Widening horizons in science, technology, engineering and maths (STEM) work experience

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Abstract

The IEBE's survey (2008) of young people in work experience found that they overwhelmingly value their placements and see them as having a positive impact on their motivation to learn. As the need to attract more young people with science, technology, engineering and maths (STEM) qualifications continues to be a major concern (CBI, 2009; DfES/DTI, 2006) the interest in STEM related work experience, as a means to discovering careers in the sector has grown. There remains considerable potential to expand access for young people to stimulating STEM placements that raise aspirations and widen access to STEM careers. While there is clear research evidence to confirm that access to work experience can be gender stereotypical (Hamilton, 2003; Francis et al,2005)) and /or limited by class, gender and ethnicity (Hatcher and Le Gallais, 2008) there is also evidence to suggest that examples of effective ways of tackling inequality in work experience are still rare (Miller et al, 2004). The authors have been involved in work to promote gender equality for a number of years, including the development of a successful work experience scheme directly aimed at challenging gender stereotypes in STEM related employment sectors (Wider Horizons, won an Institute of Careers Guidance Award in 2005). The authors are currently involved in a major government project to make STEM careers more visible and attractive to all young people and as part of this project we are working with partners to develop resources that will promote equality of access to STEM related work experience. The paper will draw on the findings of previous research, the Wider Horizons scheme as well as work with partners in the current project to pose challenges and some solutions to widening participation in STEM work experience for all young people.

Key words: work experience, STEM, equality and diversity, gender stereotyping

Introduction and STEM Context

All school students are required to undertake work related learning (WRL) as part of their education at Key Stage 4 and work experience as a significant element of WRL has become a well established part of school life. Students are required to learn '*about'* work, '*for'* work and '*through'* work (QCA, 2005), the '*through'* being often delivered via work experience placement. The new diplomas and many other vocational qualifications now have a WRL aspect including a placement and there is general recognition that WRL is an important part of a young person's education (CBI, 2007). To reinforce this there are several indications that young people value WRL and work experience if it is planned and arranged to be enjoyable and stimulating (IEBE, 2008).

Science, Technology, Engineering and Maths (STEM) subjects are recognised as being of vital importance for the future of the UK economy, and STEM subjects have received significant investment by government within the 'Ten Year Framework for Science and Innovation' (DCSF, 2008). The numbers of students taking STEM subjects post 16 is now again rising, but there are still too many giving up STEM at an early stage (DCSF, 2010i) and employers continue to report difficulties in recruitment of those with highly valued STEM qualifications and skills (CBI, 2009).The greatest leakage from the STEM supply pipeline is at 16, by those who fail to attain any A level qualifications with the second greatest leakage from those who progress but fail to choose a STEM subject at A level (BIS, 2010). Technical skills as well as professional skills are in short supply and both the previous government and the new coalition government are committed to increasing the number of apprenticeships (DCSF, 2009i; BISi, 2010).The STEM Subject Choice and Careers project is part of the

national STEM Programme, with a remit to raise awareness of all young people to the breadth of STEM careers and to help young people develop the skills needed to pursue them. The project includes a wide range of different careers aspects relating to work with teachers and careers professionals, but significantly it also includes a focus on work experience / WRL. As one teacher explained "*It puts everything they are doing in context and it gives them some reason to do it instead of just coming in and doing a maths lesson. It also gives them ideas earlier...it helps them make the right choices earlier"* (Hatcher and Le Gallais, 2008, p59).

The project team has also recognised the need to ensure equality and diversity is embedded across the project, bringing together a group of experts across the strands of equality and diversity, education, careers and employers to support and advise the work of the project. We know that those from low socio-economic backgrounds are less likely to do A levels in science and maths (Royal Society, 2008) and that girls continue to be a minority in many STEM subjects, although they perform equally well at all levels (UKRC, 2009). WRL and work experience appear to be obvious positive hooks to raise the awareness of young people about opportunities in STEM careers. However in practice the organisation and low expectation of work experience for STEM placements generally and in particular relating to equality and diversity has presented some significant challenges to widening participation. In order to better understand the problems and to try and provide a positive way forward we have examined the literature, run two focus groups with practitioners and talked to a selection of our 'testbed' schools (schools closely linked to the STEM careers project). As Osgood et al (2005, p307) argue "*work experience placements have a potentially important role in providing pupils with broader, diverse and/or non-traditional experiences and ideas about the adult workplace.*" This aim fits very appropriately with the STEM Careers remit.

Review of Literature

We have identified four key themes within the project that required exploration within research literature. These themes have been explored in this paper particularly in relation to STEM subjects, but they have a wider application in all subject areas.

a) Gender - the under-representation of girls in STEM

Equal opportunities advice for schools (DfES, 2002) clearly mentions the need to counter gender stereotyping in placements including girls in engineering. Schools are required to check for overt and covert stereotyping, but the guidance also recognises that some placements where girls are isolated may need special preparation if they are to be successful. Subject choice continues to differ by gender and limit career choice in STEM based subjects for girls, particularly in vocational education, with work experience reinforcing those stereotypes (Hamilton, 2003). The extent of gender stereotyping in work experience was confirmed in a research project undertaken for the Equal Opportunities Commission in collaboration with the JIVE project and DfES (Francis et al, 2005) with areas of stereotypical experience also being 'classed.' The research covered 12 regional Learning and Skills Councils, 10 Education and Business Partnerships and 566 year 11 pupils. In addition data on 90,000 pupil placements was analysed. Girls predominantly chose hair and beauty, child care, and leisure and tourism, reflecting partly the five 'C's of their career choice (catering, caring, cashiering, clerical and cleaning) referred to by the Equality and Human Rights Commission (EHRC, 2009) and that reinforces the gender pay gap. When asked if they would have liked to try a non-traditional placement, more than a third of the girls said yes, with another third undecided, but only 15% said they had received advice or information about non-traditional placements. Reducing gender stereotyping was not seen as a priority and no targets were set. 'Choice' was interpreted in being the offer of an experience of the workplace based on individual student choice. This emphasis just reinforces the stereotype and fails to challenge the 'habitus' (Bourdieu, 1990) that limits life choices. In another study

completed by the Connexions Service in Cheshire and Warrington (reported in YWCA campaign, 2008) a high correlation was found between those in stereotypical placements going on to stereotypical jobs and training, and indeed that in some cases the work experience placements were acting as a 'placing agent', that is to say resulting in actual jobs. The study recommended that work experience placements should incorporate a "*broadening, to allow pupils to choose occupations of which they are unfamiliar*" (Connexions Cheshire & Warrington 2003 p81 in YWCA, 2008 Campaign briefing) a recommendation also made by Osgood et al (2006) in their study of gender stereotyping in work experience.

Within the JIVE project (2005) Sheffield Hallam University initiated an enhanced work experience scheme for girls, working with the local Education Business Partnership (EBP), local schools and employers. The scheme ran between 2006 and 2007 and included 37 girls, 7 schools and 30 employers (Brodie and Collins, 2006). A range of STEM related employers were involved from engineering, architecture, health laboratories, glassware and construction together with University departments. Extensive preparation and support was provided for employers, teachers, EBP and the girls themselves. The placements were designed to include a number of key components:

- girls who chose a traditional office/administration placement were interviewed to find out if they would be interested in a non-traditional placement.
- girls spent time with female role models working in STEM
- girls completed a comprehensive workbook that involved interviewing women in STEM and doing research on STEM careers
- on return to school the girls gave a presentation about their experience to their peers
- a final celebration event was held with employers, teachers, girls and their families where certificates were presented.

The indications from follow up enquires show there has been a positive impact on young women's career choices and a number are now considering or have embarked on STEM careers as a result of the experience. Employers were grateful for the support they were given in developing the placement programme and this proved to be an important aspect of the project. One of the schools involved had a high proportion of Muslim students and trying to ensure the placements were inclusive to all was another important aspect we worked on. Hatcher and Le Gallais (2008) also report on additional details that can make all the difference for young people from different faiths as well as any with disabilities, for instance family concerns about Muslim girls travelling alone. Once a sample programme had been developed and the potential benefits of offering a more varied and inspiring experience were explained, employers entered into the project with enthusiasm. The scheme won a national award from the Institute of Careers Guidance in 2005. The scheme is a 'gold standard' which demands significant investment, and this is often not sustainable for all placements. However, there are several aspects that can be replicated in general placements to improve practice, for instance including time with a diverse range of role models. The Diploma Support Programme (DCSF, 2009) has developed a guide to tackle gender stereotyping drawing on a range of case studies that follow similar approaches to Wider Horizons demonstrating that, with a focused approach and support from all involved parties, change can be achieved. Yet studies still confirm that finding non-traditional placements is generally a low priority where "*having everyone placed is sufficiently difficult whether placements are traditional or not*" (Hamilton, 2003, p2).

b) Socio-economic background and the influence on access to placements

As mentioned previously, work experience placements have been found to be 'classed' as well as gendered. The multiple effects on girls have some background in the curriculum with the vocational curriculum more strongly gendered than the academic. Middle class children studying an academic curriculum leading to university will have a different experience to

working class children who find themselves in clearly gendered and classed paths to work (Paechter, 2007). Hatcher and Le Gallais (2008) undertook a significant study of social inequality in work experience placements for the Esmée Fairburn Foundation. The study looked at five schools in one large urban area, with the schools chosen to provide a wide range of socio-economic intake. Questionnaires were completed by approximately 1000 Year 10 students just before or just after their work experience placement (4 schools before and one after) together with follow up interviews with 98 students. Teachers and the EBPs were also involved and those teachers responsible for work experience were interviewed. The study provided a large amount of rich data about the process and different management approaches to work experience that were having a direct impact on the life choices of young people.

> *"Our findings cumulatively demonstrate that these processes of individual choice and school policy combine in ways that reflect and reproduce clear patterns of social class differentiation. 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)*

What they also found was that where the school was more directive in its approach to work placements, a greater number of young people from working class backgrounds were able to access professional placements than those schools that gave less assistance to pupils. Where students were expected to find or choose their own placements from databases without support, they were either without support or dependant on family and friends of family for advice or suggestions and the procedure was often arbitrary e.g. a local shop and other manual placements. In contrast the students from the schools with a higher socio-economic background had social capital to draw on e.g. "my *dad's friend owns a business...my sister is the concert manager...the barrister was a friend of my dad*" (Hatcher and Le Gallais, 2008, p51). Parents' occupations differed considerably between the schools studied ranging from 0% in professional occupations in one school to 63% in another. The study also found that employers in professional organisations would also select schools with the higher socio-economic intake, reinforcing the challenges for those from the schools with a lower socio-economic intake. Other studies support these findings (Francis et al, 2005; Osgood et al, 2006) but the challenge to change practice on any major scale remains.

c) The academic / vocational split?

Having established that vocational subjects tend to be more gender stereotyped than academic subjects (Paechter, 2007), it is clear also that vocational and academic subjects are 'classed' (Paechter, 2007; Francis et al, 2005). In a report for the Edge Foundation (p iii) the question is asked "*Why is it so hard to make the case for practical and vocational education?*" The Foreword goes on to explain that in this country we see vocational education as being for the 'less able', while 'clever' people leave practical learning behind at primary school. Hatcher and Le Gallais found that the vocational courses that students were on limited the choice they had in work experience, in that a work placement in the subject area was part of the qualification. Students studying academic routes had no such limit to choice. On the other hand however, the introduction of Diplomas has included elements to target gender stereotyping, and while success has been very limited, schools have had the opportunity to arrange non-traditional placements within the Diploma. One school (DCSF, 2010i, p8) has adopted a focused approach to challenging stereotypes and has had success with both boys and girls in subject area and in raising aspirations. The Wider Horizons (Brodie and Collins, 2006) project was able to manipulate this requirement in obtaining a STEM placement for one young woman who was studying GCSE Catering. By placing her within a hospital kitchen, she met the requirement of her placement, but was also able to explore a wide range of STEM careers across the hospital in pathology and in building services. The perceived value of vocational qualifications continues to be an issue generally in raising aspirations for instance the BTEC national vocational qualifications may be worth 2

A-Levels, but less than half of all universities recognise them (EHRC, 2009). Following the progression of Diploma students will enable us to see if the bridge between academic and vocational has improved (Edge, 2009). The way to resolve this issue lies well beyond the scope of this paper and resides with better information, advice and guidance for all young people at key transition points (cegnet, 2009).

d) The organisation and management of work experience in the context of STEM.

Our experience in the development of Wider Horizons enabled us to see for ourselves the complexities in organising work experience in practice. The findings of Hatcher and Le Gallais (2008) confirm that the way schools organise their work experience can impact on the opportunities that young people have. The main methods of organising work experience placements are with a joint approach (schools working with a local agency) or a largely centralised approach. There are very few schools that take sole responsibility for placements (Hillage et al, 2001). A joint approach better enables schools to tailor placements to individual needs. Whichever approach is adopted, students will have some element of choice, usually in the form of a questionnaire or by searching a database. If schools with a lower socio-economic intake do not have knowledge of or access to professional high quality STEM placements, then the school needs to be pro-active in raising aspirations (Hatcher and Le Gallais, 2008). Work experience can also be seen as an unwelcome interruption to teaching (Ahier et al, 2000, p278) while there is pressure on improvement of academic results at all levels. For employers, there are often issues with the numbers of schools (and individuals) and time taken in hosting work experience. Our experience on Wider Horizons showed that with initial support and a structure to the placement, employers are willing to be involved and the KPMG survey (2010) reinforces the positive aspects of partnership with schools.

Examples of programmes that tackle gender stereotyping

We identified the need to identify a range of exemplar work experience schemes as part of the STEM careers project and build on the Wider Horizons scheme. We have worked with Connaught to design a more inclusive programme of work experience as expressed through the following quality standards:

- Recruiting & training a team of work experience ambassadors for each region
- Advertising and selecting students from partner schools
- Stipulating that schools should submit 50:50 male to female ratio of students
- Ensuring that all learners undertake a range of activities including practical as well as clerical tasks (regardless of gender)
- Providing ambassadors and learners with booklets and information to support them.

The programme was piloted in the Nottinghamshire area and then rolled out nationally and the team continued to support Connaught in its extension of the vision until the recent demise of the company.

Working in partnership with WISE, the UKRC and the RAF a scheme was developed for 24 girls based at RAF Cosford that has run successfully for two years. The RAF have a long history in developing work experience opportunities that include hands on and real live projects and have been examining initiatives to increase the numbers of girls interested in engineering. The scheme is offered on a national basis, publicised through the WISE website and through the RAF network. The RAF has invested in a range of different interventions to support the programme, such as an alternative style of ‘diary’ for the

learners to record their thoughts throughout the week. The programme has been designed to encourage girls to try something new and to step outside of their comfort zone. Training officers at RAF Cosford have all been specially briefed and are aware of the importance of using inclusive methods to encourage girls into non-traditional areas. (Further details are available on WISE website)

We know there are examples of good schemes elsewhere. The NHS Work Experience Guide is a comprehensive resource for placements in hospitals however we have had a number of reports that access to actual placements in different regions is problematic or only provided to children of employees.

STEM Careers Project Findings

The STEM careers Project set up two focus groups in 2009 (one in London and one in Sheffield) with a range of practitioners involved with work experience placements on a regular basis. The purpose of the focus groups was to inform the project and exchange ideas that would help to promote stimulating STEM placements and increase awareness of STEM careers, while building on the knowledge already built up through the Wider Horizons work experience programme. A number of issues and barriers to STEM placements were identified including

- Health and safety risks often seen as barrier to hands on STEM or 'myths' relating to STEM placements.
- Strategic partnerships can stunt personalised placements and schools from working with a broader range of companies and schemes.
- Teachers blocking students going on placement as it clashes with school work.
- Ensuring that EBP or placing agency has accurate and wide range of job descriptions and tasks involved in placements.
- Teachers do not have the time to support WRL and STEM teachers are not often involved in work experience at all.
- Companies can be inundated with requests and often have ways of managing the process. One way of managing placements has been to limit placements to children of employees.

These findings generally confirmed the findings from previous research, including the issue of access to placements for those who do not have the 'capital' and the placing systems that can fail to provide a non-traditional placement.
Another list of suggestions to improve STEM work experience was developed including

- The need to include incentives such as accreditation - like CREST
- Better links to STEM subject heads need to be made in school
- Promotion of known stimulating STEM placements
- involve students in the planning of work placements
- Recruit STEM champions who can raise the profile of WRL and the benefits of work experience
- Tackle health and safety myths

Following on from the focus groups we have developed a check list to support the arrangement of STEM placements, written in the form of questions and answers to support good practice (STEM careers, 2010).

Survey in Test-bed Schools

The project has recruited six schools across England as test bed schools. The schools have been chosen to represent a range of backgrounds and types of schools with an interest in STEM subjects and careers. We have carried out attitude surveys with teachers, parents

and pupils at two stages of the project to better understand the complexities involved. From the first round of surveys with pupils (3279 students from Y9,Y10 and Y11) we found that while between a fifth and a third of young people were already interested in a STEM career, the gender split in those who wanted to find out more was significant (44% male compared to 25% female). Those students who had already taken part in a work experience placement did exhibit a greater interest in maths and science careers (STEM Careers, 2010). The parents' survey also indicated that work experience was the activity that most supported STEM careers awareness. While 98 members of staff were surveyed from the six schools, only a tenth had any link to work experience, supporting the issue about the lack of school involvement (Hatcher and Le Gallais, 2008).

The schools have also been involved with the project in different ways, from being part of Teacher TV programmes, trialling resources, taking part in Steering Group meetings and disseminating to others. We carried out a small piece of research with the schools in 2010 to find out more about the role of work experience within the test bed schools. The research consisted of a short survey / collection of background information about arrangements for work experience and access to STEM placements, followed up by a short telephone interview to explore particular features. The organisation of work experience varied between schools, but the majority drew on the services of their EBP in some form with one school relying on self arranged placements. The contrast between the level of placements achieved reinforced the findings of the Hatcher and Le Gallais (2008) study. One school (with lower than average Free School Meals[FSM] as an approximate measure of socio-economic intake) that relied primarily on the local EBP reported 40% unskilled placements, while another school (with higher than average FSM) that admitted it was hard to get professional placements reported that they avoided unskilled placements as far as possible. This second school commented

> "*Finding meaningful placements is becoming increasingly difficult. As the economic situation is squeezed, then so too are the number of placements on offer. Business and enterprise do not have the resources that they had 20 years ago, structured daily plans are becoming the exception rather than the norm and some firms simply want to use pupils as unpaid labour."*

The number of STEM placements reported ranged from 9% through to 40% with the reasoning behind the choices often relating to the region the schools were in, for example where engineering companies were in the locality or where the school was located close to a large company (including Landrover, Siemens, Nokia) that have structured and large work experience programmes. Another school relied on garages and construction firms, with the level of the placements likely to be at craft or technical level. The estimate of STEM placement numbers was not easy for the schools to assess, many were approximations since most placements are not defined in this way and some work experience coordinators did not have a clear understanding of STEM. Other research confirms the growing difficulty faced by schools in obtaining placements (b-live.com, 2007)

Gender stereotyping was seen to be evident with peer pressure leading boys to choose mechanics and girls to choose hairdressing. One school explained that challenging stereotypes was not part of the brief they had. The main purpose was to get as many placements as possible. While some schools relied on STEM companies for placements, the placements themselves appeared to be business / admin placements rather than the offer of a STEM experience. With Wider Horizons, we were able to expand the traditional placement to give a broader experience - this method of expanding placements appears to have potential. The subject specialism of the school was seen as influencing the type of placement with one school seeing a rise in technology placements linked to their own subject specialism. Most schools operated with a two week placement in Year 10, but one (an Academy) offered a self arranged placement in Year 12 together with a more flexible arrangement of a 3 week enrichment entitlement that could include work experience

placement (also included university visits and extended projects) with only those on vocational courses in year 10 going on work experience placements. The school acknowledged the academic pressure on releasing students for work experience with the senior management team suggesting the impact on learning is too great to allow whole year groups out of school at one time, supporting the findings of Ahier et al (2001).

Conclusions and Recommendations

There is a real opportunity to improve access to and progression in STEM subjects and careers through work experience. The evidence of the value of work experience to young people exists(IEBE, 2008) and there is evidence of positive commitment from employers (KPMG, 2010). However significant barriers remain and are growing within existing systems and practice, and these barriers limit access of young people to positive experiences. A number of the potential opportunities in STEM are not realised and this limits career choice at a critical stage. The STEM careers project has drawn on other research and our own to identify a number of recommendations that we believe could help to address the inequalities of access to STEM work experience. We also believe they would have a positive impact on all types of work experience.

Gender stereotyping

- Clear action is still needed to address stereotypes in STEM – one way to do this is by promotion of targeted well organised bespoke placements like the RAF scheme or Wider Horizons type placements. Alternatively a well designed inclusive scheme such as Connaught developed will tackle stereotypes and be mixed gender.
- There is a clear need for placement agencies and schools to become more involved in tackling gender stereotypes in STEM and elsewhere. If schools take a more hands on approach they can drive the agenda with the Agencies.
- Work experience placement schemes need to have preparation and support, access to female role models and follow up and evaluation.

Best Practice

- All work experience placements should include diverse role models wherever possible
- Placement agencies should ensure that for each stereotypical placement requested an alternative non traditional placement is offered
- Employers should be prepared to request a 50/50 gender split in STEM placements

Socio economic

- Schools need to be directive in the organisation of their work experience placements if they are to challenge the status quo and raise aspirations to promote technical and professional placements in STEM.
- Employers should not limit their activities to selective and high flying schools if they are serious about improving access to the professions and STEM in general.
- There is a need to challenge perceptions of young people and to provide support in non-traditional STEM placements drawing on the Wider Horizons example and others.
- All schools need access to a wide range of levels of placements and placement agencies should address this in their management arrangements, so that a balance of craft, technical and professional placements can be accessed by all young people. Unskilled placements need to be phased out - employers can be assisted in improving placements.
- The benefits of STEM work experience should be available to all students and not just those embarked on vocational education - employability skills are beneficial to all students.

Organisation and Management

- Our research suggests that a joint approach to work experience achieves the best access to STEM placements for all. Schools need to be involved because they know their students and their needs, while Agencies have access to a wide range of employers and the systems to access placements.
- Schools with a low socio-economic intake that rely on self arranged placements do not have access to STEM professional placements and as a consequence student aspirations and career choices are limited.
- STEM subject teachers need to be made aware of the value and significance of WRL to their own subjects.
- A number of STEM companies already offer general business admin placements that could provide added value with a STEM element structured in, for instance interviews with staff, a task or industrial tour.

Programmes

- There is a need to share the knowledge gained from examples of good practice. Schemes can be adapted for use with SME's, medium or large companies. The STEM Careers project can assist with this.
- The meaning of STEM is not well understood by many groups and individuals involved in work experience or WRL. The short guide produced by STEM careers has been well received, but more explanation about the type of work experience that fits with STEM is needed, along with the connections to STEM subjects.
- The key to a successful and engaging STEM placement is in having a structure. Our work with Wider Horizons, the RAF and Connaught has shown that once set in place, the management of placements for the employer should be positive. Many employers are already familiar with provision of university or graduate placements and school work experience placements can mirror this structure, but at a more appropriate level.

Other Issues and Finally

Companies and organisations that only offer placements to employee family members usually do this as a way of managing demand and resources involved in managing placements. If companies and organisations want to promote equal access for students then a different arrangement may be required, for example building a partnership with a school in a disadvantaged area that includes a range of aspects of engagement including work experience.

There is a need for more STEM companies large and small to become engaged with schools. Brokers are available to support this (DCSF, 2010i). There needs to be an active programme in all schools to address gender stereotyping in STEM subjects to raise awareness of the potential breadth of STEM careers and the potential in progressing in subjects post 16 whether through apprenticeships, technical or academic routes. This could and should be part of a school Gender Equality Duty Action Plan (EHRC, 2009).

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The Quick Guide for STEM Work Experience placements can be obtained by emailing info@careersinstem.co.uk