Nurturing engineering talent in the inner city

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Abstract

This paper analyses the findings of a study into the attitudes and experiences of engineering students and teachers on a 'vocational trajectory' from secondary Diploma level through vocational courses to a university Access course. The research took place in 2008-09 in a deprived inner city area of London. A baseline survey with nearly 100 participants sought the views of secondary and FE students as to learning preferences, attitudes to the subject, motivation, aspirations, and sources of support. Case study interviews with secondary, vocational and HE students nominated by their teachers as talented considered these issues in more depth. Engineering teachers at secondary, further education and higher education levels were interviewed regarding their understandings of talent in engineering and their approaches to nurturing such talent. The paper overviews the findings on these issues, and focuses in more depth on factors surrounding employer engagement. Organising work experience and access to professional engineers for secondary students did not appear to be problematical in the unusually well-resourced pilot year of the Diploma in Engineering. This situation contrasted markedly with the experiences of the further and higher education lecturers (especially the former), who reported considerable difficulties in arranging work placements and integrating employer-relevant content into their courses. All teachers and learners in the study emphasised their preferences for the practical, 'hands on' aspects of learning, including problem-based learning approaches.

Introduction

This paper forms one strand of a larger study commissioned by the Stephen Lawrence Charitable Trust into engineering education in an inner city area of London (Haight 2010). The purpose of the study was to examine issues in what might be termed a vocational trajectory in engineering education leading from the new secondary Diploma in Engineering through vocational courses in a further education college to a university Access course preparing students for undergraduate B.Eng degrees. The research sought to identify and analyse the views of educators as to how to define, recognise and nurture students' talent in engineering in institutions serving an area of socio-economic deprivation. It also examined the attitudes of students, both mainstream and those nominated by teachers as talented, regarding learning preferences, sources of motivation and support, aspirations and constraints. It considered issues of retention and transition from post-16 to higher education. This paper focuses on the research findings related to students' and educators' attitudes to learning and to employer engagement as an aspect of their engineering courses.

The study was conducted in a London further education college and a London university. The college is located in one of the five most deprived boroughs of London. The borough is among the twenty most deprived areas in England, according to the 2007 Index of Multiple

Deprivation. Fifty percent of its population was classed as White British and nearly 40% as belonging to ethnic minority groups, according to the 2001 census. Unemployment in the borough is higher than the London or national averages. Over 130 languages are spoken in the area, according to pupil survey data from 2008. The college is popular with its students and has forged an effective partnership with a local secondary school in the teaching of the Diploma in Engineering. It has a solid track record in preparing its students for occupations in engineering. A number of its more academically-minded students progress from its HE Access course to engineering degree programmes in London and other parts of England and the United Kingdom. The university is a post-1992 institution with a tradition of outreach to students from non-traditional backgrounds and a strong department of engineering.

For the purposes of the research, 'talent' is defined as high potential or performance relative to the normal intake of the school or college in question (rather than, for example, performance on standardised attainment or cognitive ability tests). In other words, the definition is norm-referenced rather than criteria-referenced, in line with recent educational policy and guidance on 'gifted and talented' learners in the UK (OFSTED 2009). The research was intentionally structured to be non-directive in its approach to this issue, inviting the engineering teachers to nominate the talented learners who were interviewed. The teachers' understandings of ability in their subject area and educational context formed a key aspect of the research focus and were discussed at length in the interview conversations. In other words, a grounded, contextualised, empirical and subject-specific view of talent was sought. The rationale for this is that both vocational learners and learners in socially deprived areas are likely to exhibit or discover their talents in different ways, and at different rates, than learners in more traditionally academic areas, or from more educationally privileged backgrounds (Ertl et al 2010:79; Panel on Fair Access to the Professions 2009a:133-4; Ford & Harris 1999:74-5). Teachers' experience of this is a vitally important source of knowledge in these relatively under-researched areas. In keeping with this principle, the university Access students were identified by their HE lecturers on the basis of showing notable potential. As it happened, each of the Access students had a history of dislocated or interrupted education.

Review of literature and policy

Between 1997 and 2010, New Labour's educational policy included a number of initiatives designed to improve educational opportunities for learners from socio-economically disadvantaged sections of society. Among these were:

- the 'gifted and talented' initiative, initially designed for deprived inner city areas (Excellence in Cities) and later rolled out to pockets of rural deprivation (Excellence Clusters) (House of Commons Children, Schools and Families Committee 2010)
- the Aim Higher programme, intended to encourage aspiration among post-16 learners who might otherwise leave education
- the Widening Participation agenda, designed to promote access to university among learners with no family tradition of higher education (David 2010).

Although not integrated into a unified, sequenced scheme, these programmes attempted to reach and nurture children and young people of potential from sectors of society that traditionally opted out of education early. Educational equity featured as a key plank of New Labour's 'New opportunities' policies to promote social mobility across society (HM Government 2009).

To progress this, efforts were made to dismantle the vocational–academic divide in the education system. Although the Tomlinson Report, with its much more comprehensive plans for this, was rejected, the *14-19 Education and Skills* White Paper (2005) set out proposals to improve secondary, post-16 and further education by allowing more personalisation at Key Stages 3 and 4, partly through introducing new Diplomas designed to integrate theoretical and applied knowledge (HM Government 2005). The flagship of these was the Diploma in Engineering (Hodgson and Spours 2010: 107). The potential for the Engineering Diploma to bridge the vocational–academic divide and to attract learners with aspirations to higher education and good career prospects appears to be borne out by an evaluation of the first year of the new award (Lynch et al 2010: 69, 93, 98).

To some extent this is due to the status of engineering as a domain encompassing both craft and professional occupations, with the potential, given the right structures, to allow transition from the one to the other. The 2009 Panel on Fair Access to the Professions noted with disappointment, however, that engineering was among the professions in which the proportion of entrants from wealthier-than-average backgrounds had increased in recent years, and recommended structural developments such as Apprenticeship Scholarships that would reverse this trend (Panel on Fair Access to the Professions 2009a: 83-5).

The status and perceptions of the engineering profession, and of engineering education, formed the subject of an investigation in 2009 by the House of Commons Select Committee on Innovation, Universities, Science and Skills, and an empirical study by the National Grid. The House of Commons Select Committee identified problems with shortages of engineering teachers, especially at secondary school level, and stressed the importance of good careers advice in helping to redress the well-known shortages of students in STEM subjects (House of Commons IUSS Committee 2009: 98).

The National Grid report found that among learners and their families, engineering is ‘almost an invisible industry,’ with jobs in engineering perceived to be ‘menial, dirty and about fixing things.’ In secondary schools, science and maths teachers were often embarrassed by their lack of knowledge about engineering and therefore unlikely to recommend it to students as a career option. This was not the case for further education teachers, however, who had often worked as engineers themselves and viewed the profession positively (National Grid 2009: 7, 11, 14). In the workplace, the ‘engineering apprentices interviewed had often chosen their career path despite discouragement from teachers and parents’ (p. 9). Where this was not the case, a ‘significant number’ of young engineers in the study had a family connection with engineering, and this had influenced their decision to enter this occupation (p. 14)

In terms of approaches to counter misconceptions and publicise engineering more effectively, both young people and teachers surveyed felt that meaningful work experience was likely to be the most effective measure (61% of young people and 97% of teachers felt this would have the most impact) (p. 20). Other measures young people would like included meeting engineers and visiting workplaces to see what they do. Teachers, however, were not enthusiastic about approaches that required co-ordination with business and industry, as their professional performance is judged on their students’ exam results, not on their

occupations after they leave school. They were sceptical about engineering businesses offering relevant work experience placements, feeling that these might 'turn out to involve sweeping up and making tea' (p. 22).

The FE teachers interviewed in the study were concerned about the lack of integration of the needs of industry into the school curriculum, 'feeling that maths and science teaching is geared for academic "stars", not for mainstream use'. The apprentices interviewed 'enjoyed the more practical maths and science activities', but found A-levels in these subjects too 'difficult and theoretical', and aimed at more academic students. '[T]hey say that they now enjoy using maths more at work than they did at school' and 'now understand the applications of these subjects and use them in a more meaningful and more practical way' (National Grid 2009: 14). These findings confirm a recent TLRP study into 'keeping open the door' into STEM subjects through encouraging post-16 mathematics. The study found positive results from connectionist teaching approaches (ie those drawing on learners' previous experience) and the use of applied mathematics syllabuses (Williams et al 2010: 111-12). The London Engineering Partnership (sponsored by the Royal Academy of Engineering) was set up to redress these deficits in the perceptions and professional formation of engineering through a focus on secondary education, including the new Diploma, and particularly the crucial transition from post-16 education to university (London Engineering Project 2010).

Given concerns to promote social justice in education, and the special status of engineering as a domain with potential to enhance social mobility, it is relevant to consider talented engineering students in inner city areas in light of the scholarship on 'gifted and talented' learners in general and vocational talent in particular. In the decade since the introduction of the gifted and talented agenda in Britain, understandings of 'giftedness' and 'talent' have evolved. Debates around the definitions of ability and the claims of social justice and educational inclusiveness have resulted in an emerging reformulation of these terms among specialists in the field (although evidence suggests that this view is patchy in the wider educational sector, and almost entirely unknown among the general public). This new understanding emphasises multiple types of ability, the importance of motivation and dispositional issues such as resilience, and 'mastery over mystery' (Blackwell et al 2007, Dweck 2006, Matthews and Folsom 2009). By 2009, the DCSF definition of 'talented' encompassed vocational ability: 'talent' is defined as 'ability or potential in one or more skills, whether artistic, sporting, interpersonal or vocational' (Ofsted 2009: 16).

Since the mid-20th century, there has been a strand of research and theory in gifted education that is amenable to the notion of vocational giftedness. In the 1960s, Taylor's Multiple Talent Theory emphasised the importance for all learners of world-of-work abilities such as productive thinking, foresight, planning, communication, decision-making and interpersonal skills (Taylor 1968, 1969). 'Mechanical ingenuity' was listed by Ogilvie in 1973 as one of the domains in which a child could demonstrate giftedness (Ogilvie 1973). Renzulli's research on high-achieving adults informed his 'three-ring model' in which creativity and 'task commitment' combine in complex ways with above-average intelligence to produce notable performance (Renzilli 1978). He also distinguishes between 'schoolhouse giftedness' and 'creative-productive giftedness' in real-world contexts, with the latter not necessarily related to academic achievement (Renzulli 2003). Sternberg's work over the past

several decades also explores the multi-variant aspects of 'giftedness' and its fit with real-world issues. His Triarchic Theory combines 'practical' with 'analytic' and 'creative' intelligence, defining 'practical intelligence' as problem-solving and the ability to actualise ideas and plans in the real world (Sternberg 1985). More recent features of Sternberg's work include his influential definition of giftedness as 'developing expertise' (Sternberg 2001). The theme of 'developing expertise' is extended in the work of Ericcson et al, whose rigorous empirical studies in a number of domains including music, sport, mathematics and chess led them to conclude that talented individuals require 10,000 hours of practice to become 'expert performers'. With the exception of certain physical traits such as height in sport, they argue that in virtually all domains deliberate, focused, intelligent practice is more important than innate ability in determining elite performance (Ericsson et al 2007).

More recently a number of studies have considered the issue of giftedness in vocational and world-of-work domains more explicitly. Shavinina has analysed the attitudes and attributes of high-achieving entrepreneurs and concludes that such individuals often show scant regard for traditional academic learning as children, do not perform particularly well in school, and have a marked preference for applied, real-world types of learning. They are characterised by a stubborn persistence, an ability to learn from mistakes, and the resilience to keep trying despite initial setbacks (Shavinina 2006 and 2008). Analysing the views of some 200 teachers of talented vocational learners, Clow and Haight (2007) hypothesise that vocational talent is more multi-faceted than traditional academic ability, integrating dispositional characteristics such as motivation and socio-affective skills as well as sensori-motor and cognitive capacities (Clow and Haight 2007).

A careful longitudinal cohort study by Stamm has demonstrated the presence of learners of exceptionally high intelligence (as indicated by standardised IQ tests) in the 'lower', vocational tiers of the Swiss school system (Stamm 2005). In Germany, where vocational subjects traditionally enjoy parity of esteem with academic subjects, research indicates that talented vocational learners are characterised not so much by high levels of intelligence or creativity as by high motivation in the areas of both learning and work, with those from less academic backgrounds favouring job-specific vocational courses especially highly (Manstetten 2000: 444-5; see also Bals 1999).

In the US, a small-scale qualitative study by Gentry et al has investigated the conditions which make for 'exemplary' education for the vocationally talented, and concluded that real-world learning experiences and engagement with competitions and trade associations in their field are key aspects of this provision (Gentry et al 2008). Recently the principle of more relevant vocational, technical and work-based education has received renewed attention in the UK. The educational charity Edge has mounted a national campaign to promote work-based learning, and partnered the Talent Foundation in formulating and publicising a new, employment-relevant model of ability: 'New Kinds of Smart' (Edge; Lucas 2007; see also Lucas et al 2010a, 2010b).

Research design and methodology

The research design for the fieldwork in this study involved:

- a preliminary online survey to establish an overview of the attributes and attitudes of engineering students in the further education college (sample size: 94)

- semi-structured interviews with engineering teachers and students in secondary, further and higher education (sample size: 10 students, 6 teachers).

Baseline survey

The baseline survey was conducted with secondary and FE students from the entire ability range and varying in age from 14 to over 40. It was completed on a voluntary basis by engineering students on the Diploma and a range of level 1, 2 and 3 vocational courses. Just over 100 participants completed the survey and 94 consented to their responses being used. The survey, administered via web-based survey software, aimed to establish a picture of how engineering students in the secondary and post-compulsory vocational phases prefer to learn, what they like and find helpful in their learning, and what their aspirations are for the future.

Interviews

Semi-structured interviews designed to elicit more detailed, case-study evidence were conducted with engineering students and teachers in secondary, further and higher education. The interviews focused on students' learning preferences and motivation, attitudes toward their subject, and experiences of support and constraints. Ten students were interviewed:

- 4 secondary students studying on the Diploma in Engineering
- 3 FE students undertaking Level 3 National Diploma courses in engineering
- 3 HE students studying for a university Access degree in engineering jointly delivered buy the college and university.

The interviews with teachers focused on ways of defining, recognising and supporting talented engineering students, and on issues of progression and transition between educational levels. Six teachers were interviewed:

- 1 secondary teacher on the Diploma in Engineering
- 3 FE engineering lecturers
- 2 university lecturers teaching on the Access course in engineering.

Informed consent was obtained from all participants and from the parents of learners under sixteen. The interviews were audio taped, with notes made from the recordings. Notes or transcripts from the interviews with adult participants were sent to them to allow them to check, amend or clarify their statements.

Generalisability

With a sample size of nearly 100, the baseline survey allows a relatively confident degree of generalisation, at least among learners in similar areas of urban disadvantage. The case study interviews involved much smaller samples, so generalisability is limited. It is likely that the teacher responses are representative of professional views to some degree, again at least in relation to institutions catering for a similar demographic. The results from the student interviews are specific to the individual participants, yet the congruence between the survey and interview findings in several key areas indicates that they might be taken as representative to some degree. In any case the richness of detail in their individual

responses adds depth and immediacy to a number of the issues emerging from the overall research picture.

Key findings from the baseline survey

The baseline survey revealed a strong preference among Diploma and post-16 vocational students for the practical, hands-on aspects of engineering. This was confirmed in the case-study interviews, where students reported, and teachers confirmed, that for both talented and mainstream students, learning is enhanced by synergies between the theoretical and practical aspects of their courses (see discussions of 'applied learning' by Harkin 2007 and Nuffield Review of 14-19 Education and Training 2008, 'practical learning' by Lewisham College−Edge c.2005, and 'authentic pedagogy' by Newman and Wehlage 1999). Among the surveyed students, writing, mathematics and theory were cited as the weakest and least favourite aspects of their learning.

The survey also discovered high levels of intrinsic motivation for studying engineering, with 90% of respondents giving reasons such as liking hands-on work, or liking to fix things, as their primary reason for studying the subject. This finding was also strongly substantiated by the interviews with both learners and teachers. The important role of family support and of teachers' help was also highlighted in the survey. Some students expressed a self-reliant attitude to learning, with nearly a quarter indicating the prime importance of their own efforts in getting to grips with difficult content.

Perhaps the most striking finding was the high level of university aspiration among apprentices. Forty-five percent of apprentices in the survey expressed a desire to attend university, which compares with the extremely low percentages (0 to 0.2%) found in a Skills Commission study from 2007-08 (Skills Commission 2009). Tentative explanations for this might include the fact that all the apprentices surveyed in the present study were already in further education (not the case in the Skills Commission study), and the influence and example of the further education lecturers, all of whom had worked as engineers, and one of whom had been an apprentice himself before undertaking higher education.

Ten percent of the survey respondents were female (all teenagers). The proportion indicating a preference to attend university (just over half) was in line with the overall responses for their age group in the sample. The ethnic group with the highest aspirations to attend university were students self-identifying as Black/Black British: African. This was followed, in descending order, by students who identified themselves as Other White, Black/Black British:Caribbean, and White British.

Key findings from the interviews

In order to structure discussions about what talent looks like in engineering students, Clow and Haight's KAMIS model of vocational talent (2007) was presented for critique to the secondary teacher and further education lecturers, and used to inform the interview questions with learners. The model posits five key areas of capability that combine in vocational talent:

- **K**nowledge and skills
- **A**utonomy
- sensori-**M**otor abilities

- **I**ntrinsic drive
- **S**ocio-affective skills (Clow and Haight 2007: 165-7).

Responses from both teachers and learners indicate that the key facet of this model is intrinsic drive, often expressed as 'an added keenness' and passion for the subject. These characteristics were evidenced in the learners, and confirmed by teachers, with levels of motivation, independence and resilience increasing through the age groups and educational levels.

Both learners and teachers confirmed the survey findings regarding the centrality of learning through the practical, hands-on aspects of engineering and the difficulties with mathematics and theory. Teaching that maximised the synergies between practice and theory appeared to be highly developed and greatly valued by learners in the Diploma and vocational courses in the FE college. Both teachers and learners in all phases found problem-based, collaborative learning to be the most effective way for students to master and apply challenging concepts, and reported wanting to use more of this.

Most, but not all, of the students interviewed had high levels of family support. A few did not. The two Access students without such support (both in their mid-twenties) showed considerable levels of independence and determination in pursuing their studies, and found help from their teachers and fellow students. Confirming the findings of the National Grid study (2009) a number of the students had family or friends in engineering. The students reiterated the high level of appreciation for teachers shown in the survey. As one secondary student said, 'The teachers teach you in ways that you understand.' Supportive personal relationships with teachers were also valued, especially among the FE vocational learners: 'They give you an encouraging word…If you [show them] your work they smile and say, "That's really nice, man."'

The teachers reported that constraining factors on students' success included financial difficulties, family issues, peer pressure, bullying, and 'gang worries'. Inflexible work patterns (in low-skilled jobs such as shelf-stacking), shortages of child-care, and inconsistencies in the application of Benefits rules (such as those for Job Seeker's Allowance) militate against retaining some talented learners.

The Diploma in Engineering appeared to be popular and working effectively in the partnership investigated in this study. The secondary and FE teachers had forged good communications and a good working relationship. (This was felt by the secondary teacher to be atypical among similar partnerships.) The collaboration between the college and secondary school allowed talented secondary students to be promoted into Level 2 vocational classes, an interesting development in terms of breaking down the 'academic–vocational divide'. The college had benefited from a £1 million refurbishment of teaching premises. However, there appeared to be issues of equity between the secondary school and the FE college in the distribution of other supporting facilities from the London Engineering Project, such as an e-mentoring scheme, enrichment events and access to outside speakers, with the college able to access fewer of these.

The university Access course was more problematical. Both students and lecturers would have liked more 'hands on,' problem-based and collaborative learning opportunities. The university lecturers felt that it was too hurried and crammed with content at the expense of laying a solid foundation of basic principles including mathematics. They felt that the promise of adequate preparation for 'an intense BEng course' in one year gave Access students 'false hopes.' From their end, the FE lecturers would have liked to increase the amount of mathematics on the course. They also reported that students arrived at the college ill-prepared to begin post-16 work at the appropriate level, with weaknesses in numeracy and literacy needing to be remediated before students could tackle core engineering content.

Employment issues and employer engagement

What the learners said

Work-related issues were investigated in the baseline survey and also emerged as an important theme in the case study interviews. The survey included questions about students' reasons for studying engineering. They were invited to rank a given set of options to explain their decision to undertake their courses. These options included both intrinsic motivators such as 'I like the problem-solving' and 'I like knowing how things work and being able to fix them' and extrinsic motivators such as 'Someone in my family is in engineering' and 'It will help me get a job.' A striking proportion of learners ranked intrinsic motivators most highly, with 90% of the students (n = 85) giving a first or second ranking to one of these. Thirty-five percent of students (n = 33) gave an extrinsic motivator a first or second ranking (out of seven possible options). Percentages do not tally to 100 because of the structure of the question and the analysis, which includes both first- and second-ranked responses. The question format did not require respondents to rank every option, so a number of students only selected three or four options for ranking.

Of the extrinsic motivators, the most highly ranked was 'It will help me get a job', with 33% of students (n = 17) who selected this option ranking it as first or second most important. However, a slightly higher proportion, 37% (n = 18) ranked this as the least or second least important option. As a comparator, twice as many students (n = 36) selected the intrinsic motivator 'I like practical, hands-on work' as their first or second-ranked preference.

Interestingly, the highest rankings for 'It will help me get a job' were with the 14-16 age group, with 41% of students who selected this option giving it a first or second ranking (n = 9). One-third of the 17-19 year-olds who selected the option (n = 6) and the same proportion of 20-29 year-olds (n = 2) ranked it first or second. None of the 17 respondents aged 30 or over gave this option a high ranking, and of the six respondents who selected it at all, four ranked it as of low importance (fifth, sixth or seventh out of the seven options). There may be a number of reasons for these results, including the possibility that the older students were already employed and taking the courses (which included classes such as motorcycle maintenance) out of personal interest. It is also possible that, in this area of high unemployment, the students least experienced in job seeking (ie the youngest) were the most optimistic about the possibility of finding engineering-related employment. The university Access students did not participate in the online survey as it was administered on a day they did not attend the college, but interview statements from their FE tutors suggest

that these students would rank employability highly, given their decision to commit significant time and resources to pursuing engineering degrees.

Most of the interviewed secondary and FE students intended to pursue their studies to university level, and most, but not all, could see themselves working in some area of engineering in the future. (In the following discussion, the names of all interview participants have been changed to ensure anonymity.) Carlos, a responsible 15-year-old whose family had emigrated from a Latin American country when he was 3, wanted to be an entrepreneur running his own engineering business. Tommy, a Black classmate of the same age, wanted to be an automotive engineer, and Robert, of Black African heritage, thought he might study to be a doctor or an engineer. Charmaine, White British and the only girl in the sample, appeared to be the secondary student least decided on her future occupation (perhaps a realistic attitude for a 15-year-old). She was uncertain about whether to try for engineering (mechanical or electrical), dance or possibly hairdressing.

The FE students, in their older teens and all studying for the BTEC Level 3 National Diploma, were more focused on their future plans. Mike, the oldest at 19, had lived and studied in his birthplace of Jamaica until 2 years ago. He wanted to 'go to university and study computer system engineering.' He was starting to look seriously at universities and expressed some apprehension about finding sufficient information to make a good decision. This was not true of Antony, also of Black Caribbean heritage, who had attended a local secondary school. Antony's father had 'some experience in the sector' and Antony had also benefitted from university outreach and enrichment programmes in secondary school. He was already thinking beyond a first degree to postgraduate study in engineering. He wanted 'to go to university and to do …a degree in electrical and electronics engineering, and after that … I maybe want to go and get a Masters, and then maybe go into industry or maybe teaching, and maybe later on, go for a PhD.' Paul, 17 and White, particularly liked the computer-related aspects of his course. He was 'thinking of working and going to university at the same time, but I'm . . . not really 100% sure that's what I want to do.'

The three HE Access students all had conditional places on engineering courses at good universities: University College London, Queen Mary's London, and the University of Edinburgh. They were primarily focused on acquitting themselves well in their Access courses and moving on to university. Scott, in his early twenties and of mixed White-British–Black Caribbean heritage, reported his long-term plans to be 'research and development, and maybe my own lab'. Kate, who was in her mid-twenties and already had five years' experience working as a sound engineer, was about to embark on a five-year degree programme at Edinburgh. She wasn't sure what she would do after university. 'I've got to decide where my strengths lie and what I enjoy. If they meet in the right place, that's where I'm going to go.' Luke, a recent immigrant from Eritrea, was not able to formulate clear plans for his future after university. He was keen to acquire work experience during his studies, and was disappointed that neither the university nor the college had been able to find him a placement.

What the teachers said

Secondary and further education teachers

In the main, the engineering teachers described a rather dispiriting picture of employer engagement, that is perhaps not surprising in a deprived inner-city area. The exception to this is the report from Tariq, the secondary teacher on the Engineering Diploma. Unusually for secondary teachers on the Engineering Diploma, Tariq was an engineering graduate who had ten years' experience working in industry before he trained as a teacher. He was closely involved in the development work for the pilot year of the Diploma, led by the London Engineering Project (LEP 2010). These factors meant that his students benefited from the exceptional levels of time, resources and expertise lavished on the development of the new award.

Tariq described a range of enrichment opportunities and support mechanisms available to his students through the London Engineering Project, including 'special residentials… weekends and trips, or one-day outings' that might involve 'a Royal Navy [event]…helicopter rides and boat rides.' This support also involved visits to universities and workplaces, and access to a number of inspirational speakers from industry and the professional ranks of engineering. Tariq felt that 'the best thing they've done in the engineering consortium is that they've got a set of speakers. All you have to do is drop your name to them, give them a time and a day and they'll provide a speaker to come into school…There's no way we can talk about all these specialist areas, but the people who work in these areas love their job and so are the best person to talk about [it]. So these motivational speakers come into schools from all areas of engineering, and you can't beat that.'

His students were also able to take advantage of an electronic mentoring website sponsored by the LEP in partnership with the Brightside Trust. Two of the four talented secondary students interviewed mentioned the e-mentoring website as a key source of information and guidance. As Tommy said, 'I don't have any family in engineering, but there's this Internet site thingy which gets you to talk to actual engineers. They've actually worked in the engineering profession.'

The secondary school also appeared to have reasonably good access to employers. Tariq described the secondary students' 'two or three week work experience'. In organizing these, he tried to 'liaise with employers and tell them, "Can you please put [the students] in different areas, so they get exposed to more, rather than just seeing one discipline." And the employers are aware of that.'

Tariq's experiences contrasted markedly with those of the three further education lecturers interviewed. Ed, a lecturer who taught motorcycle maintenance and a range of other vocational engineering courses, regretted that work experience is 'ever so difficult to organise, and expensive. So [apart from limited pre-entry programmes for students with learning disabilities] we're not able to do it.' His colleague, Richard, who co-ordinated the college's input on the Diploma in Engineering and also taught BTEC and National Diploma courses, expressed considerable frustration about this. When asked what would best promote occupational success for students, he replied, 'We have very little contact with employers, which is an absolute travesty. I think that would be the big thing that would really help: work experience, contacts with these employers, …definitely employer

engagement. At the moment we're very poor at it. There are engineering companies in the area, but we haven't engaged with them and we don't have time to do this.'

Richard was acutely aware that courses could be configured to maximize synergies between education and employers. 'There's the scope and range in courses to pick units, and I would bend over backwards to gear [our courses] toward any company that took an interest, to ensure that the students were going down a route that the company wanted them to go down. It's the one thing that really pains me. I can't get my students at the end of a course and say "Here's an option: that you can go and work for these people, or they may be interested in you." There's nothing, nothing at all.' He added, 'There are some specific courses that are set up to be 'employer-responsive', but I think every course should be employer-responsive because that, at the end of the day, **is** the goal.'

Perhaps the variance in the school's and college's experiences reflects the difference between compulsory-phase, school-mediated 'work experience' and the type of placements that might be closer to real world-of-work experiences, which may well be more difficult and time-consuming to organise. Ed mentioned the difficulty of restoring relationships with employers who had had bad experiences of taking FE students on placements, even if they came from a different college. When asked about the constraints to organising more effective outreach to employers, Richard pointed to a lack of time and staffing (the college's Advertising and Business Development Unit, for example, was staffed at only a 1.5 full time equivalent). This reflects the FE sector's well-known problems with underfunding, but the contrast with the well-resourced pilot year of the Diploma is striking.

Ed understood employers' reluctance to offer work experience to students, observing that hard-pressed businesses 'haven't got the time or the money to spare having to nurture someone for a couple of weeks [on a work placement]. It gets in the way of bottom-line profits.' He added rather wistfully, 'I've often thought it would be nice if the government could set up some small, genuine real businesses, non-profit-making businesses [where] you could spend the entire year having a turnover of [students] working…some real hands-on stuff and some real business.' Richard also yearned to see better links with employers. 'For example, the BTEC National Diploma has a year-long project. Some employer involvement [in this] would be fantastic.'

Despite the difficulties in establishing successful connections with employers, inside the college the lecturers were conscientious in inculcating work-readiness in their students. Punctuality and regular attendance were heavily emphasised in the college, as part of a range of self-presentation skills that would make students attractive to employers. Ed was proud that students on his motorcycle courses sometimes got part-time jobs while still at college. 'And all of those without exception have then been transferred eventually into full-time, and those have all been permanent jobs. Some have been in jobs now for close on 6 years.' Phil emphasised to his Access students the importance in interviews of 'doing your homework, and coming across confidently in what you do, and what you've done.' Not all students were fortunate enough to finish their engineering studies to a level that allowed them to get jobs in engineering. Both Phil and Richard reported that, due to difficult personal or financial circumstances, or the complications of the benefits system, some students with very high potential had to drop out of college and 'end up in some silly little

job somewhere'. One of Richard's most promising students had been sent to a Young Offenders' Unit after being convicted of a stabbing.

Employability was also emphasised by Tariq, who had a decade's experience of working as a software designer for machine tools and heavy engineering equipment. He was keen to inculcate in his students both interpersonal skills, such as teamwork, and industry standards, remarking 'I work to British standards and that way, when [my students] go out into the real world, they know what's required of them.' Tariq, Richard, Phil and Ed had all had experience working in industry before becoming teachers. (Phil had entered the motor industry as an engineering apprentice.) This allowed these teachers to model the role of 'engineer' to their students for whom, in some cases, the school or college was the most stable and secure aspect of their lives.

Higher education teachers

The two university lecturers interviewed in the study expressed different views on employer engagement and issues of employability. Jean, responsible for her department's collaboration in the college's Access programme, felt that having more industrial contacts and placements would be helpful for the students. She agreed with the FE lecturers' views that organizing such contacts is prohibitively time-consuming, and felt that 'it would be good to have a liaison officer' appointed by the university, someone 'qualified in the area [who] could build up a rapport and contacts in industry. It's a different social network to academic staff.' Her colleague David had greater involvement with the university's Higher National Diploma and Higher National Certificate programmes, and felt that the university's links to employers worked quite effectively. In these programmes, 'the employers quite often come in and we talk to them' and students establish informal networks to help each other with employment opportunities.

David's students on the HND specialised in a variety of types of engineering, and 'the able ones will go on to the degree.' When David was asked whether there was a correlation between ability and types of engineering, he replied, 'I'm not aware of any correlation, but that doesn't mean to say that there isn't any. The more able tend to become chartered engineers quite quickly, so they tend to be working further away from the tools, shall we say.'

He felt the key attributes that made students attractive to employers were their ability to 'fit in and relate to others' as well as having a good technical and academic background. In his experience, the detailed transcript that HND students left their course with was attractive to employers as it gave them 'an idea of how well the student performs overall, and which areas are their strengths and weaknesses. With a degree you just get a classification.' Jean felt that students' projects were of key interest to employers: 'that's what defines them as a student'. Also important are the ability to work independently, to be honest about their work 'and [about] how they've got their answers, especially what they do when they hit an obstacle.'

Both HE lecturers also mentioned self-presentation issues such as interview skills and appropriate attire as being important to a student's employability, as well as the ability to produce reports in correct English.

Conclusion

This study examined a snapshot of three points on what might be termed a 'vocational trajectory' in engineering education, analysing learners' and teachers' perspectives on the Diploma in Engineering, a range of vocational courses at levels 1 to 3, and an HE Access course preparing students for B.Eng degrees. It took place during the pilot year of the Diploma in Engineering, in an exemplary partnership between a secondary school and a further education college. Although sited in a deprived inner-city area, the partnership benefited from its location in London, home of the London Engineering Partnership, and from exceptional levels of funding and expertise used to 'seed' the new award and revitalise engineering education.

It is widely recognised that further education institutions and vocational courses serve as collecting and remediating points for learners from dislocated and disadvantaged backgrounds. The importance of the sector in reaching such students was emphasised by the 2009 Panel on Fair Access to the Professions. In its collaborations with both the secondary school and the university, the further education college in this study was pivotal. The learners, both those in the mainstream and those identified as talented, were overwhelmingly 'hungry for hands-on' (to use Tariq's phrase), expressing preferences for practical, collaborative, and real-world types of learning. The teachers in the Diploma partnership and on the vocational courses supplied this type of learning, drawing on their own experiences of employment in the engineering industry. The teachers on the HE Access course struggled with an over-crowded syllabus and lack of time to bring students up to the required level of preparedness for degree study.

In terms of external enrichment and support, the secondary students appeared to enjoy a better deal than the FE students. This was no doubt due in part to the unusual level of funding, effort and attention surrounding the development and launch of the Diploma in Engineering. The FE students did not appear to have access to the e-mentoring provision or to the extensive menu of events, visits and speakers described by Tariq. Although the London Engineering Project includes two FE colleges among its partner institutions, and invites FE students to activities (Hawthorne 2010), much of its provision appears to be focused toward A-level rather than vocational students. It is likely that logistical difficulties – and the constraints of an underfunded sector – make it difficult for FE students and lecturers to take advantage of these opportunities. Despite its importance in the education of young people from disadvantaged backgrounds, and its potential to foster social mobility, further education remains something of a 'Cinderella sector'.

The London Engineering Project has identified the critical importance of the transition from post-16 to university education. This transition is particularly crucial, and particularly challenging, for vocational learners seeking to enter higher education via Access courses. For this reason, the reports of the higher education lecturers involved in preparing Access students for university degree programmes in engineering are alarming. Both academics felt that a one-year Access course provided insufficient time for students to prepare effectively for 'an intense BEng course'. Despite the best efforts of the college lecturers, many vocational students arrived on the Access course with insufficient knowledge of maths and

underpinning theory. In turn, the college lecturers reported, students arrived at the college with insufficient levels in numeracy and literacy.

As these reports illustrate, in areas of social and educational disadvantage, learners' gaps and deficits in mastering content can be shunted through the phases with successive teachers struggling to remediate them. For many learners Access courses such as the one in this study, where vocational pathways are intended to catch up to academic pathways, are tipping points. Talented learners such as Kate or Scott can, with determination and the right support, redress earlier deficits and catch up. Yet, as David reported, there are a number of learners of good potential who are lost. This illustrates the limitations of some widening participation efforts which purport to provide equal preparation, but instead supply too little, too late, and offer students 'false hopes'. It is to be hoped that the 'pupil premium' slated to be introduced by the Coalition government is targeted at preventing educational gaps being entrenched in the earliest phases, so that greater equity in preparedness for higher-level work is established.

An area identified for improvement by both teachers and learners was the lack of effective involvement with industry and employers. Richard summed up the further education lecturers' frustration with the difficulties involved in organising links with employers, calling it 'an absolute travesty' and 'the one thing that really pains me.' While Tariq, the secondary teacher, did not identify problems in this area, this may be unusual, due possibly to his close involvement with the piloting of the Diploma. It might be conjectured that many secondary schools experience these issues also. Jean, the university lecturer, also raised the problem, suggesting that a university liaison officer be specifically dedicated to forging relationships between the university and the engineering sector. From the students' perspective Luke expressed disappointment that neither the college nor the university had been able to organise a placement for him.

The power of authentic pedagogy and applied learning, cited by virtually all the students and teachers interviewed, would take on new momentum if there were actual businesses and business problems involved. Given the retrenchment currently facing all educational sectors, however, it is unlikely that the constraints surrounding effective employer-educator partnerships will decrease. An increased use of problem-based learning and business simulations may at least provide adequate substitutes to redress students' lack of more direct contact with employers.

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