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Inspiring young people to engage in engineering education: The Aston University Engineering Academy Birmingham

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Abstract:

This paper initially reports concerns about the falling interest in engineering and mathematical disciplines and looks at some of the reasons for this. It then discusses the aims of the Engineering Diploma – a qualification for 14-19 year olds in the UK - and the pedagogical research that that has informed the design and development. The paper highlights the key learning theories that support the delivery of this qualification and provides an example of how this pedagogy has been applied effectively through the curriculum partnership that has been developed between a consortium of schools in the Birmingham local authority, Aston University and employers. It establishes the importance of aligning the curriculum and articulating clear engineering progression routes from the age of fourteen to enable young people to be inspired and motivated towards careers in engineering. The paper presents the view of parents, teachers and pupils involved with the Diploma, during the first year, and the way in which the partnership is informing future developments in the delivery of engineering curriculum within the region. The success of this regional partnership model has resulted in the Department of Children, Schools and Families agreeing to fund the development of the Aston University Engineering Academy Birmingham. This is a school for 14-19 year olds that will open in 2012 on the Aston Science Park adjacent to the University. The final part of the paper looks at the benefits to the young local engineers of this initiative.

Introduction

It has been recognised that there are unprecedented global challenges for engineering education across the world. In the UK it is recognised that education and the industrial sector are simply unable to inspire and motivate sufficient young people to enter engineering programmes and future predictions show a significant fall in meeting business and industrial need (RAEng, 2007). There is a growing requirement for engineers and scientists. In the UK, despite an increase in the numbers of students entering higher education, the numbers entering engineering programmes overall has remained static and in some areas such as electrical engineering the numbers entering higher education declined by about 45% between 2001 and 2006. The situation is hindered by a major shortage of mathematics and physics teachers in secondary schools, despite many initiatives by the Training and Development Agency for Schools (TDA, 2010). A further challenge comes from the fact that the nature of engineering jobs is rapidly changing but in many higher education departments the programmes are not always evolving as rapidly (RAEng, 2007).

The National Curriculum in the UK has never included engineering specifically within its framework, although there have been elements within the science curriculum. In the 14-16 and post 16 curriculum some education providers offer optional study programmes such as GCSE Engineering or BTEC First in Engineering, however this offer is not widespread and for most 14-16 year olds access to Engineering is very limited. The main way in which learners have been introduced to engineering and enthused by the options in engineering have been through bolted on extras, such as after school clubs, F1 in schools, fantasy football and energy challenges. Opportunities have been provided for immersion in engineering through summer school days and residential experiences through Universities and organisations such as the Smallpiece Trust and Royal Academy of Engineering. In addition learners in both primary and secondary schools have been exposed to visits, and science and

engineering ambassadors from local industry have provided mentoring. Despite all of these initiatives the needs of UK industry for engineers at apprenticeship, graduate and postgraduate level are unable to be met.

In response to the publication of the White paper '14-19 Education and Skills' in February 2005 (DCSF, 2005) the Government has developed a new suite of qualifications for 14-19 year old learners called Diploma. The Engineering Diploma was one of the first to be offered and when successfully completed the Higher Engineering Diploma will provide the equivalent of 7 GCSEs (at grades A* - C) and the Advanced Engineering Diploma the equivalent of 3.5 A levels (420 UCAS points). These equivalences have been determined by an independent panel reporting to QCDA and form part of the strategy of bringing all accredited qualifications together on a common Qualification and Curriculum Framework. The first national pilots commenced in September 2008. About 2,500 learners completed the first year of a Diploma in Engineering in July 2009. Approximately 4,500 started the first year of a Diploma in Engineering in September 2009. The majority of learners studying the Diploma in Engineering are at Higher Level, and Engineering has the largest number of learners at Advanced Level of all the Diplomas (IET, 2009).

The Diploma is an optional programme of study; for 14-16 year old learners it is taken alongside a compulsory 'core' which includes English, Mathematics, Science, ICT, etc; for post 16 learners it may form part or all of the learner's curriculum. The current government intention is that by 2013 all young people will be entitled to study the Engineering Diploma whether or not this is delivered by their 'home' study provider. The next section looks briefly at the content, structure and pedagogy behind the design and delivery of these new qualifications.

Pedagogy of the Engineering Diploma

The Engineering Diploma has been designed by a Diploma Development Partnership (DDP) of employers and educators to ensure that there is a direct and powerful link between the knowledge taught and its application in the workplace. It has been designed to demonstrate and engage young people in the excitement of working in engineering, blending academic and practical aspects. The Diploma in Engineering has three areas of learning: Principal, Additional and/or Specialist, and Generic.

Principal Learning

A variety of units are taught, for example:

- The Engineering World: the importance and impact of engineering on our lives.
- Discovered Engineering Technology: basic engineering principles.
- Engineering the Future: what makes innovations succeed, how new materials contribute to design, how to develop and launch new ideas.
- Engineering experience in the work place: learners have to complete a minimum of 10 days in industry.

Additional and/or Specialist Learning

Learners can choose options to meet their own interests from a range of accredited courses made available to them, for example engineering topics such as biomedical engineering, transport, or renewable, etc. or select subjects from language, humanities or art options.

Generic Learning

This covers the applied learning of English, Mathematics and Information Technology to demonstrate how learners use these in engineering and in everyday contexts. There is a mandatory emphasis on communication, personal, professional and employability skills.

Learners complete an extended project that develops and demonstrates skills such as independent research, analysis and synthesis, evaluation, time and project management. This can be within the field of engineering or follow another line of enquiry that is of interest to them.

Design and Delivery of the Diploma

The Diploma is designed to broaden a young person's horizons by offering them a wide range of next-

step options. The purpose of Diploma learning is to motivate and engage the young person in a subject area for which they have a passion and aptitude and to broaden that interest. The delivery should enable them to develop their knowledge, skills and understanding about the social, economic and environmental aspects that apply to working in the engineering sector. In order to create these coherent learning environments that seamlessly blend the acquisition of knowledge and application to current issues and problems, the DDPs have drawn on learning theories associated with the recognition of the different type of skills and knowledge that people will need for economic development in the future (Pring *et al*., 2009). The Diploma has been proactively designed to enable young engineers to experience education and work at various levels and to participate in the creation and utilisation of knowledge through a 'community of practice' (Wenger and Snyder, 2000). The Diploma has three overarching aims, which are mirrored in all national and international policy documents on qualifications (Young, 2003)

- Clarity of learning outcomes and what can be achieved
- There should be seamless progression in both vertical and horizontal directions
- Maximum access, flexibility across different educational and work settings.

To deliver this new qualification successfully requires a new approach by education staff, employers and learners. In developing this model it is important that there is a full exchange about the design and selection of an individual's specialist options. In addition expectations and progression routes need to be clearly articulated. (Higham *et al*., 2005). Learning, teaching and assessment needs to be designed to be applied to 'real world environments' (RWEs) and problems and over half of the Principal Learning should be centered on current industrial practice and challenges. Most importantly the purpose of the task in which the learner is asked to apply their knowledge, skills and understanding must be relevant to industry (QCA, 2006). This focus on industrial knowledge and challenges provides incredible (emotive term? subjective?) motivation and purpose to an individual.

'Young people need to see the point of it all. They especially want practical application (not just practical work). This might be learning about a job, developing personal skills, experiencing team work or having a subject explained to them in terms of its contemporary context' (Lord, 2006*).*

The need for this type of applied learning draws on both experiential learning (Kolb, 1984 and Boud and Miller, 1996) in which an individual learns most effectively by planning, doing, reflecting and reviewing and situated learning (Lave and Wenger, 1991) whereby tasks are authentic and the individual is able to engage with a variety of others who work in related industrial and learning environments. An effective pedagogy for the Diploma is a balanced approach in which 'learner factors, teaching context, learning processes and outcomes support one another in an aligned and constructive manner' (Biggs, 1999).

This section has briefly highlighted some of the key learning theories that have underpinned the concept of the Engineering Diploma and focused on aspects that need to be considered for successful design, delivery and partnership working. The next section reports the progress in terms of recruitment and progression from the first years of the Engineering Diploma and looks in detail at the teachers, learners, parents and supporters from one consortium.

A curriculum partnership between employers, schools, colleges and universities

National success for the inception of Engineering Diploma has been mixed. It had been hoped that initial recruitment would bring in excess of 12,000 learners in the first year of delivery. The confirmed learner numbers for consortia have been variable but overall do not exceed 7,000. The nature of consortia and modes of delivery vary widely. The statistics on progress of learners on these early programmes have been well summarized by the review of the first year of the Engineering Diploma carried out by the Institution of Engineering and Technology (IET, 2009). Some groups have not had schemes in place to enable young people to proceed to the next level and in other cases the assessments have been too challenging for the participants. This section provides the insight into a partnership model of development and delivery developed at the Frankley City Learning Centre in the South West Area Network of Birmingham that has proved to be highly successful for the learners. The partnership established between five schools, employers, colleges, the local authority and local universities succeeded in attracting 33 young people of which 14 were girls in September 2008. Currently all learners are on track to achieve the equivalent of seven GCSEs between A* and C. At this stage over half of the learners are enthusiastic about continuing to the Advanced Level and all remain positive about the experience. The next section reports early findings from a study that has

been commissioned by Birmingham Local Authority to review the Diploma roll out in the LA including Engineering. Early feedback about the successes and challenges is helping to inform future development. It has been structured round informal feedback acquired through semi-structured focus groups and interviews with learners, teachers and senior leaders and managers.

What the students liked

The overall response from the learners when asked if they were enjoying their course was yes. They highlighted how much they enjoyed the practical and applied aspects of the programme. They were motivated by the fact that they were trusted to use complex and modern equipment and learn skills that they could understand were directly relevant in the workplace and this developed their interest and achievement. They contrasted their learning on the Diploma programme with that in much of their other curriculum, which they saw as being full of text books, readings and endless questions to answer.

They saw the approach and delivery methods used by the staff on the Diploma as being different from those in school. They felt they were treated in a more mature manner as the following comments indicate:

- 'They treat you like an adult'
- 'You get treated as your own person'
- 'You can actually have a laugh with the teachers about anything'
- 'They trust us to do more adult things here than the school does'
- 'In school they are always watching you, seeing what you are doing but here they just generally let you get on and ask for help if you need it and not always checking up on you all the time'
- 'There is more trust; they treat us more like adults than children at school'

What the teachers highlighted

The teachers exhibited high levels of enthusiasm for the Engineering Diploma and the support that they had received from senior managers and the other partners, particularly the universities, and employers in supporting the promotion, design and delivery of the curriculum. One CEO from a small wind turbine manufacturer had installed a small turbine on site and run a session on the design, construction and running of such a device. Similarly the educational partners had supported parent-briefing days, provided tours and insight sessions and recruited undergraduates to mentor the learners. The scheme appointed a coordinator from the start that enabled the early negotiation of a common timetable and buy in and support from the Heads of the Schools and Local Authority. Specific remarks from teachers include the following:

- 'The Diploma provides a great deal of freedom for you to develop the curriculum to meet pupil needs'
- 'Without doubt it's one of the best courses that I have taught. In terms of preparing learners for the adult world, this does it in a way that GCSEs and 'A' levels, well they just don't do it.'
- 'The relationships are different between the adults and the learners. The type of work they're engaged in, the way they go about it, the way teaching happens. The whole thing is different'
- 'The Diploma is providing the scope for us to take some of the best practice within the school'
- 'It is important to scaffold the Principal Learning. We need to teach the students how to investigate, how to work in teams and how to research.'

What the senior leaders and managers thought

The headteachers from each of the participating schools had a well-established partnership prior to their decision to co-deliver the Engineering Diploma through the Frankley City Learning Centre. This ensured trust, that co-operation and finance did not become issues and that the learners, and the benefits to them, were at the centre of development and decision-making. The comments below indicate the benefits that the senior leaders observed for the young people:

- 'It is a different way of learning for the learners'
- 'It's giving them responsibility for their own learning, open ended tasks where they can develop their own interest'
- 'It is all down to independence and teamwork'
- 'For most learners, their level of confidence, their sense of what they're capable of, their ability to take ownership and responsibility for their work has increased'
- 'Some learners have found the programme highly motivational'

What the parents thought

There was a high level of parent involvement, commitment and expectation as might be expected from a group that elect to take a new qualification. To date they indicate contentment with the progress that is being made reflected by the following comments:

- '…….'s personal confidence and engagement with the subject has really grown'
- 'This is exactly what she wants to be doing in the future'
- 'Her development in one year has been incredible'

However, there are some other comments that indicate some lack of clarity concerning learners' options in the future:

- 'we are not clear what opportunities are available for her to continue in this direction'

It is interesting that the final remark brings to the fore the importance of communicating clear progression routes and options.

The challenges

The challenge and measure of success of the Diplomas lies in the strength of the links that are created between the various partners, the schools, the colleges, the employers, the learners, the teachers, parents and the universities. That is the success with which the consortia manage to create a *'Community of Practice*' (Wenger and Snyder, 2000). This is extremely important in providing the appropriate scaffolding for their learning experience and clear messages on progression routes which can be directly to work, to an apprenticeship, to further or higher education and that no route is closed.

The overall findings of the preliminary review suggest that this consortium has made a very good start in implementing the Diploma. This was assisted by the fact that this was an existing partnership group of schools that already used the Frankley Learning Centre and the working relationships were enhanced by bringing in the employers and other educational providers. The individual schools demonstrate an enthusiasm for the qualification and the positive impact that it has on teaching, learning and young people's personal development. It can be seen to be providing a new and invigorating approach to 14-19 education, combining the knowledge of academic qualifications with the relevant focus of vocational ones, which appear to be benefiting both teachers and learners. Planning is already underway for the Advanced Diploma that will include even greater input from the employers and university partners and at present over 20 young people have expressed interest in this route that will commence in September 2010.

What next? The creation of the Aston University Engineering Academy Birmingham

To build on the collaborative partnership working that has been established in Birmingham to deliver the Engineering Diploma in partnership with employers, universities and the local education authority Aston University, supported by Birmingham City Council, is intending to create an Engineering Academy for 14 - 19 year olds, adjacent to Aston University in the centre of Birmingham. Backed and supported by the Baker-Dearing Educational Trust it is one of the group of technical schools that are being proposed to enable greater numbers of engineering opportunities to be created. The DCSF has given financial support to the project and the new school is expected to open in September 2012. The 600 strong Academy will admit learners based on aptitude in engineering and related disciplines. Curriculum areas available will include Engineering, Mathematics, and Physics, Information Technology and Business with all learners studying a European language or Mandarin. The unique emphasis on Engineering will be enhanced by strong links with local and national industrial and commercial partners. These partners will provide the necessary work experience and sponsorship that will support and enhance the academic curriculum. The Engineering Academy will seek to become a local centre of excellence and act as a hub for other secondary schools in the region engaged in delivering the engineering diploma lines.

As the principal sponsor, Aston University has one of its four main faculties focused on the development of engineering and applied disciplines. A research-intensive University that is currently 13th in the UK leagues tables it offers the majority of degree programmes with links to industry (over 70% of undergraduate students engage in a placement year). Aston is keen to ensure that from age 14 young people can see clear progression routes into university, college or through apprenticeships to employment. Its leadership will ensure that creativity, innovation and problem-based and enquiry-

led learning feature strongly within the curriculum delivery. The industrial partners linked to the lead sponsor will also ensure that the Academy has an employer-led and supported curriculum in place. The partners have close links with AimHigher and various school partnerships providing glimmer days, master classes and mentoring support. They will also have close links with Pupil Connect who will be able to identify appropriate students for the Academy and support students who are newly arrived in the City. The Academy will provide exciting opportunities for collaboration between the universities, colleges of Further Education, Work-Based Learning Providers, secondary schools and the multiplicity of engineering and skill-based companies within the West Midlands Area. Apprenticeships will be available to the students at age 14 and 16. The industrial partners and associates will support these programmes.

Part of the Academy's brief will be to lead in supporting Teacher Training across the specialised sector relevant to the College. The lead sponsor is currently developing a range of QTS qualifications with Newman University College in Birmingham to provide undergraduates and teachers with higher-level skills and qualifications in this area. Staff appointed to the Academy will be a mixture of QTS and those recruited directly from industries that can be trained as teachers through the Graduate and Registered Teacher Training Programmes. Qualifications available will include first and higher degrees. It is the intention to explore new and short-term contracts with industrial partners to promote passion, excitement and relevance into the curriculum and student experience.

The Academy will be an imaginative, innovative and dynamic part of the Transforming Education within Birmingham. The transformational agenda recognises that in the rapidly changing economic and social priorities of Birmingham there is an increasing need for wider educational and training opportunities for those young people looking for an opportunity to work in, or gain experience in, engineering and allied vocational areas.

Available data highlights a shortfall in skilled employees who can replace an ageing workforce within engineering and manufacturing. Data also indicates that there is a renaissance within small engineering industries and design engineering. A key focus of the new Engineering Academy will be to motivate and inspire young people into careers in engineering and allied industries.

Because of the unique business of its lead sponsor (Aston University) the Academy will be well placed to plan effective links and routes into higher education for its student body. The University has internationally recognised provision in engineering and allied vocational areas. It also has superb links with business and industry and happily works in partnership with further education and other providers across the area.

Summary

The paper has sought to highlight the challenges and opportunities that engineering educators and employers face in ensuring that sufficient young people are inspired to both train and work as engineers. It has focused on the creation and success of a pilot scheme run in the south west of Birmingham with its radical pedagogy and strategy for partnership that has both listened to existing research on how young people learn and attempted to apply it to practice. The key criteria for success have been on ensuring that experiential, situational and connective learning has been understood and implemented, capitalizing on the education professionals' expertise and sector knowledge of the employers. The experiences of the young people, parents, teachers and heads involved to date have been overwhelmingly positive and the model is now being extended within the development of the university led engineering academy.

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