of STEM careers	D. Enhancement and enrichment
Level 1	No explicit or planned reference to STEM contexts and careers in curriculum planning. Individual teachers might make occasional reference to STEM careers if opportunites arise.	No verbal awareness of their own personal skills or capabilities. No planned acknowledgement of personal skills or capabilities within the curriculum. Teachers rarely make reference to personal skills.	Low level of subject teacher awareness of STEM career pathways and use of STEM subjects in the workplace.	Rare use made of enhancement and enrichment activities. Individual STEM teachers might make occasional 'use of STEM visitors from industry.
Level 2	Some STEM teachers make use of work related contexts to achieve greater pupil engagement in STEM subjects.	Reasonable awareness of personal skills & capabilities development and is able to give examples. Teachers occasionally use associate language in ad-hoc way. Reference to skills is driven by individual teachers enthusiasm rather than whole school action.	Some STEM teachers are aware of career pathways and use of STEM subjects in the workplace. Use is made of futuremorph, mathscareers, jobs4u, etc.	Some use made of STEM enhancement and enrichment activities with some pupils, though this tends to be only with those already commited to STEM subjects.
Level 3	Widespread use of work related contexts to support curriculum planning delivery by teachers across the STEM subjects.	Good awareness of personal skills & capabilities and can give examples and identify what made them worthwhile. Explicit, progressive and inclusive provision is given to personal skills & capabilities in subject lessons, whole school and curriculum activities by most staff.	Widespread knowledge and use of STEM subjects in the work place and career pathways. Teachers confident to answer front line enquiries from students and to help them make effective use of the wide range of web and hard copy STEM careers information.	Good use of STEM enhancement activities with substantial numbers of students. High level of awareness amongst staff of the opportunities and benefits of this approach and of STEM Directories.
Level 4	Whole school approach to use of work related contexts to support curriculum planning and delivery across all the STEM subjects.	Strong awareness of personal skills & capabilities and can give examples, identify worthy features and describe why they are useful. They work with other pupils to peer assess and coach others, and actively seek out opportunities to develop further. They experience personal skills & capabilities embedded into school and lesson activities by most staff; parents know about them.	Whole school approach to updating teachers on STEM applications and career pathways. Positive use of knowledge to enthuse and engage students. Direct links to futuremorph, mathscareers, jobs4u, etc.	Whole school approach to STEM enhancement and enrichment. Progressive programme for Key Stages 3, 4 and post-16. Support for students to reflect on learning and connections to and implications for career choice.

E. Equality and diversity	F. Communication about STEM careers	G. Leadership and management	H. Partnerships	
No explicit plan to tackle limited and stereotypical views of STEM courses and careers.	No explicit efforts made to rasie awareness of STEM careers by teachers or personal advisers.	No explicit lead on STEM choice and careers.	No explicit links are in place with partners such as Connexions, local universities, Aimhigher and STEM enrichment providers to support STEM subject choice and careers.	Level 1
Efforts made to tackle student and parents' stereotypical views of STEM courses and careers by some teachers through role models and curriculum materials. Some recognition of equality duties.	Individual teachers try to raise awareness of STEM careers in class and with individual pupils in response to interest. Personal advisers run group work and provide information, advice and guidance on STEM opportunities in response to requests.	STEM faculty heads are aware of potential and make efforts to encourage students to progress in STEM subjects.	Some individual teachers have links with partners to enhance delivery.	Level 2
Good recognition of equality duties. Active use of role models and mentors to promote equality in STEM subjects and careers. Targets set to achieve representative participants in STEM enrichment activities. Strategy in place to deliver an inclusive STEM curriculum.	There are comprehensive efforts by STEM teachers through diplays, visiting speakers, discussions, and information for individual pupils to raise awareness of STEM courses and careers. Personal advisers make positive efforts to broaden pupils' knowledge of STEM opportunities through group sessions, presentations at events, etc.	STEM faculty heads have started to define a strategy for encouraging pupils to explore STEM careers and develop interest in further STEM study through curriculum development and enrichment and enhancement activities. Some monitoring of students participation and achievement in STEM subjects to monitor effect.	STEM faculties have good links with key partners from higher education, Connexions, Aimhigher and industry to enhance student learning. These are celebrated within the school and wider community.	Level 3
Creative whole school approach to equality duties that engage all students in successful experiences of, and progression, in STEM courses and ensure that all pupils are able to fully achieve their potential. Differentiated activities to engage under-represented student groups in STEM courses and activities.	There is a whole school strategy for communication about STEM choice and careers with pupils and parents. This is evident in the careers library, school intranet and displays, as well as newsletters and events. There is a widespread commitment to the social and economic benefits of STEM careers. Personal advisers contribute to this strategy.	Whole school STEM engagement and careers policy in place in partnership with other key agencies. Monitoring of effectiveness is undertaken by studying participation and achievement in STEM subjects and career choice.	The STEM careers policy is developed, delivered, reviewed and celebrated in close collaboration with key partners including Connexions, Aimhigher, local universities and industry.	Level 4

Schools might want to consider identifying their priority areas for development, as progressing on all eight 'fronts' at once may prove difficult. For instance, an initial baseline assessment using the Audit tool might reveal a series of areas for development, but in two planned phases as shown below.



The various resources produced by the SSCC programme (including CPD), and the other Action Programme 8 resources such as Future Morph could be used as starting points for developing practice in a way to advance up the levels.

An example of a CPD-led package: moving from level 1 to level 2 in A. *Teaching and learning*.

In terms of A. *Teaching and learning*, the shift from level 1 to level 2 involves:

Level 1	Intervention ▶	Level 2
No explicit or planned reference to STEM contexts and careers in curriculum planning. Individual teachers might make occasional reference to STEM careers if opportunities arise.	CPD in the use of project curriculum resources, and raised awareness of other resources such as Future Morph, industry-sourced materials etc – separate programmes for science, maths and design and technology teachers.	Some STEM teachers make use of work-related contexts to achieve greater pupil engagement in STEM subjects.

In moving to Level 2, teachers begin to use 'images' of specific STEM careers in their teaching, e.g. through the use of the curriculum resources published for science by the upd8 project www.upd8.org.uk, for maths on www.mathscareers.org.uk or design and technology www.data.org.uk or for all on www.nationalstemcentre.org.uk Additional resources are found on www.futuremorph.org

Teachers develop their understanding of the need to motivate pupils in STEM subjects, as this has an impact on attitudes and subject choice (e.g. at 14, triple/double/single science, single/double mathematics, and at 16 and over, towards STEM-related post-16 courses).

Broader research and policy overview

The national focus and concern about STEM subject choice and careers has continued throughout the period of the project and there have been a number of policy reviews and reports issued in 2010 that directly relate to the project's content, impact and the future. As Derek Bell put it in his foreword for the Wellcome Trust's systematic review of literature,

'Helping young people to make the most appropriate subject choices is therefore crucial, both to ensure that the country has the skills it needs for the economy and to enable young people to make the best choices to meet their own future needs and aspirations.[8]*'*

In 2010 the importance of STEM skills and knowledge to employers has been reinforced by the CBI[9], reviews funded by the Department of Business, Innovation and Skills[10] and the Review of Higher Education.[11]

The attitude research undertaken with 5 of our 6 test bed schools gave us a useful overview at the start of the project as well as indications about the impact of STEM careers awareness within schools over the life of the project, with the first review taking place in spring/summer 2009 and the second in spring/summer 2010. A final round of data will be collected in spring 2011. Each round of research has targeted Y9, Y10, Y11 students, parents and carers of the students and STEM teachers and careers professionals. Findings from Wave 2 of the research show students developing increased engagement and interest in STEM subjects and careers. The research also gives an insight into equality and diversity issues such as access to work experience and the link between parents' knowledge about STEM careers and confidence in advising their children about STEM careers. A report focused on the Wave 2 research will be published in spring 2011.

The policy positions of CEIAG[12] have shifted dramatically since the Careers Task Force Review of 2010 and under the new coalition government. In 2008, our project focused on developing knowledge and awareness within the existing CEIAG workforce through the STEM Choices Pack with a constant range of face to face CPD opportunities. Our project has since needed to adapt to meet new challenges of spending cuts and changes in CEIAG policy in order to maximise the legacy of STEM Careers work. We have supported the Careers Profession Task Force in its recognition of STEM as an area of importance for new careers professionals and existing CEIAG development, and are already working on an online version of STEM careers CPD as recommended in the STEM Careers Review.[13]

This report makes links within the following pages to specific policy and other literature, but a separate and updated STEM careers literature review will be published in March 2011.

8 p5, Foreword, Subject Choice in STEM: Factors influencing young people (14-19) in education, Wellcome Trust

9 Ready to Grow, CBI, 2010

10 Science for Careers Expert Group and Science for Learning Group, 2010

11 Browne Review, 2010

12 Cegnet, Supporting Careers Education (CE) and IAG Briefing, October 2010

13 Gatsby Report, November 2010

STEM careers in practice

The following short case studies are used to illustrate different aspects of the eight key areas of school practice identified within our developmental framework and to show how positive change can be achieved in schools now and in the future.

Case study one: STEM careers in the curriculum

Aims

- teaching and learning to create greater pupil engagement and to promote STEM careers awareness, including cross-departmental work teacher awareness of the application of STEM in the workplace and careers pathways

The issue

STEM teachers have an important role to play in a coherent and coordinated whole school strategy to develop pupils' STEM careers awareness and engagement. Through the use of visual media, case studies, careers profiles, stimulating STEM context-based curriculum resources and active teaching and learning approaches they can develop and capture the students' interest and imagination in STEM and then progressively enable students to develop an appreciation

- of the applications of STEM in everyday life and a range of sectors and jobs
- that STEM-based jobs are really exciting, satisfying and rewarding
- that STEM workers make an important contribution to society
- that STEM workers use the skills they are developing (both process skills and personal capabilities)
- that STEM workers work in multidisciplinary STEM teams
- that there are many different careers and jobs in STEM and of the subjects and qualifications they require for the variety of jobs

At the start of the project there were few resources and little CPD available to support STEM teachers in the achievement of these goals. However, through the period of the project a number of high quality visual media resources and curriculum materials have been developed by a number of projects, such as Future Morph, Engineering Everywhere, Teachers TV, How Science Works, science upd8, cre8ate maths, and Maths Careers, in addition to the resources produced within the project. A number of conferences and events run by the National Science Learning Centre (SLC), the network of regional SLC's, SSAT and others have supported dissemination.

Starting points

Thomas Deacon Academy is one of the six test bed schools. The academy opened in September 2007 as an amalgamation of three predecessor schools in the centre and east of Peterborough. It is the biggest single academy in the country, a specialist college of science and mathematics, and a training school.

The academy has an established programme of STEM careers fairs, work placements, industry visits and visitor programmes organised by Bev Lindsey. Bev has also provided links to useful careers websites for STEM subjects on the school Virtual Learning Environment (VLE). The next phase of working towards a coherent and coordinated programme across the curriculum was to work with STEM subjects to integrate STEM careers awareness into the curriculum.

What they did

Bev and the project team worked with Caroline Jackson, an advanced skills teacher (AST) in science to start the process of working towards integrating STEM subject choice and careers into the science curriculum. First they introduced Caroline to the range of visual media resources and curriculum materials listed above, and careers websites with STEM careers profiles.

Caroline used some of her AST planning time to familiarise herself with all the resources, producing a document which mapped all the resources against appropriate topics/modules taught in the KS3, KS4 and Key Stage 5 science curricula. This mapping document and the visual media resources, including videos and curriculum materials, were uploaded onto the VLE.

Caroline also produced a bank of career profiles mapped against all the science topics. She then developed a series of exemplar starter and plenary activities for Key Stage 3 and 4, which adopted teaching and learning models which could be used for any science topic, using the careers resources available on the VLE. Caroline and her colleague Nichola Offer, also an AST in science then introduced the resources and support materials Caroline had developed to key staff in the science team for trialling before introducing them to all science staff through a departmental CPD.

Activity

Nichola Offer was filmed for one of the eight CPD programmes in a science series developed for the Teachers TV programme. She used a range of techniques to help her students think about careers in STEM professions. The lesson filmed focused on IVF and Nichola invited the school nurse, Rachael Bines, into the lesson to talk to her Year 8 class about her work and to provide professional support. The students performed a role play which got them thinking about the number of professions involved in IVF and raised some interesting questions. The second part of the lesson challenged students in their groups to focus on one particular profession by searching various STEM careers websites, with the students creating a poster trail of their findings.

The activities used in the programme were adapted from the Science upd8 activity 'Three parents'. The activity introduces the potential use of in vitro fertilisation to help a couple where the potential mother has Leber's hereditary optic neuropathy (LHON), a genetic disorder causing sight impairment, to have a baby which will not carry the mitochondrial gene causing the disorder. The background science and context is introduced through PowerPoint dialogue between a doctor and a nurse. The nurse (some of the students) will then counsel a couple (other students) where the potential mother has the disorder.

In the lesson shown in the programme, Nichola introduced the structure and context for the lesson. The school nurse then introduced the scenario and provided some basic additional explanation of in vitro fertilisation. The students were then involved in a role play which involved three roles potential mother, potential father and nurse. The couple were seeking information from the nurse to help them to understand the process they could potentially go through. During the debriefing of the activity Nichola asked the students if they could name all the professionals involved in helping and supporting the students. From the list the teacher identified five professions for the different groups to research using the Future Morph, NHS careers, and Connexions websites. The groups had to produce an information poster on the profession they researched. They also wrote questions to test readers of their poster. This enabled the teacher to produce a poster trail.

Impact

The students were surprised at the number and range of professionals involved in the IVF treatment. They commented that they had learnt so much about the science, the application of the science and the role the different professionals play in the treatment. Some students commented that they had become interested in careers they had not considered in the past, and that they had learned about what subjects and courses they needed to do for those careers. They were also surprised by the salaries earned by some of the professions. This positive attitude on STEM careers was backed up in the research, with an increase in percentage of students keen to continue studying all of the three sciences (and maths) in the second wave compared with the first wave of research.

Challenges

Caroline needed the time to familiarise herself with all the resources, identify where they could be built into the curriculum, and plan how they could be used effectively and made easily available to staff. With the pressures of introducing new examination courses and a new Key stage 3 scheme she needed to identify a strategy for progressive introduction into the curriculum. Thus the department started with BTEC courses, and Key Stage 4 and 5 lessons.

Key teachers selected and taught an individual lesson so they could report back during departmental CPD. Staff chose single lessons to trial during a half term period and shared experiences. They could then replace existing

lessons in their schemes with the new lessons which would not only develop the desired knowledge, understanding and skills, but also STEM career awareness and engagement. Thus the implementation was sensitively planned and carefully staged, not over burdening staff, and ensuring sustainability. The department is still going through this process.

Messages for other schools

- identify time for a member of the team to lead and go through the processes of familiarisation, mapping, planning and developing outlined above
- stage the implementation of the resources and lessons sensitively and strategically, enabling staff to make their own choices with regard which resources they want to trial
- provide time for CPD, support, mentoring and reflection during implementation

Case study two: effective use of role models

Aims

- establishment and utilisation of external partnerships to promote STEM subject choices and careers
- use of enhancement and enrichment activities to promote greater engagement with STEM, and promote awareness of STEM careers

The issue

There are a huge range of STEM enrichment organisations and activities available to schools and many of them draw on the use of role models to provide a living understanding of what STEM careers can be. Yet the opportunity to help young people reflect on the relevance of their own experience and individual decision making can be easily missed, or stereotypes can end up being reinforced to the detriment of widening opportunities. This case study illustrates how hands on enrichment activities delivered by confident, diverse and well prepared STEM role models and STEM ambassadors can help young people explore new areas of interest and develop fresh insight to the potential of STEM careers.

Starting points

Getting the best out of the use of role models can be difficult for schools. While events with ambassadors can go well, they can also present problems to schools. We worked with STEMNET to develop training materials for ambassadors and guidance for schools. These materials can now be accessed via the STEM networking site (on www.stemnet.org.uk) and can be worked through on an individual basis without the need for formal delivery by an organisation.

Another example of getting the best out of visitors is used by Collingwood College, Surrey. Shown as part of a Teacher TV programme, it involved putting the organisation and management of the event into the pupils' hands. The guidelines are available on the National STEM Centre website (www.nationalstemcentre.org.uk).

Activity

STEM ambassadors (students at the University of Sheffield) took part in training and delivered activities to a group of girls at Bradfield School in Sheffield (as part of a Teacher TV programme). The main focus of the initial training was to enable the STEM ambassadors to communicate more effectively with the school pupils in order to maximise the impact of their visit.

STEM ambassadors were encouraged to consider their own career choices and what they enjoyed about their own careers. They also practised responding to potential questions from pupils, and discussed a range of scenarios which highlighted many of the misconceptions that young people have about careers in STEM. The ambassadors were introduced to a number of web-based resources designed to support young people with information about careers in STEM.

Through developing their own awareness of what is available, the ambassadors in turn are able to signpost school pupils more effectively to appropriate sources of information and support. Having experienced the training, the STEM ambassadors then delivered a hands-on activity which demonstrated the practical application of their knowledge in a way which engaged the pupils. The ambassadors responded to general questions from the pupils about their own careers and were able to confidently signpost to web-based resources such as Future Morph.

Impact

STEM ambassadors frequently feel nervous about embarking on any activities with young people, fearing that they are out of touch with the school system or the choices that young people have to make. By developing an awareness of the sources of information available which are designed specifically for young people, the ambassadors are able to signpost with confidence. Also, through encouraging the ambassadors to reflect on their own career choices and likes and dislikes in terms of their course or job, it makes them more accessible as a role model, and more empathetic to the decisions facing young people.

If STEM ambassadors feel more confident, they are more likely to become and remain active, which in turn leads to greater employer engagement between schools and STEM industry, and may lead to increased take up of STEM subjects in schools and further and higher education. Likewise teachers feel nervous about inviting in visitors who are unused to communicating with young people, fearing they may put them off STEM careers rather than engaging them. In keeping the management of the experience in the hands of the pupils and the school, the visitors are put at their ease and the pupils develop their own personal skills at the same time.

Challenges

Ambassadors and role models may be reluctant to accept that they lack communication skills with young people, particularly if they have been undertaking this role for some time, and need careful handling. The planning time required for recruiting ambassadors can be underestimated and identifying diverse ambassadors with appropriate backgrounds can be difficult in some regions.

Messages for other schools

- role models can have a huge positive impact on young people if the circumstances are right. Gain help from STEMNET and other specialist groups like UKRC and Women's Engineering Society to increase diversity.
- ensuring that role models and ambassadors are well briefed and that they have planned an effective session which will engage the school pupils is essential
- teachers will need to support inexperienced ambassadors and by involving the pupils in organisation of the visit can maximise the value for both sides[14]
- it is essential to demonstrate how the ambassador's area of work or study links to subjects that have been taught in school to ensure that there is tie-in with the curriculum

14 The Visitor Experience Teacher TV http://www.teachers.tv/video/31983

Case study three: tackling equality and diversity in work experience placements

Aims

- establishment and utilisation of external partnerships to promote STEM subject choices and careers
- effective practice in equality and diversity

The issue

The evidence[15] (IEBE, 2008) confirms that work experience can have a positive impact on the motivation to learn and can thus be a very useful insight into the potential of STEM career opportunities for young people. On the other hand there is evidence to confirm that access to STEM vocational subjects and work placements can be heavily gender stereotypical (Francis et al, 2005; OFSTED, 2010) and limited by class, gender and ethnicity (Hatcher and Le Gallais, 2008).

The STEM careers project identified work experience as a potential hook for STEM subjects and careers from the beginning of the project and has been working to better understand barriers while developing approaches that tackle stereotypes and promote wider access to STEM work experience. This case study shows how different approaches to work experience can impact on widening access.

Starting points

The STEM careers project team developed a checklist to support improved arrangement of STEM placements, based on knowledge drawn from previous interventions and the findings from two focus groups of practitioners involved in work experience. Building on our research with test bed schools we asked how work experience worked in practice, by means of a short survey and telephone interview. We wanted to compare the experience in school with other research that shows barriers on socio-economic grounds as well as strong gender stereotyping. '*If work experience is about learning and labour, it is about how working class kids get working class placements and middle class kids get managerial and professional ones.'* (Hatcher and Le Gallais, 2008, p73). The team have considerable experience of tackling gender stereotyping in work experience through the Wider Horizons award winning programme (2005-2007) and more recently with RAF and Navy in partnership with WISE and UKRC.

Activity

While the majority of the six schools draw on their local Education Business Partnership (EBP) to obtain placements, they do it in different ways, with only one school relying completely on self-arranged placements. One school with higher than average free school meals (FSM) pupils was actively involved in driving the quality of work experience, while another with average FSM relied heavily on the EBP.

The estimate of STEM placements available was hard to determine because school co-ordinators did not have a good understanding of the breadth of and links to STEM in industry. In many cases the main focus was on gaining sufficient placements, avoiding the challenge to gender stereotypes or level and quality of placement. Most schools operated with a two week placement in year 10, but one academy offered a self-arranged placement in Year 12 together with a more flexible three week enrichment entitlement that could include work experience (and university visits or extended projects) with only those on vocational courses in year 10 going on work experience placements.

15 - Full references for this case study will be found in Widening Horizons in STEM work experience, by Collins and Morton for Employer Education Research conference, 2010.

Impact

The school with higher than average FSM acknowledged it was hard to get professional level placements, reinforcing other research findings (Hatcher and Le Gallais, 2008), but they also actively intervened to avoid unskilled placements. Another school that left management with EBP acknowledged that some 40% of placements were unskilled. The impact of school intervention was seen to be crucial in tackling the barriers of socio-economic disadvantage. The number of STEM placements reported ranged from 9% to 40%, with higher numbers obtained linked to the proximity of large companies with structured placements (including Landrover, Siemens and Nokia) or local garages that offer craft placements. Gender stereotyping was widespread with peer pressure being cited as well as the lack of challenges from placement providers.

Challenges

This aspect of STEM careers opportunities remains a huge challenge to deliver fair opportunities to all young people. While individual small scale interventions to tackle gender and class stereotyping have been successful, the evidence from our typical schools has identified considerable embedded challenges. As one head teacher said:

> *'Finding meaningful placements is becoming increasingly difficult. As the economic situation is squeezed then so too are the number of placements on offer. Structured daily plans are becoming the exception rather than the norm and some firms want to use the pupils as unpaid labour.'*

If work experience placements are to make a positive contribution to widening the opportunity to STEM subject choice and careers then the challenges we have identified require further intervention.

Messages for other schools

- school management teams need to be pro-active in the organisation of work experience placements if they are to tackle gender stereotypes and raise aspirations
- unskilled placements need to be used with caution where there are specific reasons – employers can be supported to provide structured and meaningful STEM placements
- if interesting and structured STEM work placements are available to all then a positive impact on the motivation to learn in STEM subjects can be achieved by all

Case study four: one school's approach to STEM careers

Aims

- communication about STEM careers and use of personal advisers
- teacher awareness of the application of STEM in the workplace and careers pathways

The issue

Careers education, information and guidance should open young people's eyes to the full range of available choices and enable them to explore the options that are in *their* best interests rather than in the interests of a learning provider or employer. Collingwood College in Surrey was one of six test bed schools working with the STEM Subject Choice and Careers project. This case study explores how Collingwood used the resources and momentum of the project to strengthen pupils' awareness of STEM courses and careers without compromising the breadth of advice available to their students.

Starting points

Collingwood College is a large 11–18 school in the north-west part of Surrey with over 2,000 students, including 450 in the sixth form. The school is a well-established specialist technology college with a second Applied Learning specialism. Collingwood College hoped involvement in the project would boost the numbers of students progressing to post-16 courses in Science, help address gender imbalance in progression and support performance in technology. The school is part of a vibrant learning network of 14–19 providers in the SHAPE learning network offering a very wide range of choices to students including vocational courses, GCSE and GCE courses, the diploma and young apprenticeships.

Activity

A defining feature of Collingwood's work within the STEM Choice and Careers project has been strong and effective teamwork between the STEM and the careers and information, advice and guidance (IAG) departments. The links between Angalika Newton in science and Lorette Parker in the IAG department has been particularly strong. The progress monitoring against the DCSF Benchmark review of Specialist School Targets in the school highlights the very wide range of different activities for young people that encourage performance and progression in STEM. These include

- bringing in the drama group Cragrats to demonstrate to Year 7 students the power and potential of technology
- leading on two of the Teachers TV programmes produced as part of the STEM Subject Choice and Careers project
- identifying a career link in all departments in the school and working with the STEM departments to establish displays demonstrating the relevance of the subject skills to the world of work, and the range of jobs that the subjects can lead to
- working with GCSE groups to discuss their future goals and investigating the use of science in a wide range of careers including beautician and careers in the RAF
- running a range of after school clubs including Puzzle Clubs, to support interest in STEM
- a comprehensive range of master classes and revision programmes drawing on resources inside and outside the school including the Further Maths Network
- establishing a Year 8 STEM group to take part in STEM competitions for National Science Week. They recently took place in the IET Faraday Challenge and, having progressed to the next round with their device for the medical industry, hope to be one of the finalists at the Big Bang Exhibition in March 2011
- working on STEM challenges with Year 6 students to support progression to Collingwood
- working with employers to address the gender imbalance in work experience placements

The school encourages a wide range of choice in the range of learning pathways open to students but care is taken in the booklets and advice to ensure that students are aware of the implications of different choices and where they may lead.

The IAG coordinator has used the STEM project to provide impetus to the school's journey towards achieving the national Investor in Careers Award. Members of the team have been able to attend a range of CPD activities linked to the project including the national STEM timeline conference. Angalika made a powerful and effective contribution to the Science Festival at Surrey University in September 2009.

Impact

There is a range of quantitative and qualitative evidence of progress in raising awareness of STEM courses and careers, and involvement with the STEM Choice and Careers has helped to support the staff engaged with that work.

- the school achieved Investor in Careers Award in October 2010, and the most recent Ofsted inspection rates the care and guidance as good
- the findings from the first and second wave of test bed school evaluation reflect interesting overall changes in pupil, parent and teacher awareness of STEM courses and careers. There was an increase in the proportion of students agreeing that STEM careers can be enjoyable, up to 64% from 45%. With both pupils and parents, there was a significant increase in the numbers agreeing with the statements that STEM careers are more highly paid, offer more prospects for advancement and can make a difference to environmental issues.
- the school is building on experiences to encourage and motivate students. There has for instance been an increased interest in engineering as a result of work on the Teachers TV programme and the school is following this up with targeted work experience with key employers such as British Airways.
- the IAG coordinator has effectively raised the profile of STEM careers with the governing body
- there is anecdotal evidence of increases in motivation of students. They report seeing the value of working hard. It is telling that the personal skills noted as most relevant to STEM in the baseline survey was tenacity. Staff at Collingwood report that some students who undertook BTEC Science want to do Science GCSE alongside A levels to expand their options.
- a doubling of take up of Chemistry at AS
- building commitment of all staff – strengthening the contribution of form tutors to careers and IAG and raising the profile overall of IAG

The school are keen to explore ways of supporting wider parental involvement. Over a third of the parents completing Wave 2 of the test bed schools postal questionnaire were from Collingwood. This included a positive encouragement to the school to follow this up. *'I think there should be more information on careers that these subjects could lead to, not only for the students but also for the parents so we could discuss the options with our children. I would be very happy for my children to pursue learning and careers in these STEM subjects.'*

Challenges

Senior management have acknowledged the progress and impact of the STEM careers work led by Lorette and the value and potential of placing careers education at the centre of the school. Since local authority spending cuts to the Connexions service have taken place, Lorette's remit has expanded to cover a much wider careers brief including leading subject departments on student careers awareness and progression. Securing resources and support to maintain and develop this work is a key challenge.

Messages for other schools

- engage the support of the management team
- have a coordinator or champion who can work as part of a team bringing together STEM and careers
- build a progressive range of activities for all year groups and celebrate the successes
- promote the good news stories
- draw on the resources outside the school in particular STEM ambassadors
- harness student voice to address issues in retention and progression in STEM courses

Case study five: personal skills and capabilities

Aims

- development of pupil personal skills and capabilities
- use of enhancement and enrichment activities to promote greater engagement with STEM, and promotion of awareness of STEM careers

The issue

Where youngsters are being encouraged to consider career choices in STEM, they require a degree of self awareness and personal understanding in order to effectively choose those careers that fit most closely with their personal strengths, skills and capabilities. Increasingly the discussion around personal, learning and thinking skills links to the PLTS framework in schools, but employability skills that are also increasingly being called for by employers. The CBI[16] suggested that over half (57%) of employers cited STEM graduates lacking employability skills and believed that the teaching of these skills should not be viewed as a discretionary 'add-on' – they are vital to enable graduates to apply their degree skills to the workplace. Enhancement and enrichment opportunities provide a powerful opportunity for young people to reflect on the relevance of these events for their own individual career decisions. Enrichment and enhancement activities can challenge stereotypical thinking by opening up an insight or possibility that may previously have been outside the student's personal career construct or 'horizon for action'[17].

Starting points

We made a conscious effort to try and make clear and explicit the need for personal skills and capabilities (PCs) to be embedded into the teaching materials. This was easier in science than in any other STEM subject. Other examples of links formed included working with partner organisations on good practice work experience programmes[18] and the STEM Leader Qualification[19] and CREST awards. Lynne Bianchi[20] explained, *'For me, we must aspire not just to enhance youngsters' teamwork skills, or their communication skills, or their self management or creative capabilities – those may well be relevant skills – but our ultimate goal is to have youngsters who can utilise the knowledge of personal development, their increased understanding of their personal strengths, their attuned aptitude to self and peer assess and knowledge of strategies to improve and make informed choices and judgements about their futures. Without this they are disempowered to make effective choices and not skilled up enough about themselves to locate careers that would suit or not suit their personal interests, aspirations and needs.'*

Activity

Some of the test bed schools have been encouraged to address these messages in an overt way with their students. The IAG lead in Collingwood School in Surrey has worked with STEM teachers to put up displays that demonstrate how their subjects develop the skills and qualifications employers require. Many of these displays also highlight careers and pathways open to young people committed to these subjects.

The project has shown a variety of ways in which schools can foster both the contribution of STEM to personal skills and capabilities and the relevance of these skills in the workplace. Each of the science curriculum materials has also had associated PCs inserted into the teacher's notes to draw on.

With the support of the project a wide variety of stimulating enhancement and enrichment activities have taken place including the food technology suspended timetable activity at Helsby High School (SSAT lead practitioner school), a STEM evening for parents and young people from Years 8–13 Rosebery School in Surrey, a STEM careers day on a shoestring budget at Kineton High School, and Collingwood's pupil interviews with STEM ambassadors (test bed

16 CBI 2009

17 Hodkinson et al, 2008

18 see RAF work experience programme.

19 www.leadersaward.com

20 Director of the Comino Centre for Personal Capabilities and Leadership

school). Resources from the project, including how to run a STEM Careers Day, have been used in a variety of different settings.

These events have shown young people and teachers that knowledge about careers is not simply acquired through information and advice. *'Career learning and development is constructed through activity and in interactions with a variety of people (including career professionals, employers, teachers, parents and peers). Individuals need ongoing experiences and opportunities for discussion in order to construct this knowledge within their changing social and cultural context. [21]'*

Impact

Students at Collingwood have experienced a wide range of activities and interactions with a variety of people. Wave 2 of the research we carried out with the test bed schools asked the students about the personal skills they experienced within STEM subjects. While the response from all test bed schools was encouraging, the feedback from Collingwood showed the highest over all recognition of all PCs in STEM subjects with 80% or more confirming that they always or sometimes used each of the skills in the Personal Capabilities framework, with teamwork being identified as the most used (91%).

Challenges

Personal skills recognition within the STEM curriculum is not well developed or coherent. Enhancement and enrichment activities in STEM are generally growing in schools with the number of after school STEM clubs also increasing, but there needs to be greater recognition and acknowledgement of how such cross curricula activity and personal skills and capability development in STEM can contribute to students' careers education. There needs to be further development at all key stages to embed PCs within the STEM curriculum.

Messages for other schools

- carry out an audit of STEM careers and enrichment activity within departments and across school drawing on the Timeline Project[22] Audit tool
- draw on award schemes such as CREST awards[23] and the STEM Leader Qualification[24]
- collaborative approaches between careers and enterprise coordinators and STEM subject leaders will enhance outcomes and management

21 An Introduction to Career Learning and Development 11-19 – Perspectives, Practice and Possibilities Anthony Barnes, Barbara Bassot and Anne Chant Routledge 2011 ISBN 978-0-415-57778-6

22 Timeline Project, led by CEI University of Warwick.

23 run by the British Science Association

24 www.leadersaward.com

Case Study Six: Developing a whole school approach

Aims

- leadership and management in school of STEM subject choice and careers policy and practice

The issue

As identified within the STEM Careers Awareness Timeline Project,[25] senior management support is essential if schools are to introduce an effective approach to STEM careers, but this remains a challenge for many schools. Models and examples of good practice along with tools for change have been identified as part of the Timeline Project, but significant challenges remain including STEM departments not working together and STEM departments not working with careers education (CE) and information, advice and guidance (IAG) staff.

Starting points

Two of the Specialist Schools and Academies Trust (SSAT) STEM careers lead practitioners chose to take forward STEM interdepartmental planning and a whole school approach to bring in STEM careers awareness. The initiative is at a very early stage and it is far too soon to identify progress. However both teachers are positive about their interventions. Each of the schools has very different identities and different priorities.

Activity

Michelle Dooley, head of maths at Wilmington Grammar School for Girls, a maths and computing specialist school in Kent adapted STEM Careers resources and materials to meet the needs of her maths department. Following this she met with the science and technology departments to show them the sorts of activities being used in lessons and where they could locate all the resources.

The second part of her project was to develop a STEM Careers Awareness Timeline. Each term all KS3 students are to have an activity involving STEM careers. The KS3 schemes of work were altered to incorporate STEM activities from September 2010. A STEM learning team is being created, to promote STEM across the school, which she will be leading.

Andi Manns, an advanced skills teacher (AST) in science at Thomas Hepburn Community College, an inner city 11–18 school in Gateshead and specialist science school, wanted to raise the profile of STEM subjects at Key Stage 4 and 5 prior to pupils making subject choice and career options post-16, to raise aspirations by planning and delivering a series of careers lessons using the Future Morph website and developing more detailed lessons that illustrate STEM careers in context. He organised a STEM Day targeted at Y11 pupils prior to them making subject choice or career options post-16 in partnership with the heads of science, maths and technology, together with the local STEMpoint. Andi's aim is to take things forward from September 2010

- to achieve a more joined up thinking between STEM departments, Connexions and further and higher education widening participation schemes to ensure Schemes of Work are more rigorous
- to ensure STEM pathways are embedded into the application for and delivery of projects, for example Royal Society funded projects and CREST projects etc
- to actively use role models that challenge the stereotypical view that pupils and parents have about STEM subjects
- and finally to use the SSCCC Level criteria to help develop an action plan for the future delivery of STEM at KS3, 4 and 5

25 Lengthening Ladders, Shortening Snakes, October 2009

Impact

This strand of the STEM Subject Choice and Careers project is still at a developmental stage. The Timeline project has made progress in identifying a number of barriers to a whole school approach to STEM careers, as well as beginning to develop a planning tool that can tackle some of the barriers. Where head teachers and the leadership team of a school are proactive on STEM careers then change can be achieved. The SSAT Lead Practitioners in our schools have had an impact within their own departments, winning recognition and / or promotion as a result of their interventions. Another example drawn from the wider AP8 programme shows a STEM careers approach from the top, with head teacher Liz Allen at Newstead Wood School[26] explaining how hard she has worked to achieve success. As she says, *'There are no quick fixes.'*

Challenges

The challenges in applying a whole school approach to STEM careers remain considerable. If taken step by step and with a coordinated approach, positive change has begun to be observed in the project test bed schools and the SSAT Lead Practitioner schools as well as being found in a wider range of STEM departments across the country. With the structure of the Careers Profession at a crossroads, schools will need to be vigilant and proactive if they are going to ensure careers education is to be maintained as part of STEM careers policy and practice.

Messages for other schools

- there needs to be a lead person with status appointed to develop awareness and coordinate STEM careers activity
- STEM careers activity can be developed in one subject and then lessons learned can be shared with other departments. Different approaches may be required to meet the priorities of different subjects.
- different schools will need a different approach according to the students' needs and school priorities
- senior leadership is necessary to support a whole school approach to STEM careers
- the importance of good careers education to students' subject and career choice has been acknowledged in recent education policy reports[27]

26 See Discovering talent, developing skills, 2010

27 Securing a Sustainable Future for Higher Education, 2010; STEM Careers Review, 2010.

Conclusion

The case studies illustrate both the progress made and the progress that is still needed within STEM subject choice and careers. In order to tackle the complexities of the interactions influencing student subject choice and careers in relation to STEM we identified eight key aspects of school practice, and through case studies in schools we have shown how teachers, careers professionals and allied staff have taken the STEM careers aims and objectives on board.

Even though there is evidence of good practice there is still much to do. Our work has focused mainly on Key Stage 3 and there is still much more to do at this key stage as well as before and after. This report is the first of a number we are working on to ensure that the lessons we have learned in our wide-ranging project can be developed and built upon to ensure all young people have access to good quality information and advice that challenges stereotypes and informs subject choice in STEM subjects and careers.

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Test bed schools

Collingwood College, Surrey

Thomas Deacon Academy, Peterborough

CTC Kingshurst Academy, Birmingham

Pleckgate High School, Blackburn

Ecclesfield School, Sheffield

Comberton College, Cambridge

Specialist Schools and Academies Trust (SSAT) STEM careers lead practitioner schools

Helsby High School, Cheshire

Wilmington Grammar School for Girls, Kent

Thomas Hepburn Community College, Gateshead

Francis Bacon Maths and Computing College, St. Albans

Bay House School, Gosport

The Long Eaton School, Nottingham

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